CONTENTS

ARCE-PÉREZ, ROBERTO—Psephenopalpus browni, a new genus and species of Psepheninae (Coleoptera: Byrrhoidea: Psephenidae) from Mexico ................................................................. 90

BUFFINGTON, MATTHEW L.—Taxonomic notes on Nordlandiella Diaz and Ganaspidiun Weld (Hymenoptera: Figitidae: Eucoilinae) ................................................................. 192

CHAMORRO-LACAYO, MARIA LOURDES and RALPH W. HOLZENTHAL—Seven new species of Polyplectropus Ulmer (Trichoptera: Polycentropodidae) from Costa Rica ............ 202

CHEN, XUEXIN, J. B. WHITFIELD, and JUNHUA HE—Revision of the subfamily Cardiochilinae (Hymenoptera: Braconidae) in China. I. The genera Austerocardiochiles Dangerfield, Austin, and Whitfield, Eurycardiochiles Dangerfield, Austin, and Whitfield and Psilommiscits Enderlein ........................................................................................................... 35

COLEMAN, B. K., J. K. BISSELL, J. CIHA, P. MacKEGAN, AND J. B. KEIPER—The moths (Lepidoptera) and associated flora of Kelleys Island, Lake Erie .................................................................................................................. 217

FAVRET, COLIN, JOHN F. TOOKER, and LAWRENCE M. HANKS—Iowana frisoni Hottes (Hemiptera: Aphididae) redescribed, with notes on its biology ........................................ 26

FOOTE, B. A.—Acalyptrate Diptera associated with stands of Carex laevis and C. stricta (Cyperaceae) in northeastern Ohio ................................................................. 166

FLORES-MENDOZA, CARMEN, E. L. PEYTON, RICHARD C. WILKERSON, and RICARDO LOURENÇO de OLIVEIRA—Anopheles (Nyssorhynchus) konderi Galvão and Damasceno: Neotype designation and resurrection from synonymy with Anopheles (Nyssorhynchus) oswaldoi (Peryassu) (Diptera: Culicidae) ........................................................................................................... 118

GAGNÉ, RAYMOND J. and CELIA dr. MEDINA—A new species of Procontarinia (Diptera: Cecidomyiidae), an important new pest of mango in the Philippines .................................................................................................................. 19

GRANARA de WILLINK, MARIA CRISTINA and DOUGLASS R. MILLER—Two new species of mealybugs (Hemiptera: Coccoidea: Pseudococcidae) from Patagonia, Argentina ................................................................. 140

HEIDEMAA, MIKK and ALEXEY ZINOVJEV—Dolerus amatolii, n. sp., the first Palearctic member of the subgenus Neodolerus Goulet (Hymenoptera: Tenthredinidae) ........................................................................................................... 159

HOLZENTHAL, RALPH W.—Three new species of Chilean caddisflies (Insecta: Trichoptera) .................................................................................................................. 110

(Continued on back cover)
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A NEW SPECIES OF *MOMPHA HÜBNER* (LEPIDOPTERA: COLEOPHORIDAE: MOMPHINAE) FROM BUTTONBUSH (*CEPHALANTHUS OCCIDENTALIS* L.) WITH DESCRIPTIONS OF THE EARLY STAGES

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Abstract.—*Mompha solomoni*, n. sp., is described from moths reared from buttonbush, *Cephalanthus occidentalis* L. (Rubiaceae). Spring generations bore in young terminals of this plant species; summer and fall generations mine leaves. The egg, larval, pupal, and adult stages of the new species are described and illustrated. *Mompha solomoni* appears to be related to other Rubiaceae-feeding momphines, including the previously described and widely distributed *Mompha cephalonthiella* (Chambers), which also feeds on buttonbush. Life history data are provided for both of these *Cephalanthus*-feeding momphines. Parasites of *Mompha solomoni* include members of the genera *Pholetesor* Mason (Braconidae), *Bracon* F. (Braconidae), and *Euderus* Haliday (Eulophidae).

Key Words: leafmining, stem-mining, flagging, Rubiaceae

In North America the Momphinae contain 37 described species and at least as many unrecognized species (Hodges et al. 1983, Hodges 1992, Poole and Gentili 1996, Koster 2002). While all momphines in North America are thought to share the habit of being internal feeders, larvae show a remarkably diverse range of feeding niches—tunneling in stems, forming galls, mining leaves, and boring through flowers and fruits. Larvae of the species described here feed in young shoots, killing the terminal portion in spring and early summer broods, but in subsequent broods the larvae mine leaves. Because *Mompha solomoni* appears to be related to a second buttonbush-leafminer, *Mompha cephalonthiella* (Chambers), we include considerable information on this species as well.

Preparations of all life stages were examined with dissecting, compound, and scanning electron microscopes. *The Methuen Handbook of Colour* (Kornerup and Wanscher 1978) was used as a color standard for the description of the adult. Genitalia were dissected as described by Clarke (1941), except that mercurochrome and chlorazol black were used as stains. All measurements were made with a calibrated ocular micrometer.

Ultrastructural studies were performed with a Hitachi HH-S-2R scanning electron microscope at an accelerating voltage of 20kV. For SEM examination, immature specimens were fixed in 3% glutaraldehyde in 0.1M potassium phosphate buffer (pH 7.3), rinsed in phosphate buffer (pH 7.3),
and postfixed in 2% osmium tetroxide in 0.1M potassium phosphate (pH 7.3). After dehydration in ethyl alcohol, specimens were critical point dried, mounted on stubs with silver paint and paste, and coated with gold-palladium.

Life history data for both *Mompha* species were obtained from laboratory rearings at ambient temperatures. James D. Solomon studied a population of the new *Mompha* species in the Delta Experimental Forest in Stoneville, Washington Co., MS. Casual observations were made on the population beginning in 1980. In 1986, collections of 10–20 shoots were made once or twice weekly in April, May, and June. Half of these were dissected to monitor larval development; larvae in the other half of the shoots were held in plastic Petri dishes over filter paper in ventilated jars to study pupation habits, parasitoids, and adult emergence. Additional collections were made by James Solomon in 1987 and 1988, mostly in the Delta National Forest, Issaquena and Sharkey cos., MS, but a few additional samples were secured from Chicot Co., AR, and East Carroll Parish, LA.

Leafmines of *Mompha cephalonthiella* were taken at Nicholas along the Feather River, Sutter Co., CA. in September 1981 (DLW Lot: 81J6) and October 1982 (DLW Lot: 82K5); from along the American River, 4.8 km E of Auburn, El Dorado Co., CA. in September 1982 (DLW Lot: 82J12); Mansfield, Tolland Co., CT (DLW Lot: 89H49) in August 1989; and Sand Bar State Park, Chittenden Co., VT, in June 1987 (DLW Lot: 87F59). Collections of *Mompha solomoni* were made from Tolland and Windham cos., CT, in August, September, and October 1989 (DLW Lots: 89H49, 89J6, 89J14, 89K37, and 89K62); Monroe Co., FL in March, 1991 (DLW Lot: 91C14); Anne Arundel Co., MD. August 2002 (DLW Lot: 2002H28); and from Oak Point, Hammond, Saint Lawrence Co., NY. in August 1988 (DLW Lot: 88H45). In each case, leaves with actively feeding larvae were placed in a plastic bag with lightly moistened paper toweling and were monitored daily for adult emergences. Rearing lots were held outdoors during the winter months. Larvae and pupae for subsequent study were killed in boiling water and transferred to 70% ethyl alcohol.

Specimen repositories are as follows: BL = private collection of Bernard Landry, Geneve, Switzerland; CNC = Canadian National Collection, Ottawa; ECK = private collection of Edward C. Knudson, Houston, TX; GB = private collection of George Balogh, Portage, MI; INHS = Illinois Natural History Survey, Champaign; JRW = private collection of James R. Wiker, Athens, IL; MEM = Mississippi Entomological Museum, Mississippi State; SK = private collection of Sjaak Koster, Leiden, Netherlands; UCONN = University of Connecticut Insect Collection, Storrs; USNM = National Museum of Natural History, Smithsonian Institution, Washington DC. In the material examined a "u" indicates a specimen could not be reliably sexed.

*Mompha solomoni* Wagner, Adamski, and Brown, new species (Figs. 1, 3, 4, 7, 9–18, 20–40, 43–46, 49)

Diagnosis.—In the discal area of the forewing, *M. solomoni* (Fig. 1) possesses an elongate black dash that is usually joined with a white dash along its anterior margin; neither marking is well developed in *M. cephalonthiella* (Fig. 2). The forewing of *M. cephalonthiella* is usually suffused with appreciably more coffee-brown and steely blue scales than that of *M. solomoni*. In *M. solomoni* the dark spot along forewing costa at ⅔ is often strongly oblique and directed toward the outer edge of the wing or tornus; in *M. cephalonthiella* this mark is often less oblique and directed toward the tornus or inner margin. Between the dark costal spots at ⅔ and ¾, *M. cephalonthiella* has a patch of tan scales; this area is mostly gray or brown in *M. solomoni*. In *M. cephalonthiella* the 1 or 2 white flagellomeres that cap the antenna are preceded by a series of five dark flagellomeres; in *M. solo-
moni an additional pale ring interrupts the preapical run of dark flagellomeres.

Genitalia of the two species (Figs. 3–8) are very different in both sexes. In male M. solomoni (Fig. 3) the anellus has distolateral, curved arms (that are absent in M. cephalonthiella) (Fig. 5); the ventral margin of the valva is entire (notched in M. cephalonthiella); and the sacculus is narrow and acuminate (wide and erose in M. cephalonthiella). In female M. solomoni (Fig. 7), the invaginated pockets at the postero-lateral corners of tergum VII are much less prominent than in M. cephalonthiella (Fig. 8): also, in M. solomoni, the posterior projections of the lamella postvaginalis are subtriangular, separated by a deep, V-shaped cleft, and preceded by a short, spinothickening located medially at the anterior end of the cleft (projections rounded, separated by a shallow cleft, and preceded by a long, sclerotinized thickening at the anterior end of cleft in M. cephalonthiella); furthermore, both of the sclerotized plates associated with the signa are small and crescent shaped in M. solomoni (one or both of the plates are large and round and completely surround the signum in M. cephalonthiella); and finally, a lamella antevaginalis is present in M. solomoni, but absent in M. cephalonthiella. The mandibular setae of the larvae differ: in M. solomoni the setae are of unequal length (Fig. 18), whereas those of M. cephalonthiella are of similar length (Fig. 19).

Description.—Head: Base of proboscis and frons shiny white, vertex yellowish white, becoming gray to brownish gray posteriorly on occiput, a line of sparse brown scales extend from middle of eye anteriorly to base of antenna, brown scales becoming dense and covering dorsal surface of scape; distal portion of antenna with six white rings of one flagellomere each, each white ring separated by three brown flagellomeres, except terminal two rings separated by two brown flagellomeres; labial palpus with first segment and medial surface of second segment white, lateral surface of second segment brown basally, intermixed with variable number of white scales apically, third segment brown, intermixed with white scales, with indistinct white bands at middle and apex.

Thorax: Mesonotum and tegula dark brownish gray, some scales with gray tips, tegula with apex gray to orange gray; foreleg with femur laterally brownish gray basally, white to gray apically, medially white except for brownish-gray posterior margin, tibia laterally dark brownish gray, medially dark brownish gray on margins, white in middle, tarsomeres laterally dark brownish gray with white apices, medially white mixed with scattered brownish-gray scales: midleg with femur white except for scattered dark brownish-gray scales on postero-lateral margin, tibia laterally dark brownish gray intermixed with white to form diagonal bands at base, middle, and apex, tarsomeres dark brownish gray laterally, first, second, fourth, and fifth tarsomeres with
white apices; hindleg with femur white, tibia dark brownish gray with broad white diagonal bands of setiform scales near base, middle, and apex, tarsus dark brownish gray with tarsomere 5 and apices of tarsomeres 1–4 white. Forewing (Fig. 1): Length: 3–3.9 mm (16 males), 2.7–3.8 mm (13 females); ground color dark gray to
brownish gray, scales with white apices except on basal ⅔ of costa; scale tufts at ⅓ and ⅔, each with 5–6 rows of erect scales, basal tuft dark brown, outer tuft white basally, dark brown apically, line of sparse dark brown scales extending apically for short distance from middle of basal tuft, line of dense dark brown scales extending along Rs from anteropapalor of each tuft, basal radial line bordered by narrow white to orange white line on costal side; costa with dark brown strigulae at about ⅓, ⅔, and ¾; apical strigula connecting with apical radial line near its midlength, areas between basal radial line and dorsum and on each side of apical radial line suffused with light brown, small white spot posterior to end of apical radial line; dark brown apical strigula, radial line, and apical margin of pale brown spot forming acutely angled indistinct patch contrasting with band of gray scales with white tips on apical end of wing; margin of wing membrane with line of dark brown scales, expanded to form a spot opposite apical end of radial line in some specimens; apical fringe scales with long white bases from apex to midwing, pale gray from midwing to tornus. Under-side dark grayish brown, some specimens with white near midwing. Hindwing: Uniformly grayish brown on both surfaces. 

**Abdomen:** Grayish brown dorsally, white to orange white ventrally.

**Male genitalia** (Fig. 3, 4, 9–14): Uncus separated from tegumen by membranous line, dorsally rounded at base, ventrally and apically flattened, apex acuminate, laterally with flattened setae at base (Figs. 9–10); anellus divided into two flat plates with curved apicolateral arm; aedeagus tubular with subparallel sides, cornuti absent (Fig. 4); valva (Figs. 3, 12–14) apically cleft for ⅓ length of costa, apex rounded in dorsal division, acute in ventral division (sacculus), costa lightly sclerotized, densely setose apically, sacculus folded dorsally for ⅔ length of valva, fold narrowed apically, apical third of ventral division more heavily sclerotized than basal ⅔, sacculus and apical third of ventral division sparsely setose (five preparations examined).

**Female genitalia** (Fig. 7): Tergum VIII weakly sclerotized with line of sparse setae on posterior margin; papillae anales facing laterally, sparsely setose; lamella postvaginalis with two subtriangular projections separated posteriorly by V-shaped cleft, anterior end of the cleft with a small dentate projection. Lamella antevaginalis forming projecting rim over ostium bursae; ductus bursae heavily sclerotized near ostium bursae; corpus bursae with two bladelike signa connected to crescent-shaped plates (four preparations examined).

Holotype.—♂. Mississippian, Washington Co., Stoneville, May 1987, J. D. Solomon, *ex Cephalanthus occidentalis*, twig borer. Data are given as on labels except for bracketed information. Deposited in USNM.


D. R. Davis (6 ♂, 11 ♀, 1 u) (USNM). ILLINOIS: Clark Co., Rocky Branch Preserve, 3 July 1995, T. Harrison, coll. as adult at UV light (1 ♀) (INHS); Coles Co., Lake View Park, T12N, R9E, NW ¼ Sec. 24, 6 Jul. 1996, T. Harrison, coll. as adult at UV light (1 ♂) (INHS), 21 Jun. 1997, T. Harrison, coll. as adult at UV light (1 ♀) (INHS); Mason Co., 1.5 mi. west of Topeka along C & IM RR in wetland. T22N, R8W.

Other material examined.—UNITED STATES: OHIO: Hamilton Co., Cincinnati, Ferris Woods, mines 14 Sep. 1912, B. 134, A. Braun (3 ♂, 1 ♀, 1 u) (USNM).

Distribution.—Mompha solomoni has been found from Illinois, Michigan, southern Québec south to Florida and Texas (Fig. 51).

Etymology.—Mompha solomoni is named for James D. Solomon, an entomologist retired from the US Forest Service Southern Hardwoods Laboratory in Stoneville, MS, who first brought our attention to this species.

Egg (Figs. 45, 46).—Size 0.13–0.17 × 0.22–0.29 mm (n = 5). Glassy, iridescent, oval to round and somewhat flattened, with small nipplelike projection to one side from which numerous small ridges radiate.

 Larva (Figs. 15–18, 20–31).—Length 3.8–5.6 mm (n = 8). Body cream, with slightly raised dome-shaped spinules; thoracic legs and pinacula not strongly pigmented. Head (Figs. 20–26): Hypognathous; generally smooth, with some shallow ridges; frons wide, AF1 not observed, F1 and AF2 short, C1 much longer than C2 long; labrum shallowly notched; P1, A3, and S2 about equal in length, longest setae on head; A2 slightly longer than adfrontal setae, A1 intermediate in length; L1 posterior to A3, short; three mid-dorsal setae very reduced; six stellmata arranged in a C-shaped configuration (Fig. 23); antenna as in Fig. 24; mandible (Fig. 18) broad, with several rounded dentitions; two unequal setae on outer surface; labium (Figs. 21, 26) with two-segmented palpus, spinneret parallel sided; maxilla prominent (Fig. 25). Prothorax (Figs. 15, 22): L-group bisetose, L2 and L1 in straight line parallel to median longitudinal axis; L1 about twice length of L2; shield with SD1 3–4 times longer than XD2 and SD2; SD2 posterior to SD1; XD1 about ¾ length of SD1; D2 about 4 times length of D1; T2 and T3 with D2 about 2–3 times longer than D1. D2 in vertical line with SD2; SD1 about 2½ times length of SD2; L2 and L3 subequal in length. L1 about two times longer than L2 and L3; SV1 slightly posterior to L3; all thoracic legs with a pair of broad bladelike setae ventrolateral of terminal claw (Fig. 27). Abdomen (Figs. 16, 17, 28, 30, 31): Prolegs on A3–A6 and A10 of equal size; crochets in a circle, uniserial and uniordinal (Fig. 29); A1–A7 with D2 about 2–2.5 times longer than D1; SD1 slightly anterior to D1, SD1 above spiracle; L2 posteriad of SD1. L1 about 2.5 times length of L2; L3 subequal to L1; A3–A6 with SV-group trisetose; SV-group unisetose on A1–A2 and A7–A10; A8 with L-group trisetose. L1, L3, SV1, and V1 roughly in line; A9 with 6 setae, all setae in line; A10 with SD1 about twice the length of SD2 and about three times the length of D1 and D2: L-group trisetose.

Pupa (Figs. 32–40).—Elongate oval in dorsal and ventral view. widest and slightly depressed dorsally in thoracic region; epicranial suture present; anterior tentorial pits visible (Figs. 33, 35); frontoclypeal suture absent and mandibular and/or piliferal area demarcated as a subovate disk (Figs. 33, 35); caudal portion of antennae adjacent on meson, not separating distally to expose metathoracic legs as in most other Gelechioidea (Mosher 1916); axillary tubercle (= mesothoracic spiracle) covered with honeycomb latticework (Fig. 36); midabdominal segments with mediolateral excavations (Figs. 32, 37, 38); cremaster with one pair of dorsal setae and three pairs of ventrolateral setae (Figs. 39, 40).

**Biology**

Although the new species of *Mompha* was initially identified as *M. cephalonthiella*, differences in the biologies between these two *Cephalanthus*-feeding morphines suggested otherwise. *Mompha solomoni* is a borer in young shoots of *Cephalanthus occidentalis* early in the growing season but later switches to leafmining. *M. cephalonthiella* is believed only to mine leaves of *C. occidentalis*. The life histories of the two species, as far as known, are given below.
Shoot-mining broods of *Mompha solomoni*.—Early instar larvae tunnel in new shoots below the shoot apex in the first week of April in MS. Only tender, succulent new growth is utilized. The larval tunnel meanders about the shoot axis, eventually killing the new growth. Initially, the larva may proceed upward to the meristem, but eventually the tunnel is directed toward the base of the new shoot, where the stem is hollowed out and filled with dark brown frass (Fig. 43). Gallery lengths range from 15 to 55 mm (n = 60). Of 100+ dissected shoots, about 90% were occupied by a sin-
Figs. 32–34. Pupa of *Mompha solomoni* (montages at ca. ×65). 32, Dorsal. 33, Ventral. 34, Lateral.

gle larva, the remaining shoots by two larvae: exit holes (Fig. 42) on a few shoots suggest that as many as three larvae mature in a single twig. Prepupal larvae exited mined shoots from 16 April to 7 May in MS.

Infested shoots wilt, droop, and within a few days begin to blacken (Fig. 41). Slight swellings, just below the discolored portion of the shoot, may be evident (Fig. 41). The majority of the damaged shoots wither and break away from the plant, although a few swell and split about the gallery and remain on the plant as evidence of previous attack. Wilting and dying shoots were most conspicuous from 17 April to 15 May (MS). Damage ranged from none to severe, and on some plants, larvae killed every new shoot.

A few infested shoots were found in June, indicating that at least a partial second stem-mining generation is produced. Be-
cause succulent, thick-stemmed new growth of *Cephalanthus* is much reduced after the spring flush, only a small percentage of the population is able to locate suitable stem tissue for larval development during the summer and fall months; most individuals develop as leafminers through the rest of the growing season (see below).

Natural enemies issued from about 10% of the field-collected stem-mining larvae; these included three braconids (*Pholetesor* Mason, *Bracon* F. and an undescribed spe-
cies of microgastrine) and an eulophid of the genus Eudorus Haliday. Previously recorded hosts for Pholetesor were all leaf-mining or shelter-feeding Lepidoptera (Whitfield and Wagner 1988). Predaceous thrips were recovered from five dissected shoots that contained dead Mompha larvae.

Leafmining broods of Mompha solomonii.—Oviposition on leaves occurs alongside the midrib or a lateral vein on the leaf underside, often under tufts of axillary hairs (n = 35). The egg texture is remarkably similar to that of the leaf surface (Figs. 45, 46). The first instar tunnels from the egg directly into the leaf blade and, in so doing, fills the eggshell with brown or black frass. The mine begins as a hair-thin sinuous track that is extended to the upper leaf surface, such that the mine is visible from both above and below (Figs. 47, 48). Some early instar mines are tortuously contorted and appear blotch-like. Early mines start adjacent to the midrib (30/54) or a secondary vein (14/54)—none were noted in the lamina away from larger veins. The larva may exit the first mine, after tunneling for 5–10 mm, and begin a new serpentine mine elsewhere, again alongside the midrib or a lateral vein. Secondary mines occasionally enter vascular tissue, staining it dark brown or black. Mine exit and reentry occurs through the lower leaf surface. Larvae feed ventral side up.

After the larva has tunneled for a distance of 10–20 mm, either a new mine is formed or the initial track is enlarged abruptly into a full depth blotch (Fig. 48). All green tissue is removed from within the blotch; in contrast to early mines, the blotch mine is often made along the leaf edge or apex (Fig. 48). The blotch mine is mostly free of frass; the sparse frass is scattered about the mine, staining both leaf surfaces, with most accumulating toward the base or one side of the mine. The mature mine is oval to round with an irregular outline and measures 10–15 × 22–31 mm (n = 5). The pale yellow larva turns smoky red prior to exiting the mine (Fig. 49) to pupate in leaf litter (n = 20).

The white cocoon (Fig. 50) is spun between overlapping leaves or in litter below the hostplant. The pupal stage during spring and summer generations lasts 12 to 14 days (n = 30). The majority of fall-collected larvae in New England yielded pupae that held over through the winter months, although fall-emerging adults sometimes issued from our collections made in August and as late as early September. An August lot of larvae from Hammond, NY, failed to hatch by late October, when they were placed outdoors; this same collection produced adults in May 1989. A large collection made at Thompson, CT, in early September yielded no adults that fall but more than 50 adults the following spring. Yet, another collection made the previous day nearby in Hampton, CT, produced nearly 20 adults over the ensuing five weeks (into mid October).

Our observations indicate that M. solomonii is multivoltine, reaching greatest abundance in late summer and early fall. Larvae and mines can be exceedingly common from August onwards, with a dozen or more mines occurring in a single leaf.

Mompha cephalonthiella.—Details of the life history are mostly unstudied. So far the species is only known to mine leaves. Five later instar mines are all full-depth mines, formed along a leaf margin (6–12 × 12–16 mm). In appearance the mines resemble those of M. solomonii (e.g., the two mines on the left hand side of Fig. 48). As in M. solomonii the mine is mostly free of frass. Both Frank Hsu (pers. comm.) and DLW have found abandoned Mompha mines in Cephalanthus in California, where Mompha cephalonthiella is common, with a shield-like oval cut-out at one end of the mine, reminiscent of a mine of Antispila Hübner (Heliozelidae).

Presumably these ovals are fashioned by the prepupal larva and are used to construct a cocoon, just as they are in the Heliozelidae. In Florida and the Neotropics an undescribed Mompha mines in Hamelia pat-
Figs. 41-44. Life history of *Mompha solomoni*. 41. Flagging leaves on mined shoots. 42. Larval exit holes at bases of mined shoots. 43. Larval gallery with loosely packed frass. 44. Adult resting posture, note raised scale tufts.

*Mompha solomoni* Jacq. (Rubiaceae). It too may cut-out an oval shield at the mine terminus. Adults of this moth are similar in appearance to those of *M. cephalonthiella* and *M. solomoni*. Chambers (1871: 222) stated that the mine of *M. cephalonthiella* resembles that of an *Antispila*, but he elaborated no further. In both Mexico and Costa Rica, DLW has reared additional momphines from melastomes whose prepupal larvae also remove oval leaf sections from the mine terminus, although their cut-outs are often more jagged than those of the Rubiaceae-feeding momphines. Busck’s (1912) account of *Moriloma pardella* Busck, a momphine leafminer in *Conostegia* sp. (Melastomataceae), also makes mention of this rather unusual behavior.

We have collected active mines of *Mompha cephalonthiella* from mid June (VT) through early October (CA), contradicting reports by both Chambers (1871) and Forbes (1923) that it is single-brooded. Certainly, populations reach their greatest abundance in late summer (as do those of *Mompha solomoni*). In our collections adults issued two to four weeks after the larvae were secured—with no pupae holding over to the following season, supporting the suggestion of Chambers (1871) and Forbes (1923) that this species overwinters as an adult. A March record of a flown...
adult of *Mompha cephalonthiella* collected by Edward Knudson from Houston, Texas further supports the notion that adults overwinter.

**Discussion**

Leafmining moths are usually highly specific in the tissues that they mine (Needham et al. 1928. Hering 1951), but momphines provide numerous exceptions. The Palearctic momphines include species that switch between mining leaves and flowers or seeds, e.g., *Mompha miscella* (Dennis and Schiffermüller) (Lhomme [1948–1949]); stems and seed pods, e.g., *Mompha sternipennella* (Treitschke) (Emmet 1982); and stems and leaves, e.g., *Mompha ochraceella* (Curtis) and *M. propinquella* (Stain...
in another member of the Rubiaceae, *Hamelia patens*. DLW has made collections of this moth in both southern Florida and Costa Rica. Other undescribed taxa that may be members of this species cluster were found among unsorted Floridian morphines in the USNM. Given the phenotypic similarity of the imagoes, the group’s members exhibit marked biological differences, e.g., *Mompha cephalonthiella* is thought to overwinter as an adult and *M. solomoni* as a pupa. *M. cephalonthiella* and the *Hamelia*-feeder may fashion an oval cut-out or shield from the mine terminus, in the same manner as is done by heliozelids; *M. solomoni* simply drops into leaf litter to make its cocoon. (Curiously, the shield-making behavior appears to be facultative in both *M. cephalonthiella* and the new species from *Hamelia*.)

While many authors have recognized the importance of Onagraceae in temperate radiations of the Momphinae (Forbes 1923, Powell 1980, Stehr 1987, Scoble 1992, Hodges 1998, Powell et al. 1998), few have
mentioned Rubiaceae as a host family for morphines. We know of five North American species associated with Rubiaceae (the two on Cephalanthus treated here and three undescribed species: on Galium, Hamelia, and Spermacoce). Given our present understanding of the biology of the North American morphines, which is admittedly incomplete, the Rubiaceae rank third in their importance as larval hosts for Mompheinae, behind the Onagraceae and Cistaceae (DLW unpublished data: T. Harrison in litt.). Given the presence of morphines in Central America and the great diversity of Rubiaceae in low latitudes, we think it likely that many other (undescribed) species will be found to be associated with this family.

L group is bisetose on T1 (Fig. 22)—a condition unique to the morphines among all Gelechioidea (Stehr 1987, Hodges 1998). Larvae of Mompha solomoni possess a pair of flattened setae below each tarsal claw (Fig. 27), a feature present in many but not all morphines (Hodges 1998). Mosher (1916) claimed that the frontocylindrical suture was present in morphids; our preparation of the pupa of M. solomoni (Fig. 35) lacked the suture. One of the most curious features separating the two button-bush-feeding species is the development of the lateral oval pockets that open toward the caudal end of A7 in females of Mompha solomoni (Fig. 7) and M. cephalonthiella (Fig. 8). These pockets are more pronounced in M. cephalonthiella than in M. solomoni. Their function is unknown; perhaps they receive the valvae during copulation or are in some way involved in pheromone release. Evidently, these pockets are widespread among morphines (John Wilterding, personal communication).

Additional taxonomic and biological work is needed. It would be helpful to document that the spring-active, stem-mining individuals do, in fact, give rise to the summer-active leafmining generations. Stated differently, confirmation is needed that Mompha solomoni is a single species, and not two closely allied cryptic species, one of which mines only in new shoots. Are Mompha solomoni and M. cephalonthiella sister taxa or do they represent different sections of a Rubiaceae-feeding clade of morphines? Is either species capable of overwintering as both pupae and adults, or is the overwintering stage a defining trait for each of these moths?

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A NEW SPECIES OF PROCONTARINIA (DIPTERA: CECIDOMYIIDAE), AN IMPORTANT NEW PEST OF MANGO IN THE PHILIPPINES

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Abstract.—A new species of cecidomyiid, Procontarinia frugivora Gagné, is reported from mango, Mangifera indica (Anacardiaceae), in Luzon Island, Philippines, where it has become a serious pest. Adults, pupae, and larvae are described, illustrated, and compared to other Procontarinia species. Erosomyia is a new junior synonym of Procontarinia, so Erosomyia mangiferae Felt is newly combined in Procontarinia. Procontarinia mangiferae (Felt 1916) becomes a new junior homonym of P. mangiferae (Felt 1911), so is given the new replacement name P. biharana Gagné. Rabdophaga mangiferae Mani is newly referred to Procontarinia where it is made a new synonym of P. mangiferae (Felt 1911).

Key Words: mango, gall midges, new species

In February 2002, gall midge larvae were found exiting from holes of mango fruit (Fig. 1) in Bulacan Province, Luzon Island, Philippines (15.04°N, 121.02°E). Shortly after, adults were reared from these larvae that proved to be a species of Procontarinia Kieffer & Ceconì unlike any of the other 11 species of that genus, all of which make galls on mango leaves. The new species described here was also referable to Erosomyia Felt, which was known from a single species, Erosomyia mangiferae Felt, a gall-former on mango shoots. Upon investigation, the two genera were found to share distinguishing characters and so are synonymized here.

Mango, Mangifera indica L. (Anacardiaceae), is a tropical species of Indo-Burmese origin. It is widely cultivated pantropically and even subtropically, from 36°N to 33°S. In the Philippines, it is the second most important fruit crop in terms of domestic consumption and export value. The damage caused by the newly described cecidomyiid seriously affects the quality and yield of mango. Infested fruit initially show small brownish lesions of 1 mm diameter that grow larger and deeper as the fruit enlarges. Most infested fruit fall to the ground before ripening; those that reach maturity are not marketable. The population outbreak appears at present to be localized on Luzon Island in the provinces of Bulacan, Cavite, and Bataan.

METHODS

Infested fruit were collected and kept in containers lined with paper towels until full-grown larvae emerged. Larvae were then placed in individual vials with vermiculite, where pupation and eventual adult emergence occurred. Specimens of imma-
ture 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). Larvae were obtained and adults reared by C. dR. Medina who is studying the biology and impact of this pest in the Philippines. The taxonomic investigation was the responsibility of R. J. Gagné.

Procontarinia frugivora Gagné, new species
(Figs. 2–13)

Adult.—Head: Eyes connate, 7–8 facets long at vertex; facets circular, closely adjacent but not abutting, lateralmost facets farther apart, separated by up to one facet diameter. Occiput with dorsal protuberance with 2 apical setae. Frons with 4–5 setae. Labella ellipsoid, each with 5–6 lateral setae. Palpus 4-segmented, first segment slightly longer than wide, remaining segments about twice as long as wide, the two distal segments not as wide as first two segments. Antenna: Scape cylindrical, as wide as long, with 1 seta on outer lateral surface and 1–3 setae on inner lateral surface; pedicle with 5–6 setae on inner lateral and ventral surfaces combined; with 12 flagellomeres. Male flagellomeres (Fig. 2) binodal; one circumfilum on each node, loops of the circumfilum subequal in length; nodes covered with setulae. Female flagellomeres (Fig. 3) cylindrical, slightly constricted at middle, surrounded by two appressed circumfilum connected by two longitudinal bands; necks slightly longer than wide.

Thorax: Wing unmarked, 1.2–1.3 mm long in male (n = 5), 1.5–1.6 mm long in female (n = 5). R₃ curved toward apex, joining C posterior to wing apex. Rs present as stub near base of R₃. Mesanepermiron with 3–4 setae, thoracic pleura otherwise bare. Tarsal claws (Fig. 4) toothed, curved

Fig. 1. Young mango fruit with holes made by larvae of Procontarinia frugivora.
near midlength; empodia attaining bend in claws.

**Male abdomen:** First through sixth tergites entire, rectangular, with single posterior row of setae, no lateral setae, scattered scales, and 2 anterior trichoid sensilla; seventh tergite as for preceding but with fewer scales, unsclerotized posteriorly and lacking the posterior row of setae and scales; eighth tergite less sclerotized than preceding tergites, the only vestiture the anterior pair of trichoid sensilla. Second through eighth sternites rectangular, with single posterior row of setae. 2 lateral and one mesal group of setae near midlength, and 2 anterior trichoid sensilla; eighth sternite foreshortened, midlength setal groups consequently abutting posterior setae. Genitalia (Figs. 5–7): cerci nearly completely fused, only a short incision between them present posteriorly, with several posterior setae; hypoproct narrower than conjoined cerci, narrowing slightly from base to broadly convex apex, with a few posterior setae; aedeagus about as long as gonocoxite, cylindrical, rounded at apex, laterally with longitudinal rows of sensory pits; gonocoxite elongate-cylindrical with large, conical mesobasal lobe, bearing scattered cuticular spines but devoid of setulae; gonostylus elongate-cylindrical, tapering gradually from basal third to distal tooth, with setulae near base and covered beyond with minute carinae and widely scattered short setae.

**Female abdomen** (Figs. 8–10): First through seventh tergites and second through seventh sternites as for male. Eighth tergite weakly sclerotized (Fig. 8, arrow), separation from seventh tergite subequal to length of eighth, with single row of short posterior setae and anterior pair of trichoid sensilla the only vestiture. Eighth sternite not evident. Ovipositor slightly protrusible, venter of eighth segment and dorsum of ninth and tenth segments without vestiture, venter of ninth segment with setae; cerci entirely connate, short, convex apically, with 2 pairs apical sensory setae and scattered setae elsewhere; hypoproct short, narrow, with 2 posterior setae.

**Pupa.**—Unknown, not preserved.

Third larval instar (Figs. 11–13).—Length, 1.6–1.9 mm. White. Integument smooth except for several horizontal rows of tiny spicules on anteroventral surfaces of the first through seventh abdominal segments. Head with posterior apodemes longer than head capsule. Antenna about twice as long as wide. Spatula (Fig. 12) clovel-shaped with 2 acutely triangular anterior teeth. Lateral thoracic papillae on each side of central line (Fig. 12) in 2 groups, a triplet and a singlet, 2 papillae in each triplet each with tiny seta, remaining lateral setae without. Dorsal and pleural papillae with setae no longer than wide. Terminal segment (Fig. 13) narrowed abruptly from eighth segment, blunt posteriorly, with 8 papillae as follows: 1 mesoposterior pair large, corniform; 1 pair between the 2 corniform papillae each with a seta no longer than wide; and 2 pairs of papillae laterally, each with short seta several times longer than wide. Area between terminal corniform papillae not pigmented.

**Holotype.**—Male. emerged 20-II-2002 from larvae fallen from mango fruit. Alaga, Bulacan, Philippines, collected by C. dR. Medina, deposited in the University of Philippines Museum of Natural History, Los Baños, Laguna, Philippines.

**Other material examined.**—Same data as holotype. 4♂, 5♀, 5 larvae, all with same relevant data as holotype, deposited in the University of Philippines Museum of Natural History and the National Museum of Natural History, Washington, DC. USA.

**Etymology.**—The specific name, frugi-vora, is an adjective that means “fruit eating.”

**Discussion.**—The genus *Procontarinia* Kieffer & Cecconi (1906) was described for *Procontarinia matteiana* Kieffer & Cecconi (1906), reared from leaf galls found on mango grown in the Botanical Gardens in Palermo, Sicily. Felt (1911) described *Erosomyia* for *Erosomyia mangiferae* Felt gall-

Species previously in *Procontarinia,* including *Erosomyia mangicola* Shi (1990) recently transferred to *Procontarinia* by Uechi et al. (2002) and *Erosomyia mangiferae* share the following derived characters: male flagellomeres each have two circumfila per flagellomere (Fig. 2) instead of three; male cerci are more or less fused (Fig. 5) instead of separated from the base; the gonocoxite has a definite mesobasal lobe (Fig. 5), which may be low and rounded or conical, depending on the species; the female eighth tergite is weakly developed and, in addition, separated from the seventh tergite by more than the length of the eighth tergite (Fig. 8); the female cerci are short and partially or completely fused into a single lobe (Fig. 9); and the larvae have only four lateral setae, a triplet and a singlet on either side of the spatula.
(Fig. 10), instead of two triplets. Other characters shared by these species are the toothed claws (Fig. 4), probably a plesiomorphy, and the fact that one pair of larval terminal papillae are enlarged and recurved (Fig. 11). Because of the above shared characters between *Erosomyia* and *Procontarinia*, the two genera are considered synonyms here (new synonymy). The larvae are similar to those of *Contarinia*, which may indicate a relationship between the two genera.

All of the previously described species now in *Procontarinia* are from mango and all make leaf galls, except *P. mangiferae* Felt, which causes swellings on shoots. Previously described species are as follows:

*allahabadensis* Grover 1962: 312, *Amradiopsis* (as *Amraeomyia* in error), from India.


*biharana* Gagné, new name for *Indodiplosis mangiferae* Felt, from India.


*mangicola* Shi 1980: 131, *Erosomyia*, from China, Guam, and Japan, where it is evidently a recent introduction (Uechi et al. 2002).

*schreineri* Harris, in Harris & Schreiner 1992: 42, *Procontarinia*.

*mangiferae* Felt 1911: 49, *Erosomyia*, new combination, from India, Réunion: immigr.: West Indies (Guadeloupe, St. Lucia, St. Vincent, and Trinidad) and Brazil.


*mangiferae* Mani 1938: 331, *Rhabdophaga*, new junior secondary homonym of *mangiferae* Felt. Mani evidently placed this species in *Rhabdophaga* because of the fused cerci of the female. That character and the fact that the specimens were reared from mango shoot galls indicate that the species is properly placed here. New synonym, *indica* Grover & Prasad 1966: 7, *Erosomyia*.


*tennispatha* Kieffer 1909: 150, *Oligotrophus*, from India.


Illustrations of male genitalia of all of the above species accompany the original descriptions, except for the Felt species, which I have been able to study. All *Procontarinia* species differ from the new species, *P. frugivora*, in having setulae on the mesobasal lobes of the male genitalia instead of being devoid of setulae and bearing cuticular spines as in the new species. Further, only the new species and *P. mangiferae* have completely fused female cerci, although at least *P. mangicola* has almost completely fused cerci. Larvae of all *Procontarinia* species except the new species appear to have a sclerotized and pigmented area between the corniform papillae of the terminal segment.

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LITERATURE CITED


IOWANA FRISONI HOTTES (HEMIPTERA: APHIDIDAE) REDESCRIBED, WITH NOTES ON ITS BIOLOGY

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Abstract.—Iowana frisoni Hottes was collected and studied for the first time since its original collection in 1925. It was found in remnant prairies where it fed on the basal stem of the endemic plants Silphium laciniatum L. and S. terebinthinaeum Jacquin (Asteraceae). Later in the season it fed on the stem or leaf stipules within the cavity created by the leaf axil. The aphid was always tended by ants, Lasius flavus (F.), L. neoniger Emery, and two Crematogaster species, which housed the aphids by building soil collars around the bases of plants and sealing leaf axils with soil and dead plant material. The ants also carried I. frisoni underground when the aphid colony was disturbed. We redescribe the apterous vivipara morph of I. frisoni and describe for the first time the fundatrix, alate vivipara, male, ovipara, and egg.

Key Words: Silphium, Lasius, endemic species, prairie remnant, symbiosis

In 1925, G. Hendrickson collected a few aphids in a leaf axil of Silphium laciniatum L. (compass plant, Asteraceae) in Ames, Iowa. Twenty-nine years later, F. C. Hottes described a new genus and species based on two specimens (Hottes 1954). As far as we can surmise, the aphid, Iowana frisoni Hottes (Hemiptera: Aphididae), had not been seen in the 75 years since its original collection.

In the summer of 2000, we discovered I. frisoni feeding on flowering stems of S. laciniatum and S. terebinthinaeum Jacquin (prairie dock) at Loda Cemetery Prairie Nature Preserve (~1.4 ha in area; Iroquois Co., IL, 40°31.62′N × 88°4.57′W), a prairie remnant (White 1988). Both S. laciniatum and S. terebinthinaeum are common perennials in prairies of central Illinois and produce as many as 12 flowering stems per plant that can reach heights of 2–4.5 m (Weaver 1954).

Here, we redescribe the I. frisoni apterous vivipara and describe for the first time the fundatrix, alata, male, ovipara, and egg. We also discuss the biology of the aphid with regard to host plants and attendant ants, Lasius flavus (F.), L. neoniger Emery, and two unidentified Crematogaster species.

Materials and Methods

To evaluate the distribution of I. frisoni in east central Illinois, we surveyed three other prairie remnants and three prairie restorations where both species of Silphium were present, thoroughly canvassing these sites for aphids on plants of both species. Remnants were Prospect Cemetery Prairie Nature Preserve (~2 ha; 40°26.71′N × 88°5.87′W) and Paxton Railroad Prairie (~2 ha; 40°26.17′N × 88°06.36′W) in Ford County and Grant Creek Prairie Nature Pre-
serve (~31 ha; 41°22.10’N × 88°11.55’W) in Will County. The restorations were all in Champaign Co.: Red Bison Prairie Corridor (~1.7 ha; 40°4.81’N × 88°14.83’W). Trelease Prairie (~7.3 ha; 40°7.76’N × 88°8.59’W), and Meadowbrook Prairie (~24 ha; 40°4.72’N × 88°12.41’W). See Tooker et al. (2002) and Tooker and Hanks (in press), for more information on sites.

To estimate the abundance of *I. frisoni* and its attendant ant species at Loda Cemetery Prairie, we established five east-west transects across the long axis of the prairie (~200 m). We walked transects on 12, 19, and 26 July, 27 August, and 6 September 2002, examining plant stems within 1 m of transects for *I. frisoni* and ants (n = 75 *S. laciniaturn* stems, 106 *S. terebinthinaceum* stems). We also assessed the prevalence of *I. frisoni* at Prospect Cemetery Prairie in August 2002 by walking a single transect (~50 m long) through a patch of *S. terebinthinaceum* and recording the presence of *I. frisoni* and ants. Because flowering stems of *S. laciniaturn* were not abundant at that site, we examined all plants of that species.

We collected aphids (n = 42) and ants (n > 30) during the growing seasons in 2001 and 2002. On 6 October 2002, a colony was brought back to the lab and reared on a cut stem of *S. terebinthinaceum*. This colony produced males (n = 6), oviparae (n = 8), and eggs (n = 11), which were laid randomly along the stem under a leaf stipule. Collected aphids were cleared with a KOH and chloral phenol procedure and slide-mounted in Canada balsam. Species identity was confirmed with the holotype (the single paratype is a nymph) and associated ants were identified. Aphid and ant specimens are deposited at the Illinois Natural History Survey insect collection and exemplars of each aphid morph were sent to the National Museum of Natural History (aphid collection, Beltsville, MD). Fifty-seven aphids were measured with an ocular micrometer on a compound microscope. Specimen photos were taken using a Nikon Eclipse E600 microscope. Spot Insight digital camera model 3.2.0. and Spot Advanced software (Diagnostic Instruments, Inc., Sterling Heights, MI).

Because no obvious morphological differences distinguished three putative fundatrices, we performed canonical discriminant function analysis to confirm that they were indeed morphometrically distinct from the other apterous viviparae. Discriminant factor analysis of aphids has been used to discriminate between species (Brown and Blackman 1994) and populations of the same species (Foottit and Mackauer 1980). Hand (1986) used this method to discriminate holocyclic and anholocyclic alate aphids of the same species. To confirm that aphids collected as solitary adults early in the season were fundatrices and not other viviparae, discriminant function analysis was conducted (SYSTAT® 10 software, SPSS Inc. 2000) using 10 characters to confirm morphological distinctness (Albrecht 1980): lengths of the whole body, antennal segment II, antennal segment IV, the base of antennal segment V, the processus terminalis of antennal segment V, rostral segment III, siphunculus, metafemur, metatibia, and counts of rhinaria on antennal segment II. To maintain a large sample size, some typical measurements (ultimate rostral segment, for instance) were omitted if they were not available for all three putative fundatrices.

The groupings in the analysis were apterous viviparae, alate viviparae, oviparae, and males; we also added the three putative fundatrices and the holotype (apterous vivipara) to determine their association with the other groups. If putative fundatrices did not group with apterous viviparae, for example, we could conclude that they were indeed a distinct morph. To control for possible seasonal variation in aphid morphometrics (Debaraj and Singh 2000), we used apterous viviparae from throughout the growing season, including early-season collections made soon after the putative fundatrices had been collected. We tested for
distinctness using the first through fifth discriminant factors.

**Results and Discussion**

Populations of *I. frisoni* were present in all four prairie remnants but were not observed in any of the three restorations, suggesting it may be a remnant dependent species (Panzer et al. 1995). We did not search for or collect the ant species in the restorations. The aphid fed on both *S. laciniatum* and *S. terebinthinaceum* at all four sites, but not on *Silphium integrifolium* Michaux, which was also present at all four sites. Neither have we seen *I. frisoni* on *Silphium perfoliatum* L. at Meadowbrook Prairie or several railroad rights-of-way in east central Illinois.

Because all colonies of *I. frisoni* observed were tended in summer by the ants *L. flavus*, *L. neoniger*, or one of two *Cre-matogaster* species, it seems likely that the symbiosis is obligate, as is true for some other aphid species (Eastop 1953, Carter 1983). In October, ants were absent in the several declining aphid colonies, the ants having retreated below ground to overwinter. The ant species never co-occurred on the same plant, but occasionally tended aphids on adjacent plants. *Lasius flavus* is a common species that ranges across North America and Eurasia (Wilson 1955), may be completely subterranean, and tends a diversity of aphid species (Wilson 1955, Zwölfer 1958). This ant is known to carry aphid eggs into its nest for overwintering (Pontin 1960), but it also may be an aphid predator (Pontin 1958, 1978). *Lasius neo-niger* is a dominant ant species in open, grassy habitats of eastern North America and commonly tends aphids, including the corn root aphid, *Aphis maidiradicis* Forbes (Wilson 1955, Traniello and Levings 1986), which also may be entirely dependent on
Ants (Hottes and Frison 1931). The identity of the two *CreMATogaster* species remains uncertain because their colonies appear rare and we have collected very few individuals, even after further searches during the summer of 2003. Nevertheless, the genus is cosmopolitan (Hölldobler and Wilson 1990) and tends hemipterans, including other aphid species (Dejean et al. 1991). Ant species appeared to nest at the base of individual plants and built a collar of soil (~4–8 cm in height) encircling the bases of a few to several flowering stems of *S. laciniatum* and *S. terebinthinaeceum* (we did not observe the aphid on leaf stems). *Iowan frisoni* fed within this ant-built refuge. Some soil collars had tunnels isolated from the stem through which ants could move around the base of the plant and down into the nest. When *L. frisoni* colonies were disturbed, the ants of all species carried the aphids underground, moving the entire colony within the course of a few minutes. Aphids also occurred in leaf axils feeding on either the stem or clasping leaf stipules, where they were also tended by ants (Fig. 2). *Lasius neoniger* usually sealed these leaf axils with soil and/or dead plant material, housing the aphids, but did not transport aphids from these feeding sites. Late in the season (September), a few plants of both species had ants and aphids present in every leaf axil and even in axils of branches and modified leaves in proximity to flowers (>2 m above the ground).

In our transects at Loda Cemetery Prairie, *L. frisoni* was present on only one of 75 *S. laciniatum* plants (1.3% of all plants) and this one aphid colony was tended by *L. neoniger*. *Iowan frisoni* was present on 34 of 106 (32%) *S. terebinthinaeceum* plants and the majority of these were tended by *L. neoniger*. At Prospect Cemetery Prairie, *I. frisoni* was present on three of five *S. laciniatum* (40%) and 10 of 12 *S. terebinthinaeceum* (83%), and *L. neoniger* was the dominant ant species tending these aphid colonies.

The first discriminant factor did not distinguish the fundatrices as separate from the other apterous viviparae. This was not unexpected because the first discriminant factor may be a function of size (Footit 1992) and the greatest size variation was between alatae and apterae, and not between fundatrices and other apterae. The second discriminant factor did separate the putative fundatrices from the other apterous viviparae (Fig. 1), but the third, fourth and fifth factors did not discriminate any of them. Based on these results we believe that our three specimens were indeed fundatrices and we describe them as such below.

**DESCRIPTION**

*Iowan frisoni* Hottes 1954 (Figs. 2–19)

Apterous vivipara (Table 1, Figs. 3, 7, 10, 15).—*Color (alive):* Body pale green. Adults with head and prothorax light reddish brown. Eyes dark brown to red. All of ant I, ant II, and proximal ½ of ant III segments pale green; distal ½ of ant III, and all of ant IV and ant V brown. Legs pale green except distal-most portion of tibiae and both tarsal segments brown. Siphunculus brown. *Morphology of cleared, slide-mounted specimens:* See Table 1 for anatomical measurements. Body entirely pale, neither sclerites nor sclerites present (Fig. 3). *Head:* Frons flat, smooth with a few scattered minute hairs. Rostrum reaches abdominal segment I. Rostral segments III to V dark, each darker than one before (Fig. 7). Rostral segment IV with 2 small accessory setae (Fig. 9), these may not be visible in some specimens. Antenna 5 segmented, dark and imbricated beyond base of ant III (Fig. 10). Ant III with 0–21 apical and subapical rhinaria. Ant IV with a single apical primary rhinarium. *Thorax:* Large prothoracic tubercles, usually small lateral tubercles on thoracic segments 2 and 3 which may be hard to see on some specimens. Furculum broadly V-shaped (Fig. 7). Legs short. Metatibia darkened distally only, with darkening continuing into tarsus; no
Figs. 2-6. *Iowana frisoni*. 2, Feeding on the inside of a leaf stipule of *Silphium laciniatum*, tended by *Crematogaster* sp. 3. Apterous vivipara. 4. Alate vivipara. 5. Male. 6. Ovipara.
Table 1. Morphological measurements, mean and range, in mm, for five morphs of *Iowa frisoni* and the holotype.

<table>
<thead>
<tr>
<th>Morph/Body Part</th>
<th>Holotype</th>
<th>Apterous vivipara (n = 28)</th>
<th>Apterous fondatrix (n = 3)</th>
<th>Alate vivipara (n = 11)</th>
<th>Apterous ovipara (n = 8)</th>
<th>Apterous male (n = 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body (frons to cauda)</td>
<td>2.21</td>
<td>2.32 (1.75–3.06)</td>
<td>2.43 (2.10–2.72)</td>
<td>1.62 (1.38–1.95)</td>
<td>1.76 (1.50–2.02)</td>
<td>1.14 (1.07–1.23)</td>
</tr>
<tr>
<td>Frons (between antennal sockets)</td>
<td>0.230</td>
<td>0.241 (0.214–0.270)</td>
<td>0.233 (0.232–0.233)</td>
<td>0.204 (0.192–0.235)</td>
<td>0.211 (0.195–0.226)</td>
<td>0.170 (0.151–0.182)</td>
</tr>
<tr>
<td>Ant. III</td>
<td>0.289</td>
<td>0.327 (0.195–0.435)</td>
<td>0.374 (0.365–0.383)</td>
<td>0.342 (0.304–0.37)</td>
<td>0.215 (0.182–0.264)</td>
<td>0.161 (0.145–0.176)</td>
</tr>
<tr>
<td>Ant. IV</td>
<td>0.124</td>
<td>0.139 (0.082–0.193)</td>
<td>0.134 (0.128–0.138)</td>
<td>0.141 (0.115–0.154)</td>
<td>0.109 (0.101–0.119)</td>
<td>0.078 (0.075–0.088)</td>
</tr>
<tr>
<td>Ant. V base</td>
<td>0.098</td>
<td>0.113 (0.088–0.138)</td>
<td>0.106 (0.091–0.118)</td>
<td>0.107 (0.093–0.124)</td>
<td>0.101 (0.069–0.126)</td>
<td>0.091 (0.082–0.123)</td>
</tr>
<tr>
<td>Ant. V PT</td>
<td>0.154</td>
<td>0.172 (0.101–0.216)</td>
<td>0.175 (0.159–0.190)</td>
<td>0.184 (0.163–0.203)</td>
<td>0.142 (0.119–0.163)</td>
<td>0.108 (0.094–0.126)</td>
</tr>
<tr>
<td>Rostrum III</td>
<td>0.157</td>
<td>0.156 (0.132–0.177)</td>
<td>0.151 (0.144–0.164)</td>
<td>0.143 (0.122–0.157)</td>
<td>0.131 (0.113–0.151)</td>
<td>0.108 (0.101–0.119)</td>
</tr>
<tr>
<td>Rostrum IV</td>
<td>0.160</td>
<td>0.179 (0.152–0.207)</td>
<td>0.160 (0.160–0.160)</td>
<td>0.157 (0.146–0.172)</td>
<td>0.176 (0.163–0.189)</td>
<td>0.126 (0.119–0.132)</td>
</tr>
<tr>
<td>Metatibia</td>
<td>0.43</td>
<td>0.49 (0.33–0.69)</td>
<td>0.47 (0.45–0.50)</td>
<td>0.47 (0.40–0.52)</td>
<td>0.33 (0.30–0.38)</td>
<td>0.23 (0.21–0.25)</td>
</tr>
<tr>
<td>Metatarsus I, ventral</td>
<td>0.67</td>
<td>0.79 (0.56–1.07)</td>
<td>0.77 (0.73–0.81)</td>
<td>0.83 (0.70–0.90)</td>
<td>0.55 (0.50–0.65)</td>
<td>0.39 (0.36–0.41)</td>
</tr>
<tr>
<td>Metatarsus I</td>
<td>0.047</td>
<td>0.046 (0.038–0.053)</td>
<td>0.047 (0.045–0.049)</td>
<td>0.045 (0.039–0.049)</td>
<td>0.039 (0.031–0.044)</td>
<td>0.028 (0.025–0.031)</td>
</tr>
<tr>
<td>Metatarsus II</td>
<td>0.122</td>
<td>0.123 (0.063–0.145)</td>
<td>0.114 (0.104–0.124)</td>
<td>0.123 (0.112–0.133)</td>
<td>0.108 (0.101–0.119)</td>
<td>0.091 (0.088–0.094)</td>
</tr>
<tr>
<td>Siphunculus length</td>
<td>0.249</td>
<td>0.299 (0.176–0.428)</td>
<td>0.284 (0.265–0.301)</td>
<td>0.235 (0.188–0.263)</td>
<td>0.180 (0.157–0.220)</td>
<td>0.093 (0.082–0.107)</td>
</tr>
<tr>
<td>Siphunculus width at base</td>
<td>0.093</td>
<td>0.085 (0.057–0.118)</td>
<td>0.076 (0.056–0.094)</td>
<td>0.062 (0.046–0.085)</td>
<td>0.061 (0.050–0.069)</td>
<td>0.042 (0.038–0.047)</td>
</tr>
<tr>
<td>Cauda length</td>
<td>na</td>
<td>0.110 (0.094–0.130)</td>
<td>0.108 (0.093–0.123)</td>
<td>0.106 (0.082–0.120)</td>
<td>0.103 (0.094–0.107)</td>
<td>0.050 (0.044–0.063)</td>
</tr>
<tr>
<td>Cauda width at base</td>
<td>na</td>
<td>0.119 (0.088–0.145)</td>
<td>0.138 (0.125–0.150)</td>
<td>0.110 (0.093–0.128)</td>
<td>0.112 (0.107–0.138)</td>
<td>0.079 (0.069–0.094)</td>
</tr>
<tr>
<td>Prothoracic tubercle length</td>
<td>0.113</td>
<td>0.100 (0.069–0.138)</td>
<td>0.096 (0.079–0.114)</td>
<td>0.096 (0.077–0.108)</td>
<td>0.078 (0.069–0.088)</td>
<td>0.068 (0.063–0.075)</td>
</tr>
<tr>
<td>Prothoracic tubercle height</td>
<td>0.065</td>
<td>0.071 (0.038–0.107)</td>
<td>0.074 (0.059–0.089)</td>
<td>0.067 (0.055–0.089)</td>
<td>0.043 (0.031–0.050)</td>
<td>0.044 (0.044–0.044)</td>
</tr>
</tbody>
</table>
Three rudimentary gonapophyses. Siphunculus dark, imbricated, with rounded flange and slight constriction just below distal end (Fig. 15). Collection dates: 8 June, 8 August 2001, 27 August 2002.

Apterous fundatrix (Table 1, Figs. 11, 16).—As apterous vivipara except for following. Head: Ant. III with 6–11 rhinaria (Fig. 11). Collection date: 9 May 2002.

Alate vivipara (Table 1, Figs. 4, 12, 17).—As apterous vivipara except for following. Head: Ant. III with 12–22 rhinaria (Fig. 12). Thorax: Media once (Fig. 4) or twice forked, if twice, second branch arises right before apex of wing. Abdomen: Siphunculus parallel-sided and straight, with or without slight flange (Fig. 17). Collection dates: 22 May, 8 June, 8 August 2001.

Apterous male (Table 1, Figs. 5, 13, 18).—As apterous vivipara except for following. Head: Rostrum reaches abdominal segment V. Ant. III with 5–11 rhinaria. Ant. IV with 0–2 secondary rhinaria, 1 primary rhinarium (Fig. 13). Abdomen: Siphunculus only about twice as long as wide, lightly pigmented (Fig. 18). Male genitalia with 2 setose claspers anteriorly, aedeagus centrally, and 2 sclerotized apophyses posteriorly. Collection date: 6 October 2002.

Apterous ovipara (Table 1, Figs. 6, 14, 19).—As apterous vivipara except for following. Head: Rostrum reaches abdominal segment V. Ant. III with 1–9 rhinaria (Fig. 14). Thorax: Metatibia with 10–18 sensoria. Collection date: 6 October 2002.

Egg.—Oval, smooth, shiny and black, 0.34–0.36 mm wide by 0.78–0.93 mm long (means of 11 measurements are 0.351 and 0.853 mm, respectively). Collection date: 6 October 2002.

Diagnosis.—The viviparae (apterae and alatae) of I. frisoni are similar to Aphis species in having the same lateral tubercle placement (ventral to the line joining the first two abdominal spiracles), the siphunculus longer than the cauda, and the processus terminalis longer than the base of terminal antennal segment. Iowana frisoni is unique with its enlarged lateral protho-


darkening of the knees. Abdomen: Tergum smooth with a few scattered minute hairs, <0.01 mm long. Venter with scattered minute hairs and faint imbrications. Large lateral tubercles on abdominal segments I–V and VII. A small lateral tubercle on either, neither, or both sides of segment VI. Subgenital plate with short hairs profuse only on hind margin, sparse elsewhere. Cauda short, roughly as broad at base as it is long.
racic and abdominal tubercles, five-segmented antenna, and sparse and minute setae. The alate morph is also unusual in having the medial vein either forked once, or the second fork arising only at the wing apex.

ACKNOWLEDGMENTS

Our grateful appreciation to D. J. Voegtlin (Center for Economic Entomology, Illinois Natural History Survey) for assistance with basic issues of aphid biology, photomicroscopy, and for helpful comments on the manuscript. Thanks to S. Cover (Museum of Comparative Zoology, Harvard University) and S. Beshers (Department of Entomology, University of Illinois at Urbana-Champaign [UIUC]) for identifying the two Lasius species; to M. B. Stotzel (Systematic Entomology Laboratory,
U.S. Department of Agriculture) for loan of the type specimen of *I. frisoni* from the National Aphid Collection, Beltsville, MD, and for a helpful review of the manuscript; and to J. B. Nardi (Department of Entomology, UIUC) for use of his photomicroscopy equipment. We appreciate the assistance provided by J. A. Mohler, M. W. Tooker, and A. V. Weaver in the field. We also thank the Illinois Nature Preserves Commission, Red Bison (a UIUC Registered Student Organization), the Urbana Park District, and Steve Buck and the Committee of Natural Areas of the School of Integrative Biology, UIUC, for access to research sites.

**LITERATURE CITED**


REVISION OF THE SUBFAMILY CARDIOCHILINAE (HYMENOPTERA: BRACONIDAE) IN CHINA. I. THE GENERA AUSTEROCARDIOCHILES DANGERFIELD, AUSTIN, AND WHITFIELD, EURYCARDIOCHILES DANGERFIELD, AUSTIN, AND WHITFIELD AND PSILOMMISSCUS ENDERLEIN

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Abstract.—An illustrated key to the six genera of the Cardiochilinae known to occur in China is presented, with three genera, Austerocardiochiles Dangerfield, Austin, and Whitfield, Eurycardiochiles Dangerfield, Austin, and Whitfield and Psilommiscus Enderlein, reported for the first time. Three new species of Austerocardiochiles are described: A. tujiazu Chen, Whitfield and He, A. xibozu Chen, Whitfield and He, and A. zhejiangensis Chen, Whitfield and He. Four species of Eurycardiochiles are reported: E. occidentalis Dangerfield and Austin, and the new species E. dongzu Chen, Whitfield and He, E. shezu Chen, Whitfield and He, and E. jiulong Chen, Whitfield and He. Psilommiscus is new to China, represented only by P. sunatranus Enderlein. Austerocardiochiles japonicus (Watanabe), new combination, and A. turga (Belokobyinskij), new combination, are transferred from Cardiochiles Nees.

Key Words: Braconidae, Cardiochilinae, Austerocardiochiles, Eurycardiochiles, Psilommiscus, new species, new records, China

The subfamily Cardiochilinae is a small, well-established subfamily in the family Braconidae (Quicke and van Achterberg 1990, Whitfield and Mason 1994, Whitfield and Dangerfield 1997, Dangerfield et al. 1999, Mercado and Wharton 2003). The knowledge of its biology is mostly restricted to a few commonly studied species of Cardiochiles Nees s.s. and Toxoneuron Say, particularly T. nigriceps (Viereck). Cardiochilinae are endoparasitoids of lepidopteran larvae of the families Apateolidae, Cosmopterigidae, Gelechiidae, Pyralidae, Noctuidae and Uraniidae, some of which are major pests of agricultural crops and forests (Huddleston and Walker 1988). The species appear to be most diverse and abundant in temperate grasslands and tropical forests, especially seasonally dry forests.

The Cardiochilinae contain 16 extant genera worldwide according to the new generic classification of this subfamily based on a phylogenetic analysis of qualitative and morphometric characters carried out by Dangerfield et al. (1999). The subfamily is cosmopolitan in distribution, while individual genera are sometimes restricted to individual hemispheres or continents (Table 1). Several of the sixteen genera have been redefined recently (Mercado and Wharton 2003), and it is likely that the generic total will continue to change for some time. Dolphin and Quicke (2001) have estimated a total diversity of from 187 to 283 world
Table 1. World genera of Cardiochilinae with their known distributions and their occurrence in China.

<table>
<thead>
<tr>
<th>Genus</th>
<th>Known Distribution</th>
<th>Recorded from China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asiocardiochiles Telenga</td>
<td>Palaearctic, Australian Regions</td>
<td>No</td>
</tr>
<tr>
<td>Ansterocardiochiles Dan., Aust., and Whitf.</td>
<td>Palaearctic, Oriental, Afrotropical, Australian</td>
<td>This paper</td>
</tr>
<tr>
<td>Bohayella Belolobyskij</td>
<td>All regions except Neotropical</td>
<td>No</td>
</tr>
<tr>
<td>Cardiochiles Nees</td>
<td>Cosmopolitan</td>
<td>Kokonjev, 1895; Szepligeti, 1902; Enderlein, 1906; Chou, 1995</td>
</tr>
<tr>
<td>Eurycardiochiles Dan., Aust., and Whitf.</td>
<td>Oriental, Palaearctic Regions</td>
<td>This paper</td>
</tr>
<tr>
<td>Givenia Dan., Aust., and Whitf.</td>
<td>Australian Region</td>
<td>No</td>
</tr>
<tr>
<td>Hansonia Dangerfield</td>
<td>Neotropical Region</td>
<td>No</td>
</tr>
<tr>
<td>Hartenita Cameron</td>
<td>Oriental Region</td>
<td>Dangerfield &amp; Austin, 1990; Chen, He and Ma (1998)</td>
</tr>
<tr>
<td>Heteropteron Brullé</td>
<td>Neotropical Region</td>
<td>No</td>
</tr>
<tr>
<td>Hymenecis Dan., Aust., and Whitf.</td>
<td>Australian Region</td>
<td>No</td>
</tr>
<tr>
<td>Latitergum Dan., Aust., and Whitf.</td>
<td>Australian Region</td>
<td>No</td>
</tr>
<tr>
<td>Pseudocardiochilus Hedwig</td>
<td>Palaearctic, Australian Regions</td>
<td>No</td>
</tr>
<tr>
<td>Psilomniscus Enderlein</td>
<td>Oriental Region</td>
<td>This paper</td>
</tr>
<tr>
<td>Retustigaster Dan., Aust., and Whitf.</td>
<td>Holartic Region</td>
<td>No</td>
</tr>
<tr>
<td>Schoenandella Cameron</td>
<td>Cosmopolitan</td>
<td>Enderlein, 1906; Chou, 1995</td>
</tr>
<tr>
<td>Toxoneuron Say</td>
<td>Afrotropical, Neartic, Neotropical Regions</td>
<td>No</td>
</tr>
</tbody>
</table>
cardiochiline species, using different estimation methods. There are just under 200 described species at present (Dangerfield et al. 1999, Mercado and Wharton 2003); however, there are large numbers of undescribed species, particularly from southeastern Asia, Africa, and Central and South America where the subfamily has not been studied comprehensively. For example, Mercado and Wharton (2003) recognize 45 species from Mexico where only 28 are currently described, even after their study. Thus the Dolphin and Quicke (2001) estimates are likely somewhat low.

The Chinese fauna of Cardiochilinae is among the most sparsely studied in the world, only the species of Hartemita Cameron having been revised (Chen et al. 1998). This paper is the first to more broadly revise the Chinese Cardiochilinae. Previously, three genera, i.e., Cardiochiles Nees s. str., Hartemita Cameron, and Schoenlandella Cameron were recorded from China, but revision of the large genera Cardiochiles s.s. and Schoenlandella Cameron from China still remains. Austerocardiochiles Dangerfield, Austin, and Whitfield, Eurycardiochiles Dangerfield, Austin, and Whitfield and Psilommiscus Enderlein are reported and described here for the first time from China. Based on their presently recorded distributions, Asiacardiochiles Teng, Bohayella Belolobylskij and Pseudocardiochilus Hedwig are also likely to occur in China, but we have not seen Chinese specimens of them.

The number of specimens available for the taxa treated here is low. XC and JH have examined the following collections: Zoological Research Institute (Beijing); Entomological Research Institute (Shanghai) of the Chinese Academy of Sciences; Fujian Agricultural University (Fuzhou); Shaanxi Agricultural University (Xi'an, one of the largest insect collections in China); China Agricultural University (Beijing); Nanjing Agricultural University (Nanjiang); Huanan Agricultural University (Guangzhou); Guizhou University (Guiyang); and Zhejiang University (the largest parasitic wasp collection in China). They found about 2,200 specimens of Cardiochilinae, the vast majority of them belonging to Cardiochiles, Schoenlandella, and Hartemita. For example, as many as 125 specimens of one species, Cardiochiles fuscipennis Szewczuk, were found in the Zhejiang University collection. Thus, the small numbers of specimens of the taxa treated here indicate that these genera and their species are not very abundant in China, at least compared to the three large genera, rather than that almost no material of Cardiochilinae has been sampled.

For the identification of extralimital genera of Cardiochilinae and most of the morphological terminology used in this paper, see Dangerfield et al. (1999). POL:OD:OOL refers to the three-way ratio of the distance between the inner edges of the posterior ocelli (POL) to the diameter of a posterior ocellus (OD) and to the distance between the outer edge of a posterior ocellus and its corresponding compound eye (OOL). Wing vein terminology follows Achterberg (1993). Voucher and type specimens are deposited in the Hymenoptera Collection, Zhejiang University, Hangzhou, China.

KEY TO THE CHINESE GENERA OF THE SUBFAMILY CARDIOCHILINAE

1. Ovipositor and sheaths very short, less than 0.2 times hind tibia, stout and sharply downturned; propodeal areola reduced anteriorly; hind basitarsus laminate ... Hartemita Cameron
   - Ovipositor and sheaths much longer, not as stout, only weakly downturn to straight at apex; propodeal areola complete; hind basitarsus rounded or oval in cross-section (sometimes distinctly compressed but never strongly laminate) ........................................ 2

2. T1 and laterotergites with lateral suture clearly defined throughout; hypopygium pointed at apex with medial longitudinal area desclerotized and folded inwards ............ Austerocardiochiles Dangerfield, Austin, and Whitfield
   - T1 with lateral suture reduced, poorly defined particularly in apical half; hypopygium variable ........................................ 3
Austerocardiochiles Dangerfield, Austin, and Whitfield, 1999

Austerocardiochiles is widely distributed in the Old World, being recorded from Australia, Philippines, Laos, Japan, Russia, Africa, and now China, but most species occur in the Southern Hemisphere. The species known from Philippines and Laos are currently undescribed. The biology of this genus is unknown, but A. enderleini (Szepligeti) has been collected from crops of sweet potato (*Ipomaea* sp.) in Kenya.

**Austerocardiochiles** species have the occipital carina present in the postgenal region, a longitudinal carina set in a furrow on the medial scutum, and epicnemial carina developed (except for *A. tuijazu*, n. sp.), while the medial hypopygium shows variable stages of longitudinal desclerotization among species. *Austerocardiochiles* is, in the analyses of Dangerfield et al. (1999), the sister group to *Cardiochiles* s. str. on the basis of the putative synapomorphy of the hypopygium being medially desclerotized (see Austin 1990 and Dangerfield et al. 1999 for a discussion of the polarity of this feature). It also has the lateral sutures of T1 defined and percurrent, a character also found, apparently independently, in *Hansonia* and *Heteropteron* (Dangerfield et al. 1999).

**KEY TO THE CHINESE SPECIES OF AUSTEROCARDIOCHILES**

1. T1 short, distinctly widened apically, 0.9 times as long as broad (Fig. 3); T2 punctate; wing membrane largely distinctly brown; clypeal tubercles obsolescent (Fig. 2); epicnemial carina absent; posterior cuplike pit of scutellum obvious; scutellar sulcus wide, 3.2 times as broad as long; hind basitarsus almost cylindrical; Rs bent in basal 0.20, straight to subapex, then curved downwards to apex (Fig. 1); hind wing with six hamuli; body large, approx. 9–10 mm

   - A. tuijazu n. sp.

2. Rs of fore wing evenly curved basally (Fig. 4); discal cell of fore wing 2.1 times longer than wide; T1 2.0 times longer than broad, bulblightly convex and less rugose (Fig. 5); middle lobe of T1 with a fine longitudinal carina in its longitudinal groove

   - A. xibocu, n. sp.

3. 3r in fore wing virtually always present as a spectral trace, if apparently absent then mouthparts elongate; glossa usually moderately elongate and deeply bilobed at apex; galea mostly long, narrow and bladelike

   - Schoenlandella Cameron

   - 3r in fore wing absent; glossa variable; galea never bladelike, usually short and, if moderately long, then broad

4. Hypopygium with medial longitudinal desclerotized and membranous area; galea long and broad, most clearly visible past mandible (glossa sometimes moderately long)

   - *Cardiochiles* Nees

   - Hypopygium evenly sclerotized throughout, sometimes partially desclerotized and folded inwards, but never membranous; galea short and either narrow or broad

5. Eye setae reduced to minute interommatidial spines; scutellum with apical cuplike pit

   - *Psilommuscus* Enderlein

   - Eye with conspicuous pilosity; apex of scutellum without cuplike pit

   - *Eurycardiochiles* Dangerfield, Austin, and Whitfield

Austerocardiochiles Dangerfield, Austin, and Whitfield. 1999

*Austerocardiochiles* Dangerfield, Austin, and Whitfield 1999: 929. Type species (by original designation): *Cardiochiles pollinator* Dangerfield and Austin.

The genus was proposed by Dangerfield et al. (1999) to include eight described species. Two additional described species, *Cardiochiles japonicus* (Watanabe), **n. comb.** (Japan) and C. *turga* (Belokobylskij), **n. comb.** (Russian Far East) are transferred into this genus (following Belokobylskij, personal communication). The number of species in this genus accounts for about 5% of the described cardiochiline species. It is widely distributed in the Old World, being recorded from Australia, Philippines, Laos, Japan, Russia, Africa, and now China, but most species occur in the Southern Hemisphere. The species known from Philippines and Laos are currently undescribed. The biology of this genus is unknown, but *A. enderleini* (Szepligeti) has been collected from crops of sweet potato (*Ipomaea* sp.) in Kenya.
middle lobe of T1 with a more prominent longitudinal carina in its longitudinal groove; A. zhejiangensis, n. sp.

**Austerocardiochiles tuiazu** Chen, Whitfield, and He, new species (Figs. 1–3)

Female.—Body length 9.8 mm, fore wing length 8.8 mm. **Head:** Eyes with moderately dense fine pilosity; head distinctly sculptured with dense long pilosity; labiomaxillary complex just visible below mandible; malar suture present; epistomal suture reduced but visible; clypeal margin convex laterally, with straight medio-lateral part and convex medial part with two obsolescent tubercles; clypeus convex and distinctly rugo-punctate, broad, 2.6 times as broad as high; face 2.0 times as broad as high, distinctly convex, transversely rugose, with medial dorsal node and irregular longitudinal carina indicated; frons distinctly concave, transversely carinate, with smooth medial carina; length of eye equal to length of temple in dorsal view; POL:OD:OOL = 7:6:21; vertex not raised behind ocelli, narrow, transversely rugose; depth of occiput in dorsal view 0.37 times length of head; antenna with 41(+) segments, short, robust, scape 1.4 times as long as broad; distance between antennal sockets equal to width of antennal socket.

**Mesosoma:** Side of pronotum distinctly longitudinally rugo-striate ventrally, rest rugo-striate, dorso-medial longitudinal furrow crenulate; notauli present, distinctly crenulate, of even width, meeting posteriorly; scutum distinctly punctate, middle lobe with a fine longitudinal carina in its longitudinal groove; parapsidal grooves present; scutellum sparsely pilose, coarsely...
rugose, 1.3 times as broad as long, lateral carinae distinct, posterior cuplike pit obvious; scutellar sulcus wide, 3.2 times as broad as long, with four carinae; dorsellum with medial longitudinal carina weakly defined; propodeal areola lens-shaped, 0.51 times as broad as long, propodeal spiracles elliptical, 2.2 times as long as broad; propodeum short, distinctly rugose; epicnemial carina absent; sternaulus distinct, broad, anteriorly crenulate, posterioirly nearly smooth; mesopleuron glabrous medially above sternaulus, below it foveate-rugose; metapleuron coarsely rugose.

**Legs:** Fore tibial spur 0.85 times as long as basitarsus; hind tibia expanded slightly at apex, 3.0 times as wide as at base; hind tibia and tarsus with brown spines among pilosity; inner hind tibial spur 1.4 times as long as outer spur, 0.7 times as long as basitarsus; hind basitarsus almost cylindrical with flattened dorsal ridge at base; tarsal claws pectinate, hind claw with six teeth.

**Wings:** Fore wing pilosity sparse at base, becoming thicker towards apex; stigma 4.0 times as long as wide; Rs bent in basal 0.2, straight to subapex, then curved downwards to apex; 1-SR+M 3.3 times as long as m-cu; 2-SR+M 1.7 times as long as m-cu; 1-M straight; m-cu 0.4 times as long as 1-M; 1-M 0.74 times as long as 1-SR+M; apical ¾ of 2-M and 3-M spectral; discal cell 1.5 times as long as wide; 2cu-a represented by pigmented area: 1a present, spectral in whole length; 1-2A+3A spectral, reaching to 1a; 1-CUa 0.27 times as long as 1-CUb; 2r 0.54 times inside height of second submarginal cell, arising 0.6 times length along stigma; second submarginal cell 2.4 times as long as wide; 2+3-SR slightly arched near 2-M; hind wing with six evenly spaced hamuli; 2-1A and 2A absent; 2-SC+R vertical; r present, spectral.

**Metasoma:** T1 short, distinctly widened apically, 0.9 times as long as broad, stem 0.3 times as long as bulb; bulb convex but medio-longitudinally concave, distinctly coarsely rugose; suture between T2 and T3 represented by well-defined groove; median field of T2 0.35 times as long as wide; T2 punctate; ovipositor sheaths broad and long, 0.55 times as long as hind tibia, 0.27 times as broad as long, densely hairy along length, broadening to and rounded at apex with dorsal notch; hypopygium with sparse fine hairs, hairless at apex, rounded and acutely angled at apex, largely sclerotised except medially slightly desclerotised with sclerotized bridge apically and basally.

**Color:** Black, fore tibia, tarsus and apex of fore femur orange; wing membrane distinctly brown. basally paler, stigma and veins dark brown.

**Male.—Unknown.**


Note.—This species is similar to *A. xibozu* and *A. zhejiangensis*, but can be separated from them by the characters listed in the key. From the type species, this species (as do the other two Chinese species below) has a broader and more apically rounded first metasomal tergite.

**Etymology.—**This species is named after one of the Chinese minorities, Tuja Zu, who live mainly in Hubei and Hunan provinces.

*Austerocardiochiles xibozu* Chen, Whitfield, and He, new species

(Figs. 4–6)

**Female.—**Body length 5.6 mm, fore wing length 5.4 mm. **Head:** Eyes with moderately dense fine pilosity; head distinctly sculptured with dense long pilosity; labio-
maxillary complex just visible below mandible; malar suture present; epistomal suture reduced medially; clypeal margin convex laterally, with straight medio-lateral part and convex medial part with two distinct tubercles; clypeus convex and distinctly rugo-punctate, broad, 2.1 times as broad as high; face 1.7 times as broad as high, distinctly convex, transversely rugose, with an obvious longitudinal carina; frons distinctly concave, transversely finely rugose, with a medial carina; length of eye 1.3 times as long as length of temple in dorsal view; POL:OD:OOL = 9.6:17; vertex not raised behind ocelli, narrow, transversely rugose; depth of occiput in dorsal view 0.52 times length of head; antenna with 39 segments, short, robust, scape distinctly punctate, 1.8 times as long as broad; distance between antennal sockets about equal to width of antennal socket.

Mesosoma: Side of pronotum coarsely longitudinally rugo-striate ventrally, rest rugo-striate, dorso-medial longitudinal furrow crenulate anteriorly; notauli present, distinctly crenulate, of even width, meeting posteriorly; scutum distinctly rugose, middle lobe with a fine longitudinal carina in its longitudinal groove; parapsidal grooves present; scutellar sulcus narrow, 4.4 times as broad as long, with four strong carinae; propodeal areola lens-shaped, 0.55 times as broad as long, propodeal spiracles elliptical, 2.5 times as long as broad; propodeum short, distinctly rugose; epicnemial carina present, distinctly ventrally; sternaulus distinct, broad, anteriorly crenulate, posteriorly nearly smooth; mesopleuron glabrous medially above sternaulus, below sternaulus striate-rugose; metapleuron coarsely rugose.

Legs: Fore tibial spur 0.9 times as long as basitarsus; hind tibia expanded slightly at apex, 3.0 times as wide as at base; hind tibia and tarsus with brown spines among pilosity; inner hind tibial spur 1.6 times as long as outer spur, 0.66 times as long as basitarsus; hind basitarsus compressed with flattened dorsal ridge at base; tarsal claws pectinate, hind claw with seven teeth.

Wings: Fore wing pilosity sparse at base, becoming thicker towards apex; stigma 3.4 times as long as wide; Rs bent in basal 0.25, straight to near apex, then slightly curved downwards to apex; 1-SR+M 3.6 times as long as m-cu; 2-SR+M 1.5 times as long as m-cu; 1-M straight; m-cu 0.4 times as long as 1-M; 1-M 0.7 times as long as 1-SR+M; apical ¾ of 2-M and 3-M spectral; discal cell 2.1 times as long as wide; 2cu-a represented by pigmented area; 1a present, spectral in whole length; 1-2A+3A spectral, reaching 1a; 1-CUa 0.32 times as long as 1-CUb; 2r 0.67 times inside height of second submarginal cell, arising 0.6 times length along stigma; second submarginal cell 2.6 times as long as wide; 2+3-SR slightly arched near 2-M; hind wing with five evenly spaced hamuli; 2-1A and 2A absent; 2-SC+R vertical; r present, spectral.

Metasoma: T1 long, hardly widened apically, 2.0 times as long as broad, stem about 0.33 times as long as bulb; tergite beside stem finely striate, bulb slightly convex, indistinctly rugose, but smooth apically; suture between T2 and T3 represented by well-defined groove; median field of T2 0.31 times as long as wide; T2 smooth; ovispositor sheath broad and long, 0.52 times as long as hind tibia, 0.29 times as broad as long, densely hairy along length, broadening to and rounded at apex with dorsal notch; hypopygium with sparse fine hairs, hairless at apex, rounded and acutely angled at apex, largely sclerotized except medially slightly desclerotized and folded inwards.

Color: Black; antenna and palpi dark brown; fore tibia, tarsus and apex of fore femur orange; tibia and basitarsus of middle leg brown, 2nd–5th tarsi of middle leg brownish yellow, middle and hind tibiae with a yellowish white basal ring; laterotergite of T1 dark reddish brown; wing membrane only brownish on apical ¼, rest
hyaline, stigma dark brown, veins brown to dark brown.

Male.—Unknown.

Material examined.—Holotype ♀, China: Jilin, Antu, 1994.viii.5–6, Lou Juxian, no.977083.

Note.—This species is closely similar to *A. rugosus* (Telenga) but can be separated from the latter by T1 longer, 2 times as long as wide, rugose, but smooth apically; eyes with moderately dense and fine pilosity; POL 1.5 times OD; and latero-tergite of first tergite ventrally dark reddish brown.

Etymology.—This species is named after one of the Chinese minorities, Xibo Zu, who live mainly in Jilin and Liaoning provinces.

**Asterocardiochiles zhejiangensis** Chen, Whitfield, and He, new species

(Figs. 7–9)

Female.—Body length 6.5 mm, fore wing length 6.1 mm. **Head:** Eyes with dense fine pilosity; head distinctly sculptured with dense long pilosity; labio-maxillary complex just visible below mandible; malar suture present; epistomal suture visible; clypeal margin convex laterally, with straight medio-lateral part and convex medial part with two tubercles; clypeus convex and distinctly rugose, broad, 2.1 times as broad as high; face 1.7 times as broad as high, distinctly convex, coarsely rugose, with strong but fine medio-longitudinal carina; frons distinctly concave, transversely carinate, with smooth medial carina; length of eye 1.3 times as long as temple in dorsal view; POL:OD:OOL = 10:6.5:18; vertex slightly raised behind ocelli, narrow, coarsely rugose; depth of occiput in dorsal view 0.6 times length of head; antenna with 41 segments, short, robust, sacape 1.7 times as long as broad; distance between antennal sockets equal to width of antennal socket.

**Mesosoma:** Side of pronotum coarsely longitudinally striate ventrally, dorso-medial longitudinal furrow coarsely crenulate; notauli present, distinctly crenulate, of even width, meeting posteriorly; scutum distinct-

ly foveate-rugose, middle lobe with a distinct longitudinal carina in its longitudinal groove; parapsidal grooves present; scutellum moderately densely pilose, coarsely rugose, 1.3 times as broad as long, without posterior cuplike pit; scutellar sulcus narrow, 4.5 times as broad as long, with two strong carinae; dorsellum without medial longitudinal carina; propodeal areola lens-shaped, 0.57 times as broad as long, propodeal spiracles elliptical, 2.3 times as long as broad; propodeum short, distinctly rugose; epicnemial carina present, distinctly ventrally; sternaulus distinct, broad, anterio-rly crenulate, posteriorly nearly smooth; mesopleuron glabrous medially above sternaulus, below it foveate-rugose; metapleu-
ron coarsely rugose.

**Legs:** Fore tibial spur 0.9 times as long as basitarsus; hind tibia expanded at apex, 3.1 times as wide as at base, with a longitudinal groove on its outside at apical ½; hind tibia and tarsus with brown spines among pilosity; inner hind tibial spur 1.4 times as long as outer spur, 0.7 times as long as basitarsus; hind basitarsus compressed with flattened dorsal ridge at base; tarsal claws pectinate, hind claw with seven teeth.

**Wings:** Fore wing pilosity sparse at base, becoming thicker towards apex; stigma 3.7 times as long as wide; Rs angularly bent in basal 0.24, straight to apex; 1-SR+M 4.0 times as long as m-cu; 2-SR+M 1.7 times as long as m-cu; 1-M straight; m-cu 0.4 times as long as 1-M; 1-M 0.63 times as long as 1-SR+M; apical ¾ of 2-M and 3-
M spectral; discal cell 1.7 times as long as wide; 2cu-a represented by pigmented area; 1a present, spectral in whole length; 1-
2A+3A spectral, reaching 1a; 1-CUa 0.37 times as long as 1-CUb; 2r 0.64 times in-
side height of second submarginal cell, arising 0.68 times length along stigma; second submarginal cell 2.5 times as long as wide; 2+3-SR slightly arched near 2-M; hind wing with five evenly spaced hamuli; 2-1A and 2A absent; 2-SC+R vertical; r present, spectral.
Metasoma: T1 long, hardly widened apically, 1.4 times as long as broad; stem 0.28 times as long as bulb; tergite beside stem longitudinally striate; bulb distinctly convex but medio-longitudinally concave, distinctly coarsely rugose, apically smooth; suture between T2 and T3 represented by well-defined groove; median field of T2 0.33 times as long as wide; T2 smooth; ovipositor sheath broad and long, 0.56 times as long as hind tibia, 0.28 times as broad as long, densely hairy along length, broadening to and rounded at apex with dorsal notch; hypopygium with sparse fine hairs, hairless at apex, rounded and acutely angled at apex, largely sclerotized except medially slightly desclerotized and folded inwards.

Color: Black; antenna and palpi dark brown; fore tibia, tarsus and apex of fore femur orange, middle tarsus brown to dark brown, middle and hind tibiae with a yellowish white basal ring: latero-tergite of T1 dark reddish brown; wing membrane distinctly brown at apical 1/3, basally hyaline, stigma and veins dark brown.

Variation.—Body length 6.5-7.0 mm, fore wing length 6.1-6.5 mm. Bulb of first tergite convex but medio-longitudinally not concave.

Male.—Unknown.


Note.—This species is similar to A. rugosus (Telenga), but can be separated from the latter species by having the Rs of fore wing angularly bent in basal 0.24, then straight to apex; bulb of first tergite convex, distinctly coarsely rugose, apically smooth, and sometimes medio-longitudinally concave; and POL longer than OD. It is also similar to A. xibozu n. sp., but can be distinguished from the latter by the characters listed in the key.

Etymology.—This species is named after Zhejiang province in China, on the east border of the Palaearctic and Oriental regions, where this new species occurs.

Eurycardiochiles Dangerfield, Austin, and Whitfield, 1999

Eurycardiochiles Dangerfield, Austin, and Whitfield 1999: 938. Type species (by original designation): Cardiochiles occidentalis Dangerfield and Austin.

This genus can be recognized by having an apically strongly broadened ovipositor sheath and a broadened clypeus. It is the sister group to Schoenlandella + Austerocardiochiles + Cardiochiles s. str., all of which have antennae of more than 33 segments, and two apical clypeal tubercles. It is known previously from Australia with the type species and Sri Lanka with an undescribed species. The biology of the genus is unknown.

This genus is recorded here for the first time in China and three new species are described below. The Chinese species described here are quite different from the type species in general appearance. The type species has the head and mesosoma largely smooth, and the hypopygium evenly sclerotized while all Chinese species have the head and mesosoma largely sculptured and the hypopygium medio-longitudinally less strongly sclerotized and often folded inwards. For the moment the Chinese species appear to fit best within Eurycardiochiles, but eventually may be found to represent a distinct group.

**Key to Species of Eurycardiochiles**

1. Head and mesosoma largely smooth; median field of T2 0.5 times as long as wide; hypopygium evenly sclerotized .................
   · E. occidentalis Dangerfield and Austin
   · Head and mesosoma largely sculptured; median field of T2 0.28-0.32 times as long as wide; hypopygium medio-longitudinally less sclerotized and folded inwards ................. 2

2. Body smaller, about 5.5 mm; face 1.9 times as broad as high; vein 1-CUa of fore wing 0.33 times vein 1-CUb; first metasomal tergite longer, 1.2 times as long as broad; antenna with 37 segments ................. E. dongzu, n. sp.
   · Body larger, about 7.8-8.1 mm; face 1.5 times
as broad as high; vein 1-CUa of fore wing 0.42–0.46 times vein 1-CUb; first metasomal tergite short, as long as broad; antenna with 41–46 segments .................................

3. Clypeal margin medially with two distinct tubercles; face with a distinct medio-longitudinal carina; wing membrane entirely evenly brownish; vein m-cu of fore wing 0.4 times vein l-M; hind claw with eight teeth; hind wing with eight hamuli; and antenna with 46 segments ................................. E. shezu, n. sp.

- Clypeal tubercles indistinct; medio-longitudinal carina on face much less distinct; wing membrane much less brownish basally; vein m-cu of fore wing 0.5 times vein l-M; hind claw with nine teeth, hind wing with six hamuli; and antenna with 41 segments ................................. E. jilong, n. sp.

**Eurycardiochiles dongzu** Chen, Whitfield, and He, new species (Figs. 10–12)

Female.—Body length 5.5 mm, fore wing length 5.3 mm. Head: Eyes with dense fine pilosity; head sculptured with moderately dense long pilosity; labio-maxillary complex just visible below mandible; malar suture present; epistomal suture visible; clypeal margin convex laterally, with straight medio-lateral part and convex medial part with two distinct tubercles (Fig. 12); clypeus broad, convex and distinctly rugose, 2.2 times as broad as high; face 1.9 times as broad as high, coarsely transversely rugose, with a weak medio-longitudinal carina; frons transversely striate, with a medial carina reaching near anterior ocellus; vertex not raised behind ocelli, narrow, coarsely transversely striate; depth of occiput in dorsal view 0.53 times length of head; length of eye 1.4 times length of temple in dorsal view; POL:OD:OOL = 9:6:15; antenna with 37 segments, short, thick, scape 1.7 times as long as broad; antennal sockets separated by 0.83 times width of antennal socket.

**Mesosoma:** Side of pronotum coarsely longitudinally striate ventrally, dorso-medial longitudinal furrow coarsely crenulate, rest striate; notauli present, deep, crenulate, of even width, meeting posteriorly; scutum distinctly rugose, a medio-longitudinal carina present in medio-longitudinal groove; parapsidal grooves present; scutellum with dense long pilosity, coarsely rugose, 1.4 times as broad as long, lateral carinae distinct; scutellar sulcus very narrow, 5.1 times as broad as long, with four carinae; dorsellum with a weak medial longitudinal carina; propodeum short, rugose, with crenulate branching from areola; propodeal areola lens-shaped, 0.57 times as broad as long, propodeal spiracles elliptical, 2.2 times as long as broad; epicnemial carina present; sternaulus broad, coarsely crenulate; mesopleuron smooth and shiny above sternaulus, below sternaulus distinctly reticulate-rugose.

**Wings:** Fore wing (Fig. 10) with dense pilosity, much thicker towards apex; stigma 3.2 times as long as wide; 2r 0.43 times inside height of second submarginal cell, arising 0.62 times length along stigma; Rs bent at basal 0.20, then nearly straight to apex; second submarginal cell 2.4 times as long as wide; 2+3-SR slightly arched near 2-M; 1-SR+M 3.7 times as long as m-cu; 2-SR+M 1.8 times as long as m-cu; 1-M straight; m-cu 0.39 times as long as 1-M; 1-M 0.70 times as long as 1-SR+M; discal cell 1.55 times as long as wide; 2cu-a presented by pigmented area; 1a present, spectral in apical two-thirds; 1-A+3A spectral, reaching to 1a; 1-CUa 0.33 times as long as 1-CUb; hind wing with five evenly spaced hamuli; 2-1A and 2A absent; 1-SRa present but short.

**Metasoma:** T1 widened apically, 1.2 times as long as broad, stem 0.26 times as long as bulb, tergite beside stem nearly smooth, bulb convex and smooth (Fig. 11); suture between T2 and T3 represented by
well-defined groove; median field of T2 0.28 times as long as wide; T2 smooth; ovi-
positor sheaths broad and long, 0.56 times as long as hind tibia, 0.28 times as broad as long, densely hairy along length, broad-
ening to and rounded at apex with dorsal notch; hypopygium with moderately dense hair laterally, hairless at apex, rounded and acutely angled at apex, evenly sclerotized except for medio-longitudinally less scler-
otized and folded inwards.

**Color:** Black; fore tibia, tarsus and apex of femur, middle tarsus and basal 0.2 of middle tibia, basal 0.2 of hind tibia brownish yellow to orange, first tergite except for stem and bulb dark red; wing membrane brown, paler basally, stigma and veins brown to dark brown.

**Male.—Unknown.**

**Material examined.—Holotype ♀, China: Hunan, Liuyang, 1984.viii.31, collector un-
known, no.846373.**

**Note.—This new species can be easily separated from the type species, *E. occiden-
talis* by the largely sculptured head and meso-
soma; hypopygium medio-longitudinally less sclerotized and folded inwards; median field of T2 more transverse, 0.28 times as long as wide; and hind claw with six teeth.**

**Etymology.—This species is named after one of the Chinese minorities, Dong Zu, who mainly live in Hunan and Guizhou provinces, and in the Guangxi Autonomous Administration Region.**

**Eurycardiochiles jiu-long** Chen, Whitfield, and He, new species

(Figs. 13–15)

**Female.—Body length 7.8 mm, fore wing length 7.8 mm. Head:** Eyes with dense fine pilosity; head sculptured with moderately dense long pilosity; labio-max-
illary complex just visible below mandible; malar suture present; epistomal suture vis-
ible; clypeal margin convex laterally, then evenly convex medially with two very faint tubercles (Fig. 15); clypeus broad, convex and distinctly rugose, 2.2 times as broad as high; face 1.5 times as broad as high, coarsely transversely rugose, with a fine medio-longitudinal carina; frons transverse-
ly striate, with a medial carina reaching to anterior ocellus; vertex not raised behind ocelli, narrow, coarsely transversely striate; depth of occiput in dorsal view 0.58 times length of head; length of eye 1.3 times length of temple in dorsal view; POL:OD: 

OOL = 10:6.5:21; antenna with 41 seg-
ments, short, thick, scape 2.0 times as long as broad; antennal sockets separated by 0.9 times width of antennal socket.

**Mesosoma:** Side of pronotum coarsely longitudinally striate ventrally, dorso-me-
dial longitudinal furrow coarsely rugose, rest striate; notauli present, deep, crenulate, of even width, meeting posteriorly; scutum distinctly rugose, a medio-longitudinal carina present in medio-longitudinal groove; parapsidal grooves present; scutellum with dense long pilosity, coarsely rugose, 1.3 times as broad as long, lateral carinae dis-
tinct; scutellar sulcus narrow, 3.6 times as broad as long, with three carinae; dorsellum with a fine medial longitudinal carina; pro-
podeum short, rugose, with crenulae branching from areola; propodeal areola lens-shaped, 0.47 times as broad as long, propodeal spiracles elliptical, 2.2 times as long as broad; epicnemial carina present ventrally; sternaulus shallow, broad, coarse-
ly crenulate; mesopleuron smooth and shiny above sternaulus, below sternaulus distinct-
ly reticulate-rugose.

**Legs:** Fore tibial spur as long as basitar-
sus; hind tibia expanded at apex, 2.9 times as wide as at base; hind tibia and tarsus with brown spines among pilosity; inner hind tibial spur 1.6 times as long as outer spur, 0.75 times as long as basitarsus; hind basitarsus moderately compressed with flatt-
tened dorsal ridge at base; tarsal claws pec-
tinate, hind claw with nine brown teeth.

**Wings:** Fore wing (Fig. 13) with dense pilosity, much thicker towards apex; stigma 3.7 times as long as wide; 2r 0.46 times inside height of second submarginal cell, arising 0.62 times length along stigma; Rs bent at basal 0.15, then nearly straight to
apex; second submarginal cell 2.9 times as long as wide; 2+3-SR slightly arched near 2-M; 1-SR+M 3.0 times as long as m-cu; 2-SR+M 1.3 times as long as m-cu; 1-M straight; m-cu 0.5 times as long as 1-M; 1-M 0.67 times as long as 1-SR+M; discal cell 1.5 times as long as wide; 2cu-a represented by pigmented area; la present, spectral in apical two-thirds; 1-2A+3A spectral, reaching to 1a; 1-CUb 0.46 times as long as 1-CUb; hind wing with six evenly spaced hamuli; 2-1A and 2A absent; 1-SRa shortly present.

*Mesosoma:* T1 short, widened apically, as long as broad, stem 0.3 times as long as bulb, tergite beside stem finely longitudinally striate, bulb largely smooth, but basally rugulose, medio-longitudinally concave (Fig. 14); suture between T2 and T3 represented by well-defined groove; median field of T2 0.32 times as long as wide; T2 punctulate; ovipositor sheaths broad and long, 0.48 times as long as hind tibia, 0.34 times as broad as long, densely hairy along length, broadening to and rounded at apex with dorsal notch; hypopygium with moderately dense hair laterally, hairless at apex, rounded and acutely angled at apex, evenly sclerotized except for medio-longitudinally less sclerotized and folded inwards.

*Color:* Black; palpi, fore tibia, tarsus and apex of femur, middle tarsus and basal ⅓ of middle tibia, basal ⅓ of hind tibia brownish yellow to orange, first tergite except for stem and bulb dark red; wing membrane brown, much paler basally, stigma and veins dark brown.

Male.—Unknown.


Note.—This new species is similar to *E. shezu*, but can be separated from the latter by the indistinct clypeal tubercles; medio-longitudinal carina on face much less distinct; wing membrane much less brownish; hind claw with nine teeth, hind wing with six evenly spaced hamuli; and antenna with 41 segments.

**Eurycardiochiles shezu** Chen, Whitfield, and He, new species (Figs. 16–18)

Female.—Body length 7.9 mm, fore wing length 7.9 mm. *Head:* Eyes with dense fine pilosity; head sculptured with moderately dense long pilosity; labio-maxillary complex just visible below mandible; malar suture present; epistomal suture visible; clypeal margin convex laterally, with straight medio-lateral part and convex medial part with two small tubercles (Fig. 18); clypeus broad, convex and distinctly rugose, 2.3 times as broad as high; face 1.5 times as broad as high, coarsely transversely rugose, with a distinct medio-longitudinal carina; frons transversely striate, with a medial carina reaching to anterior ocellus; vertex not raised behind ocelli, narrow, coarsely transversely striate; depth of ocellar pits in dorsal view 0.47 times length of head; length of eye 1.2 times length of temple in dorsal view; POL:OD:OOL = 8:6:18; antenna with 46 segments, short, thick, scape 1.9 times as long as broad; antennal sockets separated by 0.8 times width of antennal socket.

*Mesosoma:* Side of pronotum coarsely longitudinally striate ventrally, dorso-medial longitudinal furrow coarsely crenulate, rest striate; notauli present, deep, crenulate, of even width, meeting posteriorly; scutum distinctly rugose, a medio-longitudinal carina present in medio-longitudinal groove; parapsidal grooves present; scutellum with dense long pilosity, coarsely rugose, 1.4 times as broad as long, lateral carinae distinct; scutellar sulcus narrow. 3.4 times as broad as long, with four carinae; dorsellum without medial longitudinal carina; propo-
deum short, rugose, with crenulae branching from areola; propodeal areola lens-shaped, 0.5 times as broad as long, propodeal spiracle elliptical, 2.3 times as long as broad; epicnemial carina present ventrally; sternaulus shallow, broad, coarsely crenulate; mesopleuron smooth and shiny above sternaulus, below sternaulus distinctly reticulate-rugose.

**Legs:** Fore tibial spur 0.89 times as long as basitarsus; hind tibia expanded at apex, 2.7 times as wide as at base, medio-longitudinally slightly concave on outer side at apical ½; hind tibia and tarsus with brown spines among pilosity; inner hind tibial spur 1.6 times as long as outer spur, 0.65 times as long as basitarsus; hind basitarsus moderately compressed with flattened dorsal ridge at base; tarsal claws pectinate, hind claw with eight teeth.

**Wings:** Fore wing (Fig. 16) with dense pilosity, much thicker towards apex; stigma 3.0 times as long as wide; 2r 0.48 times inside height of second submarginal cell, arising 0.63 times length along stigma; Rs bent at basal 0.23, then nearly straight to apex; second submarginal cell 2.6 times as long as wide; 2+3-SR slightly arched near 2-M; 1-SR+M 3.3 times as long as m-cu; 2-SR+M 1.6 times as long as m-cu; 1-M straight; m-cu 0.40 times as long as 1-M; 1-M 0.72 times as long as 1-SR+M; discal cell 1.7 times as long as wide; 2cu-a presented by pigmented area; 1a present, spectral in apical two-thirds; 1-2A and 2A absent; 1-CUb present.

**Metasoma:** T1 short, widened apically, as long as broad, stem 0.25 times as long as bulb, bulb distinctly punctate-rugose (Fig. 17); suture between T2 and T3 represented by well-defined groove; median field of T2 0.29 times as long as wide; T2 punctate; ovipositor sheaths broad and long.

0.48 times as long as hind tibia, 0.34 times as broad as long, densely hairy along length, broadening to and rounded at apex with dorsal notch; hypopygium with moderately dense hair laterally, hairless at apex, rounded and acutely angled at apex, evenly sclerotized except for medio-longitudinally less sclerotized and folded inwards.

**Color:** Black; fore tibia, tarsus and apex of femur, middle tarsus and basal ½ of middle tibia, basal 0.6 of hind tibia brownish yellow to orange, first tergite except for stem and bulb dark red; wing membrane entirely evenly brown, stigma and veins brown to dark brown.

Male.—Body length 7.8–8.1 mm, fore wing length 8.0–8.2 mm. Antenna slender, 46 segments.


Note.—This new species is similar to *E. dongzu*, but can be separated from the latter by the larger body; shorter first tergite (as long as wide); T1 and T2 punctate; wing membrane evenly entirely brownish; hind claw with eight teeth; hind wing with eight evenly spaced hamuli; and antenna with 46 segments.

Etymology.—This species is named after one of the Chinese minorities, She Zu, who mainly live in Zhejiang, Jiangxi, Anhui and Fujian provinces.

*Psilommiscus* Enderlein, 1912

*Psilommiscus* Enderlein 1912: 98. Type species (by monotypy): *Psilommiscus sumatranus* Enderlein.

This genus was brought out of synonymy with *Cardiochiles s. l.* as the sister group of *Hansonia* Dangerfield based on the phylogenetic analysis of Dangerfield et al. (1999). Mercado and Wharton (2003) cast doubt upon the sister-group relationship with *Hansonia*, so currently the relationships of this genus are uncertain. It shares with *Hansonia* the presence of two clypeal tubercles and the reduction of eye setae, but can be separated from the latter by the presence of the occipital carina in the malar region, the apical scutellum with a cup-shaped medial pit, Rs curved in the fore wing, and the broad form of T1 and T3, which are laterally compressed and elongate in *Hansonia*. The genus is known only from the type species, *P. sumatranus* Enderlein in Sumatra, and three undescribed species from Brunei, Peninsula Malaysia, and eastern Malaysia (Dangerfield et al. 1999).

This genus is reported here for the first time in China and the type species is recorded below from the northeastern part of the Oriental Region in China.

*Psilommiscus sumatranus* Enderlein

*Psilommiscus sumatranus* Enderlein 1912: 98.

Material examined.—1 ♀, China: Fujian, Shaowu, 1945.x.1, Zhou Xiu fu (= Chao Hsiufu); 1 ♀, China: Fujian, Guadun, 1963.vii.12, Chen Jiahua.

Distribution.—China (Fujian); Sumatra.

Note.—This species is new to China.

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THE WORLD SUBGENERA OF Glossosoma CurtiS (Trichoptera: Glossosomatidae), With A REVIEw Of The CHINESE SPECIES Of Glossosoma SUBGENERA Synafophora Martynov And ProtoGlossa Ross

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Abstract.—Newly discovered morphological evidence suggests that there are six principal monophyletic lineages of Glossosoma globally. We designate these as subgenera and infer the relationships among them using PAUP (Ripae glossa ((Protoglossa + Lipoglossa) (Muroglossa (Glossosoma + Synafophora)))). Species of Glossosoma subgenus Synafophora are reported from China for the first time. Subgenus Synafophora is represented in Palearctic China by five species: Glossosoma (Synafophora) altaicum (Martynov), G. (S.) intermedium (Klapálek), G. (S.) minutum (Martynov), G. (S.) nylanderi (McLachlan), and G. (S.) ussuricum (Martynov). Glossosoma (Protoglossa) currently includes two species, both of which are known only from Oriental China. We transfer the Indian (Sikkim) species Glossosoma (Lipoglossa) kchinn Schmid 1971, to subgenus Protoglossa and review the Chinese species of subgenera Synafophora and Protoglossa.

Key Words: Trichoptera, Glossosomatidae, Glossosoma, Synafophora, Protoglossa, phylogeny, male genitalia

The genus Glossosoma Curtis 1834, is widely distributed in the Oriental and Holartic Biogeographic Regions and contains 115 species and 2 subspecies (Morse 2001). Ross (1956) inferred nine subgenera for the genus but Morse and Yang (1993) inferred only six subgenera. Schmid (1980, 1998) said that the genus “is of Oriental origin, with its most primitive subgenera, Lipoglossa Martynov and Muroglossa Ross, being located there.” A review of these opinions is warranted, requiring careful examination of representatives of all purported groups and reinterpretation of several characteristics of male genitalia that were thought by Ross (1956) to be novelties in the genus.

Thirty-two species of Glossosoma have been reported from China to date. Major cooperative expeditions in southeastern, south central, and north central China in 1990, 1996, and 1998 have increased our knowledge of Chinese Glossosoma species considerably. Yang and Morse (2002) reported on the species of Glossosoma subgenus Lipoglossa. In this paper, we are able to report five Glossosoma species of subgenus Synafophora Martynov that are new records for China and to review the two Chinese species of Protoglossa Ross. All specimens used in this research are preserved in the collections of Nanjing Agricultural University (NAU) unless otherwise indicated (see Acknowledgments).
Fig. 1. Phylogeny, distributions, and species numbers of subgenera of *Glossosoma*. EP = East Palearctic. NA = Nearctic, OL = Oriental, WP = West Palearctic.

**Glossosoma** Subgenera

The family Glossosomatidae was revised at the family-group and genus-group levels by Ross (1956) and Morse and Yang (1993). In the course of redescribing the species herein and reviewing the structure of additional species, our knowledge of the synapomorphic homologues at the generic and subgeneric levels for *Glossosoma* was much improved. Besides the consolidation of several of his subgenera, our phylogeny (Fig. 1; inferred with PAUP version 3.1.1.; CI = 0.917, HI = 0.083, RI = 0.800, RC = 0.733) differs from that of Ross (1956) because of new understanding of structures of sternum IX, the inferior appendages, and the phallus. By examination of specimens from a broader range of species than were available to Ross (the genus has more than doubled in number of species since 1956), we have come to realize that the structures he called "claspers" (= inferior appendages) are, in fact, a ventral projection of sternum IX and that his new so-called "fixed spiny lobes of the aedeagus" are, in fact, the inferior appendages, much modified in this genus. Our interpretations of these and other synapomorphies and reinterpretations of our earlier (1993) conclusions, relative to outgroups Agapetus (Glossosomatidae) and *Rhyacophila* (Rhyacophilidae) are numbered below to correspond with the numbers in Fig. 1.

As a result of this analysis, we still recognize six subgenera, although the justification for them now is more firmly established by this investigation. The six subgenera and their synonyms are as follows (Morse and Yang 1993):

- *Glossosoma* Curtis 1834
  - **Anseriglossa** Ross 1956
  - **Lipoglossa** Martynov 1930
  - **Muroglossa** Ross 1956
  - **Protoglossa** Ross 1956
  - **Sinoglossa** Ross 1956
  - **Ripteglossa** Ross 1956
  - **Synapophora** Martynov 1927
    - **Diploglossa** Martynov 1934a
    - **Eomysira** Martynov 1934a
    - **Klapalekia** Botosaneanu 1955
    - **Mystroglossus** Kobayashi 1982
    - **Mystrophora** Klápálek 1892
    - **Mystrophorella** Kloet and Hincks 1944

**Morphology and Synapomorphies**

Unguicurator plate.—For his new genus *Synapophora*, Martynov (1927) described a new character, an enlarged inner unguicurator lobe present apically on each front leg in all males of the *Synapophora*. Later, he used this character as a major diagnostic
feature for *Synafophora* in his key to his Glossosomatidae genera (Martynov 1934a). We now submit that this character is found in all major species groups of *Glossosoma* and probably is a synapomorphy (Synapomorphy #1) for the genus (Figs. 2–6).

Male forewing callosity.—It has long been noted that the males of many *Glossosoma* species have a “callosity” in the anal region of each forewing (McLachlan 1879), with the venation of females normal. However, the details of this peculiarity have not previously been compared widely throughout the genus. There appear to be three general patterns that seem not to be part of the same transformation series:

**Pattern #1**: Male forewing vein 2A is elongated (Synapomorphy #2; Figs. 8–12, 60, 66) in subgenera Lipoglossa and Protoglossa, and in many species it extends nearly to the arculus (Figs. 8, 12, 60, 66). Vein 2A (Fig. 8) and sometimes also 3A (Figs. 8, 10–12, 60, 66) are thickened in a variable pattern (Synapomorphy #3). When both veins are thickened, the two are sometimes fused with each other over much or all of their length, forming a broad diffusion area which is only slightly thickened, flat, and translucent.

**Pattern #2**: Male forewing vein 2A is shortened and strongly curved toward 3A, often weakened apically, usually accompanied by a rounded, thickened, translucent diffusion area on the posterior side or both sides of the vein (Synapomorphy #4; Figs. 16–25) in subgenera Ripaeglossa and Synafophora and some *Glossosoma*. We are unable to distinguish consistent patterns among these callosities, although other characters suggest that *Ripaeglossa* is distantly related to subgenera Glossosoma and Synafophora, suggesting a homoplasious parallelism in this “synapomorphy.” Some species have a dorsally protruding flap (Figs. 15, 16, 21), but this flap is not homologous in the three subgenera: The flap seen in some species of subgenus *Glossosoma* (Figs. 15a, 15b) entails a highly modified anastomosis of 1A and 3A; the flap seen in some species of *Synafophora* (Fig. 21) involves a modified vein 3A at mid-length; and the flap seen in some species of *Ripaeglossa* involves no vein modifications (Fig. 16).

**Pattern #3**: Male forewing vein 2A is shortened and extremely swollen in some species of subgenus *Glossosoma*, forming an ovate area typified by very well-defined margins and very thick, leather-like, opaque appearance (Figs. 13–14). It is quite consistent and is remarkably different from the callosity of those species of subgenus *Glossosoma* that have the fan-like fold mentioned above (Figs. 15a, 15b); there are no intermediate forms between these two types of callosity in subgenus *Glossosoma*. For now, we consider these two types of callosity as possible synapomorphies that may have relevance for recognizing species groups within subgenus *Glossosoma*.

Sternum IX.—The ventral process of segment IX [= unpaired ventral appendage of the 9th sternite (Martynov 1935); ventral process of IX (Kimmins 1953); tongue of IX (Ross 1956)] is evident in the lineage of *Muroglossa + Synafophora + Glossosoma* (Figs. 26, 28, “v.p. IX”). This structure (Synapomorphy #5) clearly arises from segment IX without articulation, although its base is sometimes quite slender; it is symmetrical in *Glossosoma* (*Muroglossa*), asymmetrical in *Glossosoma* (*Glossosoma*) (Ross 1956, figs. 327B, 328B; Synapomorphy #6), and deeply divided (and sometimes asymmetrical) in *Glossosoma* (*Synafophora*) (Figs. 28, 35, 40, 45, 51; Synapomorphy #7).

In *Synafophora*, the sclerotization of the ventral process of sternum IX continues into the phallicrypt as a high keel (Figs. 25, 30; Ross 1956) from which the inferior appendages arise (Synapomorphy #8).

Inferior appendages.—In subgenera *Muroglossa + Glossosoma + Synafophora*, the inferior appendages are vertical basally, with the bases parallel with the caudal edges of segment IX and attached by narrow membranous strips laterally with segment
Figs. 2–12. Characters of Glossosoma species. 2–6, Distotarsus, claws, and unguitractor lobes on Glossosoma male front legs; a. = dorsal, b. = ventral, c. = mesal. 2, G. (G.) aequale Banks, 1940, right front leg. 3, G. (Ripaeglossa) califica Denning, right front leg. 4, G. (Synafothora) minutum, left front leg. 5, G. (Synafothora) altaicum, left front leg. 6, G. (Lipoglossa) adunatum Yang and Morse, left front leg. 7, G. (G.) aequale, female right front leg, ventral. 8, G. (L.) mirabile Yang and Morse, male right forewing, dorsal. 9–12, Male right forewing anal region, dorsal. 9, G. (L.) adunatum. 10, G. (L.) tortum Yang and Morse. 11, G. (L.) kelleyi Ross. 12, G. (L.) phyllon Yang and Morse. 1A, 2A, 3A = independent first, second, and third anal veins; 1A+2A+3A = fused anal veins; I, II, III, IV, V = first, second, third, fourth, and fifth apical Forks; arculus = junction of 1A+2A+3A and Cu._2 on hind margin. Cu._2 = second cubital vein.
IX, such that only the apex of each inferior appendage, characteristically setose, is free from the membrane (Figs. 26, 30, "inf.app."; Synapomorphy #9; Schmid 1971, figs. 33, 38). For subgenus *Glossosoma*, Ross (1956, e.g., figs. 331A, "lt," and 327A, "tf") referred to these inferior appendages as the "lateral tendons" and their setose, free ends as "tendon flaps."

The inferior appendages of subgenus *Synafophora* are deeply imbedded in the phallicrypt, intimately appressed to the phallus, embracing it laterally (Figs. 26, 33, 38, 43, 49; Synapomorphy #10). Ross (1956) referred to this form of the inferior appendages in *Synafophora* as the "dorsal lobes of the aedeagus."

The apices of the inferior appendages of subgenus *Muroglossa* are approximate dor-sally above the phallus, anteriorly forming a bridge above the phallus that is nearly or completely fused (Synapomorphy #12).

Inferior appendages are elongate in *Lipoglossa* (Morse and Yang 1993, #39, as "ventral lobes of inferior appendages"; Synapomorphy #13 herein).

Inferior appendages are short and triangular in lateral view in *Protaglossa* (Figs. 56, 62; Synapomorphy #14).

Tergum X.—Tergum X is reduced in size and retracted beneath tergum IX and preanal appendages in *Ripaeglossa* (Morse and Yang 1993, #31 as "tergum IX hood-like"; Synapomorphy #15 herein).

Paired preanal appendages and tergum X are fused with each other and generally indistinguishable in *Muroglossa + Glossosoma + Synafophora + Protaglossa + Li-
phallosa (Figs. 26, 27, "X + pr.app."); Morse and Yang 1993, #32: Synapomorphy #16 herein).

Phallocrypt sclerotizations.—A pair of sclerotized strips is seen dorsally in the phallocrypt of subgenus Glossosoma. These dorsolateral strips are long, broad, foliaceous, and often setose, connecting the dorsolateral edge of the phallobase with the respective halves of the combined tergum X and preanal appendages (Synapomorphy #11). Ross (1956, e.g., figs. 327A, 329A, "dt") referred to these structures as “dorsal tendons.”

In subgenus Synafophora, a unique pair of well-developed lateral strips of the phallocrypt extend on each side from the apicolateral edge of the keel-bearing plate of sternum IX to the mesal bases of the respective halves of the combined tergum X and preanal appendages (Figs. 26, 33, 38, 43, 49, "lat.str.": Synapomorphy #17). These may be narrow (e.g., Fig. 26) or very broad (Fig. 49). Ross (1956, figs. 314A, 315A, 318E, 320A, "t") referred to these structures as simply the “tendons.”

The phallic shield is sclerotized in various degrees laterally and ventrally in Protoglossa and Lipoglossa, fusing with the basomesal surfaces of the inferior appendages (Fig. 59; Synapomorphy #18). This represents a new understanding of Morse and Yang’s (1993, #33) “basal plate cupping the phallobase.”

In Lipoglossa, this sclerotization is extensive, causing the ventral phallocrypt to become a deep cup beneath the phallos (Yang and Morse 2002, fig. 5; Synapomorphy #19).

Phallus.—The phallobby and phallicata are fused in Protoglossa (Figs. 59, 65; Synapomorphy #20).

Paramere spines are absent in Synafophora and Protoglossa (Figs. 29, 59; Morse and Yang 1993, #34 and 36; Synapomorphy #21 herein), apparently having been lost independently in these lineages.

The paramere spine is single, on a long erectile lobe, and terminating in a conical tuft of bristles in subgenus Glossosoma (Ross 1956, fig. 331E; Synapomorphy #22).

The phallicata is very long and compressed, bladelike, and also the phallobase is elongate in Muroglossa (Ross 1956, fig. 325C: Synapomorphy #23).

**Monophyly of Each Subgenus**

*Ripaeglossa* is a monophyletic group as evidenced by Synapomorphies #4 and 15. Synapomorphy #4 occurs in parallel in Glossosoma and Synafophora.

*Muroglossa* is a monophyletic group as evidenced by Synapomorphies #12 and 23. Morse and Yang (1993) inferred its monophyly based on “ventral lobes of inferior appendages broad apically.” but we now understand that this is a plesiomorphic, undivided, and symmetrical condition of the ventral process of sternum IX.

The subgenus Glossosoma is a monophyletic group as evidenced by Synapomorphies #4, 6, 11, and 22. Character #4 appears similar in Ripaeglossa and Synafophora. Synapomorphy #6 is a reinterpretation of Morse and Yang’s (1993, #42) “ventral lobe of left inferior appendage absent.” Synapomorphies #11 and 22 are newly observed.

Morse and Yang (1993) inferred that Synafophora is monophyletic based on a single synapomorphy: the absence of paramere spines (Synapomorphy #21 herein), although Synafophora is similar in this regard to Protoglossa. Character #4 of Synafophora is similarly expressed in Glossosoma and Ripaeglossa. However, with four additional synapomorphies (#7, 8, 10, 17), the monophyly for Synafophora is corroborated.

The characters observed for Protoglossa that suggested its monophyly for Morse and Yang (1993) were “basal plate cupping phallobase” and “paramere spines absent,” respectively characters #18 and 21 herein. The former is now shown to be a synapomorphy for Protoglossa + Lipoglossa and
the latter is also seen in Synafophora. In this work, we observed additional Synapomorphies #14 and 20 in support of the monophyly of this subgenus.

Morse and Yang (1993) observed for Lipoglossa "superior appendages with basoentral hook" (their #38) and "ventral lobes of inferior appendages long" (their #39, Synapomorphy #13 herein). We now consider the hooks and other projections of the preanal appendages too variable to provide reliable evidence for monophyly. We add
here Synapomorphy #19 in support of the monophyly of this subgenus.

**Relationships of Subgenera**

Morse and Yang (1993) inferred that Synafophora + Lippoglossa + Muroglossa + Glossosoma are a monophyletic group based on “dorsal projections of basal plate present” (their #35). We now understand that these “projections” are actually inferior appendages and that they do not have the same configuration in Lipoglossa as in the other three subgenera. The subgenera Muroglossa, Glossosoma, and Synafophora are an unresolved trichotomy. Their sister-group relationship is evidenced by Synapomorphies #5 and 9, of which #5 is newly observed and #9 is a reinterpretation of Morse and Yang’s (1993) character #35.

Synapomorphies #2 and 3 are new observations and Synapomorphy #18 is a reinterpretation of Morse and Yang’s (1993) character #33, supporting a sister-group relationship for Protoglossa and Lipoglossa.

These two clusters of genera are probably sister groups as suggested by Synapomorphy #16 (Morse and Yang 1993, #32), leaving Ripaeglossa as the basal lineage of the genus. Ross (1956) inferred the same monophyletic group based on similar evidence [“cerci (?) absent”].

**Glossosoma (Synafophora Martynov 1927)**

Synafophora Martynov 1927: 165. Type species by original designation: Synafophora minutum Martynov.


Mystrophorella Kloet and Hincks 1944: 97; nomen novum for Mystrophora Klapálek, 1892, nec Kayser, 1871.

Klapalekia Botosaneanu 1955: 792; nomen novum for Mystrophora Klapálek 1892 nec Kayser, 1871.


Martynov (1927) distinguished his genus Synafophora from its apparent ally Mystrophora by three diagnostic characters. (1) Third apical fork pedicellate. This is a variable character. In our examples of type species Synafophora minutum, three male specimens have the pedicel of the third apical fork very short and one male specimen is without a pedicel. Furthermore, the character is a plesiomorphy, common in Rhyncacphila, Agapetus, and Glossosoma (Muroglossa). (2) The fourth fork is shorter than the third. This is true in all members of most genera in this family. (3) “In the male anterior legs inner pulvilli form, each, a thick pale outgrowth inwards, nearly equal in the length to the claws.” We found that this is true not only in Synafophora, but uniquely so in the males of all species of this genus, as we discussed above. In the male genitalia, the purportedly diagnostic characters Martynov (1927) provided are no more than autapomorphies of the species. Therefore, we agree with Ross (1956) that Mystrophora and its replacement names Mystrophorella and Klapalekia are synonyms of Synafophora.

We reexamined Glossosoma (Synafophora) dulkejti, the type species of Eomystra, using specimens from the Kuriles (Figs. 53–55). The species bears all of the synapomorphies of Synafophora, such that we
are able to confirm Schmid’s (1971) opinion that *Eomystra* is a synonym of *Synafophora*.

*Glossosoma* (*Synafophora*) *altaicum* and *G. (S.) nylanderi* are redescribed and illustrated below. These type species share most of the synapomorphies of *Synafophora*, confirming the opinions of Levinidova (1982) that *Mystroglossa* and *Diploglossa*, respectively, also are synonyms of *Synafophora*.

Diagnostic characters for the subgenus include Synapomorphies #7, 8, 10, and 17 above. Also, the species of this subgenus usually differ from those of all other subgenera except *Ripaeglossa* and some species of *Glossosoma* in that male forewing vein 2A is shortened and strongly curved toward 3A, often weakened apically, usually accompanied by a rounded, thickened, translucent diffusion area on the posterior side or both sides of the vein. In addition, paramere spines are absent in only subgenus *Synafophora* and *Protaglossa*. Furthermore, males of all species examined by us have the phallographt above the phallus inflated to accommodate the apices of the inferior appendages: this possibly synapomorphic inflation is supported dorsally by a pair of sclerotized tendons in the phallo GDPR above the phallus inflated to accommodate the apices of the inferior appendages: this possibly synapomorphic inflation is supported dorsally by a pair of sclerotized tendons in the phallogel wall (Figs. 26, 27, 38, 39, 43, 44), occasionally fused in a single dorsal plate (Figs. 33, 34, 49, 50).

The 19 world species of subgenus *Synafophora* are widely distributed in the Holartic Biogeographic Region: its five Chinese species, redescribed below, occur only in the Palearctic portion of China.

*Glossosoma* (*Synafophora*) World Species

*G. (S.) altaicum* Martynov 1914b, Far East Russia, Korea, Japan, northeastern China.


*G. (S.) dulkejii* (Martynov 1934a), Far East Russia.

*G. (S.) hospitum* (Tsuda 1940), Japan.

*G. (S.) inops* Tsuda 1940, Japan.

*G. (S.) intermedium* (Klapálek 1892), Holartic Region.

*G. (S.) lividum* (Hagen 1861), northeastern North America.

*G. (S.) kiritchenkoi* (Martynov 1927), central Asia.

*G. (S.) minutum* (Martynov 1927), central Asia.


*G. (S.) nichinkata* Schmid 1971, Japan.

*G. (S.) nigrrior* Banks 1911, eastern North America.

*G. (S.) nylanderi* McLachlan 1879, Paleartic Region.


*G. (S.) ussuricum* (Martynov 1934a), Far East Russia, northeastern China.

*G. (S.) verdona* Ross 1938, western United States.

**Key to Males of Chinese *Glossosoma* (*Synafophora*) Species**

1. Forewing vein 2A resembling other veins. Inner apical spur of each hind leg broad basally, abruptly narrowed and hooked apically (Fig. 31). Tergum X + preanal appendages each with two, simple, large acute projections and without multiple teeth (Fig. 26). Ventral processes of sternum IX with inner branches slender and much shorter than lateral branches (Fig. 28)...

   Forewing vein 2A callous (Figs. 41, 47). Inner apical spur of each hind leg tapered and curved (Fig. 36). Tergum X + preanal appendages each with 5–15 small acute projections (Figs. 33, 38, 43, 49, 53). Ventral processes of sternum IX with inner branches thick (Figs. 35, 40) or longer than lateral branches (Figs. 40, 45, 54) or absent (Fig. 51)...

   *G. (S.) altaicum* 1.1. Tergum X + preanal appendages each slender and with 3–4 long, slender, irregular teeth (Figs. 38, 39). Ventral processes of sternum IX with inner branches much broader than lateral branches (Fig. 40)...

   *G. (S.) minutum* 1.2. Tergum X + preanal appendages broad and with 5–15 apical teeth of more nearly uni-
form size and shape (Figs. 33, 43, 49, 53). Ventral processes of sternum IX with inner branches much more slender than lateral branches (Figs. 34, 45, 54) or absent (Fig. 51) ................................. 3

3(2'). Lateral branches of tergum X + preanal appendages each with about 15 spines of uniform shape and size (Figs. 33, 34). Ventral processes of sternum IX with inner branches shorter than lateral branches (Fig. 35) ................................. G. (S.) intermedium

Lateral branches of tergum X + preanal appendages each with about 5 spines that may be uniform in size and shape (Fig. 49) or of different lengths (Fig. 43). Ventral processes of sternum IX with inner branches longer than outer branches (Fig. 45) or with only one pair of processes (Fig. 51) ... 4

4(3'). Lateral branches of tergum X + preanal appendages with spines of different lengths (Fig. 43). Ventral processes of sternum IX four in number (Fig. 45) ... G. (S.) nylanderi

Lateral branches of tergum X + preanal appendages with spines of uniform lengths (Fig. 49). Ventral processes of sternum IX two in number (Fig. 51) ................................. G. (S.) assuricum

Glossosoma (Synafophora) altaicum (Martynov 1914b) .......................... (Figs. 5, 26–32)

Mystrophora altaica Martynov 1914b; 72–84; holotype male (Russia, Altai), probably Zoological Institute, St. Petersburg. Mystrophora lata Tsuda 1940: 191; holotype male (Japan, Honshu), destroyed (M. Tanida, personal communication). Synonymized by Ross 1956: 155.


Glossosoma (Mystroglossa) altaicum: Kobayashi 1982: 7, type species of Mystroglossa.


This species, widely distributed in the Palearctic Region, now is found in China. It is one of a few members in this subgenus with 2A of the male forewing normal, but the inner spur of the male hind legs is highly modified (Fig. 31). It somewhat resembles G. (S.) nylanderi in that (1) the pair of dorsolateral tendons of the phalloporect have their anterior ends more widely separated from the phallobase (Figs. 30, 45) and (2) the setose apices of the inferior appendages are not so strongly recurved. These two species, together with G. (S.) dulkejti, all have their ventral process of sternum IX divided into four projections, but G. (S.) altaicum is similar to G. (S.) dulkejti in the shape of the upper branch of each process (Figs. 26, 53). Unlike other species of G. (Synafophora), the inferior appendages are not angled but are more nearly aligned with the phallus throughout their length.

Length of forewing: Male 5.1–7.4 mm; female 6.9–8.2 mm.

Length of body: Male 5.8–8.2 mm; female 7.9–9.2 mm.


Distribution.—Previously known from Far East Russia, Korea, and Japan, this species is now known in northeastern China: NEW CHINESE RECORD.

Glossosoma (Synafophora) intermedium (Klapálek 1892) .......................... (Figs. 25, 33–37)

Mystrophora intermedia Klapálek 1892: 461, figs. 1–5; syntype 1 female, 1 male [Bohemia, “Mumlava V, VII. (jedna fe-
Figs. 26–32. *Glossosoma (Synafophora) alticicum.* 26–30, Male genitalia. 26, Lateral. 27, Dorsal. 28, Ventral. 29, Phallus, lateral. 30, Relationship of phallus to lateral tendons, retracted interior appendages, and ventromesal keel of abdominal segment IX, ventral. 31, Inner spur of right hind leg of male, mesal. 32, Male abdominal sternite VI process, ventral. dor.lat.str. = dorsolateral strip of the phallocrypt (paired), inf.app. = inferior appendage (paired), IX = abdominal segment IX, keel = keel of sternum IX, lat.str. = lateral strip of the phallocrypt (paired), phall. = phallus, v.p.IX = ventral process of abdominal sternum IX (paired), X + pre.app. = abdominal tergum X and preanal appendage (paired).

male), Milnice 14. VIII. ([jeden male])", apparently Czech Republic Academy of Sciences, Prague. Many authors have reported this species in various scattered locations in Europe and northern North America by this name or in genera *Synafophora* or *Glossosoma* or *Klapalekia* or *Mystrophorella*. Martynov (1914a) first reported it in eastern Asia (Russia: Kamchatka) by this name.

Two male specimens collected from northeastern China are very similar to the description and illustration of *G. (S.) inter-

medium* provided by Ross (1956) and Vshivkova (1986) in coloring, the shape of the spurs of the male hind tibiae, and the structure of the male genitalia. Our illustrations show clearly that the species has all the synapomorphies, which are shared in this subgenus.

Anal cell of each male forewing with small, suboval thickened area bearing hairs; 2A very short and curved, with small, spu-
rious, curved vein arising posteriorly at mid length (Fig. 25). Tibial spurs 2-4-4, with inner apical spur on each male hind tibia highly modified (Fig. 36).

This species is very close to G. (S.) ussuricum Martynov in that the apicoventral process of sternum IX is divided into two simple broad and flat plates, with only their bases fused with each other (Figs. 35, 51); the mesal keel of sternum IX is very pronounced; the inflated phallockrypt above the phallus is supported by a single sclerotized plate; and the lower lateral lobes of tergum X bear several small, regular teeth apico-dorsally, each lobe with a long slender process arising basomesally. Along with G. (S.) minutum Martynov [and, we predict, with G. (S.) kiritchenkoi Martynov], these two species share an enlarged, partially sclerotized phallockrypt chamber above the phallus to accommodate the apices of the inferior appendages.

**Length of forewing:** Male 6.4–6.6 mm.

**Length of body:** Male 7.2–7.3 mm.


Distribution.—Holarctic, reported here for the first time from northeastern China: NEW CHINESE RECORD.

**Glossosoma** (Synafophora) *minutum* Martynov 1927

(Figs. 4, 24, 38–42)


This species was collected for the first time in China (Xin-jiang Province) by Dr. W. Mey (in litt.). Martynov’s original description was very detailed in the color pattern, forewing venation, and the general shape of the male genitalia. We can add a few more details.

Vein 2A in each male forewing slightly thickened but not curved, with short, water-drop-shaped thickened area (Fig. 24): inner apical spur of each male hind tibia normal.

**Male genitalia** (Figs. 38–42): Segment IX long dorsally, short ventrally, shortened gradually from top to bottom. Apicoventral process of sternum IX deeply divided mesally, conforming with those of rest of this subgenus; in this species, forming pair of long, broad lobes, very flat and approximate mesally, each bearing small lateral papillate projection near middle and much longer slender process from near lateral base. In ventral view, retracted mesal portion of sternum IX small, its mesal keel present but not pronounced. In lateral view, setose inferior appendages and pair of lateral tendons between phallobase and tergum X very distinctive. Phallockrypt enlarged and sclerotized dorsally as pair of broad plates, permitting movement of tips of inferior appendages within resulting chamber. Side lobes of tergum X long, each composed of two major parts: (1) lower lateral, elongated, finger-shaped outgrowth and (2) upper medial, elevated portion, with its apex produced in long, slender, claw-shaped process and short, papillate mesal process.

This species appears very similar to G. (S.) kiritchenkoi Martynov in the hooked apex of the upper part of tergum X. Both of them apparently have a close relationship with G. (S.) ussuricum and G. (S.) intermediate by sharing the following synapomorphies: (1) divided ventral process of sternum IX very flat and broad; (2) dorsal phallockrypt very deep and sclerotized, forming spacious chamber for apices of inferior appendages (character predicted for G. kiritchenkoi, since we have not yet seen this species); and (3) tergum X lobes each bearing dorsomesal process.

**Length of forewing:** Male 5.1–6.0 mm; female 5.8 mm.

**Length of body:** Male 5.8–6.8 mm; female 6.7 mm.

Distribution.—Previously known from "Turkestan," now known also from Xinjiang Province, northwestern China: NEW CHINESE RECORD.
Glossosoma (Synafophora) nylanderi
McLachlan 1879
(Figs. 23, 43–48)

Glossosoma nylanderi McLachlan 1879: 474, pl 50 f. 1–2; holotype male (Finland: Uleaborg), Helsingfors Museum.

Mystrophora ussurica Martynov 1934a: 79–80; 1934b: 326–327; holotype male (Russia: South-Ussuri region), probably Zoological Institute, St. Petersburg.


Levanidova (1982) first assigned this species to subgenus Synafophora, but with no detailed explanation. Our illustrations, based on Chinese specimens, confirm that this species is clearly a member of Synafophora.

Vein 2A on each male forewing only slightly thickened, nearly straight, and reaching 3A (Fig. 23), not as thickened, strongly curved, nor incomplete as for some other members of this lineage.

Male genitalia: Apicoventral process of sternum IX only partly divided, with considerable fusion basally. Lower lateral lobes of tegrum X each with four deeply and widely separated teeth and dorsomesal lobe with several smaller teeth, resembling some species of Glossosoma (Glossosoma). Spurs 2-4-4, apical spurs on male hind legs normal, not modified. Inferior appendages in this species very peculiar, autapomorphic, extending caudad almost horizontally, then recurved cephalad near apex. Lateral tendons of phallocrypt conspicuous. Dorsal tendons of phallocrypt paired.

Length of forewing: Male 6.4–6.9 mm; female 6.9–8.0 mm.

Length of body: Male 7.4–8.2 mm; female 7.7–8.9 mm.

Material examined.—JI-LIN PROVINCE: 3 ♂, 21 ♀, An-tu County (Songjiang) (N42.5, E128.3). Chang-bai Shan. Er-dao-ba-he River, 1700 m elevation, 10 Aug. 1993, Coll. Sun Chang-hai.

Distribution.—Previously reported from the South Ussuri region of Russia, now known from northeastern China: NEW CHINESE RECORD.

Glossosoma (Protaglossa Ross 1956)

Protaglossa Ross 1956: 152, 154, as subgenus of Glossosoma. Type species by original designation: Glossosoma taeniatum Ross and Hwang.

Glossosoma (Synafophora) ussuricum
(Martynov 1934a)
(Figs. 19, 49–52)

Mystrophora ussurica Martynov 1934a: 79–80; 1934b: 326–327; holotype male (Russia: South-Ussuri region), probably Zoological Institute, St. Petersburg.


Ross (1956) considered this species most closely related to Glossosoma (Eomystra) inops Kobayashi. Our colleague T. Nozaki (in litt.) considers G. inops a possible synonym of G. ussuricum.

Vein 2A on each male forewing only slightly curved, with small widened area at its end (Fig. 19). Spurs 2-4-4, inner apical spur on each male hind tibia highly modified in shape, similar to that of G. intermedium (Fig. 36). This species is closely related to G. intermedium as discussed for that species above. The inferior appendages are quite long and the phallocrypt above the phallus is especially cavernous in this species, supported by a single, wide, sclerotized plate dorsally.

Length of forewing: Male 6.4–6.9 mm; female 6.9–8.0 mm.

Length of body: Male 7.4–8.2 mm; female 7.7–8.9 mm.

Material examined.—HEI-LONG-JIANG PROVINCE: 5 ♂, Tie-li City, Lang-xiang (N46.9, E128.8). Xing-lin Bridge, 200 m elevation, 4 Aug. 1993, Coll. Sun Chang-hai.

Distribution.—Previously reported from the South Ussuri region of Russia, now known from northeastern China: NEW CHINESE RECORD.
Sinoglossa Ross 1956: 152, 154, as subgenus of Glossosoma. Type species by original designation: Glossosoma sellatum Ross and Hwang. Synonymized by Morse and Yang 1993: 140, 144.

Ross (1956) described his subgenus Protoglossa with only the type species, Morse and Yang (1993) synonymized Ross' monobasic subgenus Sinoglossa with Protoglossa to minimize redundancy after they in-
ferred that the two genera and species are sister lineages. Although the present reassessment of characters revises and adds to our 1993 inferences, the sister-group relationship, and thus our conclusion for synonymy, is confirmed. The type species of each of these two subgenera was described from China (Sichuan).

We now add a third species to subgenus Protoglossa: Glossosoma (Protoglossa) kehinum Schmid, 1971, from India (Sikkim) because it shares Synapomorphies #14, 20, and 21 with G. (P.) taeniatum and G. (P.) sellatum. Although Schmid considered his species to be close to G. (P.) taeniatum, he placed it in the subgenus Lipoglossa because he (1958) disagreed with Ross' subgeneric classification.
Besides characters #14, 20, and 21, the subgenus may be recognized by the fact that the bases of the inferior appendages are fused and the sclerotization extends to the venter of the phallobase as a cup or groove for the unusually short phallus. The paramere spines are absent (Synapomorphy #21) in species of both subgenera Protoglossa and Synafophora.

The three known species of subgenus Protoglossa occur only in the Oriental Biogeographic Region; the two Chinese species are known only from Oriental Sichuan Province.

**Glossosoma (Protoglossa) World Species**

*G. (S.) kchinam* Schmid 1971, India (Sikim).

*G. (S.) sellatum* Ross and Hwang 1953, China (Sichuan).

*G. (S.) taeniatum* Ross and Hwang 1953, China (Sichuan).

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**Glossosoma (Protoglossa) sellatum** Ross and Hwang 1953
(Figs. 56–61)

*Glossosoma sellatum* Ross and Hwang 1953: 8, f 2A–B: holotype male (China: Sichuan). CFM.


The male holotype has been preserved in alcohol for almost 50 years, such that it is very difficult to see any color pattern, but we take this opportunity to provide new figures for the male forewing and genitalia.

Vein 2A on each male forewing distinctively elongated, with its distal end beyond the cross vein m-cu (Fig. 60); this vein and 3A thickened in pattern similar to those of *Glossosoma (Protoglossa) kchinam* and *G. (P.) taeniatum*.

**Male genitalia** (Figs. 56–59, 61): Sternum VI process very small. Tergum X lat-
eral lobes elongated and bearing long, stout setae. Inferior appendages short, triangular in lateral view, fused with each other in basal half and extending along venter of phallobase to its anterior end.

Length of forewing: Male 5.8 mm, female 6.4 mm.

Material examined.—Holotype, “Sichuan, Tu-pa-keo, 2,255 m elevation, 4 Sept. 1929, Coll. Stevens” (CFM).

Diagnosis.—This species is quite different from the other two members of this subgenus in the elongated, lateral lobes of tergum X with long, stout setae; in the ventral position of the phallobase; and in the long fused bases of the inferior appendages extending along the venter of the phallobase to its anterior end.

Distribution.—Known only from the type locality.
Glossosoma (Protoglossa) taeniatum Ross and Hwang 1953
(Figs. 62–70)
Glossosoma taeniatum Ross and Hwang 1953; holotype male (China: Sichuan).
CFM.

Glossosoma (Protoglossa) taeniatum Ross 1956: 138, 154, fig. 298, chart 29.
Specimens from northern Sichuan were compared with the holotype. New structures are figured here and the female is associated with confidence for the first time.
Forewing of male (Fig. 66) with vein 2A both widened and elongated nearly to level of m-cu cross vein, about two-thirds of area between 2A and 3A translucent, slightly thickened and bearing tiny setae. Sternum VI process very small (Fig. 67), as long as sternum VII conical process (Fig. 68).

Male genitalia (Figs. 62–65): Inferior appendages short, triangular in lateral and ventral views, each with its dorsal and apical edges armed with short, stout setae; interior bases of inferior appendages fused with apical edge of phallobase, forming cup embracing phallus ventrally. Phallus very short, tubelike, phallicata fused with phallobase, beanlike spinous bump present on each side of phallicata; paramere spines absent.

Female genitalia (Fig. 69–70): Spermathecal sclerite simple, trough-like in ventral view; in lateral view, its middle portion with slight bump dorsally.

Length of forewing: Male 5.8–6.0 mm, female 6.4–6.7 mm.

Material examined.—Holotype, "Sichuan, Tu-pa-keo, 2255 m elevation, 7 Sept. 1929, Coll. Stevens" (CFM). Other material examined: 1 ♂ 4 ♀, from Sichuan Province, Wen-chuan xian (N31.4, E103.6), Wu-long-zheng, Jiao-mu-shan-cun. Pi-tiao-he. 1850 m elev. 21 June 1990, Coll. Yang Lianfeng and Li Youwen (NAU): 1 ♂ from same river and date, 3 km from Jiao-mu-shan-cun. Coll. Chen Xiao-en (Clemson University Arthropod Collection).

Diagnosis.—This species resembles Glossosoma (Protoglossa) kchinam in the similar shapes of the inferior appendages and the phallus, both species with the phallicata bearing a setose patch, but the shapes of the side lobes of tergum X are obviously different in the two species.

Distribution.—Known only from Sichuan Province, southwestern China.

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LITERATURE CITED


Kimmins, D. 1953. Entomological results from the


Addition in proof.—Since submission of our manuscript, we note that Mr. David Ruiter (in press, Western North American Naturalist) has recently reviewed the species of sister genus Anagapetus, transferring “Glossosoma (Anagapetus) shinidi” Levanidova, 1979 (Trudy Vsesoyuznogo Entomologicheskogo Obschestva 61: 92–95), to Glossosoma as a fourth unplaced species in the genus (bringing the genus Glossosoma to 116 species). This species apparently has Synapomorphies #1 and #16, placing it close to the two clusters of genera Muroglossa-Glossosoma-Synafophora and Protaglossa-Lipoglossa. However, it has none of the synapomorphies (#2, 3, 5, 9, 18) of either of these clusters of genera nor does it have any evident new synapomorphies to relate it to one or the other of them. Therefore, we infer that it may represent a third lineage, sister to them in a trichotomy.
A NEW SPECIES OF CYAMOPS MELANDER 1913
(DIPTERA: PERISCELIDIDAE) FROM JAPAN AND A REVIEW OF JAPANESE PERISCELIDIDAE

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Abstract.—Cyamops hotei Sueyoshi, a new species of Periscelididae, is described from Japan, and the Japanese species of Periscelididae are reviewed. In addition to C. hotei, four periscelidid species are reported, of which Periscelis (Myodris) annulata (Fallén) and Stenomicra (Podocera) angustiforceps Sabrosky are recorded from Japan for the first time. A key to all Japanese species and a distribution map are provided.

Key Words: Diptera, Periscelididae, Cyamops, new species, Japanese species

The Periscelididae are a small family of approximately 84 species in nine genera from all zoogeographic regions. The family is divided into two subfamilies: Periscelidinae and Stenomicrinae (Mathis and Papp 1998). Adults of both subfamilies are very small (2–2.5 mm), and those of Periscelis Loew and Stenomicra Coquillett have been collected at sap runs and grassy areas, respectively. Adults of Cyamops Melander have been collected near wet habitats (cf. streams, waterfalls, marshes, etc.) (Khoo 1985, Baptista and Mathis 1994). The larval biology of only a few periscelidid genera is known. The larvae of Periscelis breed in sap runs on trees, and a puparium of Cyamops and larvae of Stenomicra have been found in a bog and on banana, Gramineae, pineapple, and Pandanaceae, respectively (Ferrar 1987).

The genus Cyamops, which occurs worldwide, is assigned to the subfamily Stenomicrinae and currently includes 26 species (Baptista and Mathis 2000). Only six species are known from the Old World, however, and except for an unidentified species from Japan, no species are known from the Palearctic Region (Cyamops sp.: Tamaki 1997, as a member of Aulacigastri- dae, and Kubo 2000; Cyamops sp. 4: Baptista and Mathis 2000). Recently, we found specimens in good condition that represent the unidentified species in collections of the Forestry and Forest Products Research Institute. The specimens were collected in a Malaise trap and are part of the Diptera sampled in an insect survey of the Ogawa Forest Reserve (Ibaraki), a temperate forest in Honshu, Japan. Research and analysis of these collections are progressing (submitted), and description of this new species of Cyamops is needed for these studies. Moreover, we have also had a chance to examine all specimens previously listed in the above reports from Japan.

In this paper, we describe a new species of Cyamops from Japan as part of a taxonomic review of Japanese Periscelididae.
that includes a key and a distribution map for all Japanese species of the family. We also provide additional records of Stenomicrobra albibasis Sabrosky and S. fascipennitis Malloch from Japan (Sabrosky 1965) and record S. angustiforceps Sabrosky and PRISCELIS ANNULATA (Fallén) from Japan for the first time.

**Materials and Methods**

A total of 301 specimens were examined. These are preserved dry except for some specimens in 80% ethanol. External structures were observed under a stereoscopic microscope; some male and female abdomens were removed and treated in 10% KOH solution at 40°C for 10 hours, stained with Chlorazol Black E, neutralized with acetic acid, washed in distilled water, and then observed in pure glycerol. Dissected abdominal structures are preserved in pure glycerol in plastic microvials pinned under the dried mounted specimen or enclosed together with other body parts in 80% ethanol. Right wings were slide-mounted in Euparal.

All specimens examined have a serial number label attached and are deposited in the Biosystematics Laboratory, Graduate Institute of Social and Cultural Studies, Kyushu University, Fukuoka (BLKU) (Pr.1001-1004, 1008-1246, 1248-1272, 1281-1285, 2005), the Forestry and Forest Products Research Institute, Tsukuba (FFPRI) (Pr.1005-1007, 1271). Tamaki’s personal collection. Moroyama (Pr. 2003-2004, 2006-2012), the Smithsonian Institution, National Museum of Natural History, Washington, D.C. (Pr.3001-3014), and the Bernice P. Bishop Museum, Honolulu (Pr. 4001). Abbreviations of localities are as follows: C: City, P: Prefecture, T: Town, V: Village. Species with an asterisk are newly recorded from Japan. The terminology and abbreviations mostly follow McAlpine (1981), excluding terms exceptionally mentioned.

**Cyamops hotei Sueyoshi, new species**

(Figs. 1a–h, 2a–b, d, 3a–b, 4)


Cyamops sp. 4: Baptista and Mathis 2000: 504.

Male.—Head (Fig. 1a) higher than long; frons black in ground color, with velvet-like pruinescence; orbital plate, ocellar triangle, and vertex black in ground color, polished; face and gena yellow in ground color, with grayish pruinescence except narrow facial carina polished; face wide as distance between posterior ocelli (Fig. 2a): parafacial dark brown in ground color, covered with silvery pruinescence; occiput, and postgena covered with grayish pruinescence: clypeus yellow. Head chaetotaxy: 2 orbital, 1 vertical (inner vertical seta absent), 2 paravertical, 10 postocular, 9–10 peristomial, 1 genal. 2 postgenal setae, all black; ocellar, postocular. Antenna: scape, pedicel, and postpedicel (Stuckenberg 1999: 1st flagellomere: McAlpine 1981) yellow in ground color; arista black, with 12 dorsal and 3 ventral branches; pedicel with several setae on anterior margin. Mouthparts yellow.

Thorax entirely dark brown in ground color, covered with sparse grayish pruinescence except for polished propleural lobe. Thoracic chaetotaxy: 2 dorsocentral, 2 notopleural, 1 katepisternal, 1 supra-alar, 1 postalar and 2 scutellar setae all black; postpronotal, anepisternal, and anepimeral setae absent; minute dorsocentral setulae anterior to dorsocentral setae present; 2 rows of minute acrostichal setulae on presutural region present.

Wing (Fig. 2d) generally hyaline, 3.5 times long as wide, broadly infuscate dark brown on apices of cell r2+3, r4+5, and m, and along veins R1+5 and CuA1; veins dark brown: vein R3+4 slightly sinuate. Halter yellow in ground color, with dark brown knob.

Legs entirely yellow except apex of hind femur, apex of 4th tarsomere, and 5th tar-
somere dark brown; no distinct setae and spines.

Abdomen entirely dark brown; S6–7 (Baptista and Mathis 1994; 6th sternite: Khoo 1985) with distinct posterior process (Fig. 1b: pp) and largely expanded as semicircular plate anteriorly. Genitalia (Fig. 1c–h): epandrium (Fig. 1c–e: ep) spherical; both surstyli (Cumming et al. 1995: posterior surstylus: McAlpine 1981) (Fig. 1c–e: s) asymmetrical, right surstylus short, bowl-like, left surstylus long, hoe-like, with abrupt apex; hypandrium (Fig. 1f) asymmetrical, right pregonite (Fig. 1f: prg) bowl-like, left pregonite (Fig. 1f: prg) hill-like with 3 short longitudinal ridges; phal- lus (Cumming et al. 1995: aedeagus: McAlpine 1981) (Fig. 1g–h) consisting of some sclerites; basiphallus (Fig. 1g–h: bp) cylindrical, with longitudinal projection anteriorly; distiphallus (Fig. 1g–h: dp) consisting of 2 transverse strap-like sclerites, large sclerite expanded apically, terminated with cylindrical apex and sclerite with hook.

Body length 2.7 mm (anterior apex of head to posterior margin of abdomen). Wing length (base of costa to apex of vein R_{4+5}) 2.1 mm; width 0.7 mm.

Female.—Similar to male but with sexual dimorphism in head, fore femur, and wing markings: head (Fig. 3a) entirely black in ground color without yellow regions; frons, parafacial, gena, occiput, and postgena covered with grayish pruinescence; facial carina broad as distance be-

twenty outside of antennae (Fig. 2b); lateral corner of face and gena covered with silvery pruinescence; clypeus (Fig. 3a: cl) black; scape, pedicel, and basal part of postpedicel black, distal part of postpedicel orange; wing broadly infuscate, dark brown along apex of veins R_{2+3}, R_{4+5}, M, and CuA_{1}, apical infuscation of wing reaching cell r_{1}; anteroventral side of femur with row of minute spine-like setae. Postabdominal structures (Fig. 3b): T6 fused with S6, forming ring-shaped 6th syntergosternite (Fig. 3b: 6ST) (Baptista and Mathis 1994); T7 separate from S7; T8 long as T5. S8 membranous, attached to S7; T10 (10th abdominal tergite: Griffiths 1981; epiproct: McAlpine 1981) and S10 (10th abdominal sternite: Griffiths 1981; hypoproct: McAlpine 1981) triangular; cercus short (Fig. 3b: c). Two spherical spermathecae (Fig. 3b: sp).


Distribution.—Japan (Honshu and Kyushu: Fig. 4).

Etymology.—The specific epithet is derived from the Japanese noun Hotei, meaning a Buddhist priest from China who has a fan and pouch in his hands, alluding to the flat and pouchlike surstyli of this species.

Remarks.—This species is distinguished from congeners by the following combination of characters: anteroventral portion of male eye with enlarged facets (Fig. 2a); wing cell R_{2+3} broadly hyaline and with dark brown marking at apex (Fig. 2d); fore femur with ventral seta at base; anterior scutellar seta well developed; hind femur with apical dark marking; and female abdominal tergite and sternite 7 separate (Fig. 3b). This species is very similar to C. ban-vaneae Baptista and Mathis in wing markings but differs from the latter species by having dark markings on the male hind femur restricted to the apical \( \frac{1}{2} \), and the left surstylus is not bifurcate and terminated at abrupt apex (Fig. 1c, e). Cymops hotei is also similar to C. laos Baptista and Mathis in male genital structures but differs from it by the wing cell R_{2+3} without a distinct white region at middle (Fig. 2d), and the male left surstylus is abrupt at its apex (Fig. 1c, e: s).

Tamaki (1997) recorded an undetermined species of Cymops from Japan for the first time and Kubo (2000) also reported a male belonging to this genus. We examined all four specimens they reported and found that they belong to this new species. The male specimen of Cymops sp. 4 (recorded in Baptista and Mathis 2000) was also examined and found to be conspecific with C. hotei.

Baptista and Mathis (1994) documented the monophyly of Cymops with eight autapomorphies: absence of inner vertical
seta, middle of frons concave, side of frons below orbital plate silvery shiny, male clypeus retracted and tending to fill oral opening, both of surstyli asymmetrical, phallus with complex sclerites, female abdominal tergite and sternite 6 fused and forming a complete ring. Cyamops hotei has all of these characters and is thus a member of this monophyletic group. Baptista and Mathis (1994) also proposed three synapomorphies that support some subgroups within Cyamops, and C. hotei has two of them: anteroventral facets of male eye enlarged and presence of spine-like short setae on female fore femur. Cyamops hotei has two spermathecae (Fig. 3b: sp), a condition that Baptista and Mathis (1994) consider plesiomorphic. These authors suggested another five characters as potential synapomorphies of subgroups, although their polarities were not determined. Among these five synapomorphies, we observed the following in C. hotei: female abdominal tergite and sternite 7 separate (Fig. 3b); 2 pairs of dorsocentral setae posterior to transverse suture present; 2 pairs of scutellar setae present; anepisternal setae absent; wing cross-vein bM-Cu present (Fig. 2d).

Remarks.—This species is distinguished from congeners of the subgenus Myodris Lioy by the following combination of characters: scutum covered with grayish pruinose and with 3 longitudinal dark brown stripes; face with distinct medial bulging and facial carina; wing without distinct dark markings; thorn of male cerci subapical; left surstylus as long as right surstylus; postgonite gradually tapered to apex. This species is very similar to P. (M.) kabali Papp but differs from the latter species by the above genital characters (Papp 1988).

Stenomicra (Podocera) albibasis Sabrosky (Fig. 2e, 4)

Stenomicra albibasis Sabrosky 1965: 214.


Distribution.—Japan (Honshu: Sabrosky 1965) (Fig. 4).

Remarks.—This species is distinguished from congeners by the following combination of characters: wing slightly infuscate, yellow except for basal ½, with small black markings at apex and base of vein R1, base of vein R2+3, and base of alula (Fig. 2e); wing vein R2+3 terminated near wing apex (Fig. 2e); anterior orbital seta as long as posterior orbital seta; head entirely dark brown in ground color, covered with grayish pruinose. This species resembles S. bicolor Sabrosky from Réunion and S. nigricolor Sabrosky from Kenya in having a black head and thorax. However, it differs from S. bicolor by having entirely yellow legs, and from S. nigricolor by having an entirely yellow abdomen (Sabrosky 1975).

Stenomicra (Podocera) fascipennis Malloch (Fig. 2f, 4)


RECORDS OF JAPANESE SPECIES OF PERISCCELIDIDAE

Periscelis (Myodris) annulata (Fallén) (Fig. 2c, 4)

Notiphila annulata Fallén 1813: 250.

Periscelis annulata: Loew 1858: 118 [generic combination].


Distribution.—Europe (Duda 1934) and Japan (Honshu: Fig. 4).
Fig. 4. Distribution maps of Japanese periscelidid species. a, ○ *Cyamops hotei*; ♦ *Periscelis annulata*, ● *Stenomicra albibasis*, ▲ *S. angustiforceps*.


Distribution.—India, Ceylon, Nepal, Malaya, Taiwan, Philippines, Borneo, Guam, Solomon, Fiji, Hawaii (Sabrosky 1977, Khoo and Sabrosky 1989) and Japan (Ogasawara, Honshu: Sabrosky 1965; and Ryukyus) (Fig. 5).

Remarks.—This species is distinguished from congeners by the following combination of characters: head entirely yellow in ground color, covered with grayish pruinose; wing infuscate, dark yellow, with 4 hyaline transverse bands (Fig. 2f); wing vein \( R_{2+3} \) terminated near wing apex (Fig. 2f); anterior orbital seta as long as posterior orbital seta. This species is very similar to \( S. biconspicua \) Sabrosky from South Africa in having four band-like white markings of the wing but differs from the latter by its slender and strongly curved surstylus (cf. Sabrosky 1965: fig. 5, Sabrosky 1975: fig. 10).

Sabrosky (1965) examined 13 specimens from Tokyo, Shizuoka, and Kyoto prefectures and recorded this species from Japan for the first time. We examined all of these specimens as part of this study. Tamaki (1997) reported six specimens of Stenomiera sp. 1. We examined these specimens and found that five are this species.

The mesonotum and abdominal dorsum of this species are typically dark colored (i.e. black or brown) (Malloch 1927, Sabrosky 1965), and the specimens from Honshu and the Ryukyus correspond well to this description, but not the specimens from Ogasawara. The mesonotum and abdominal dorsum of specimens from Ogasawara are predominately yellow brown and paler than those from Honshu and the Ryukyus. The male postabdomen is also distinctly yellow. Although we could assign the specimens from Ogasawara as a distinct species from \( S. fascipennis \), we have identified them as conspecific because there are no distinct differences, including structures of the male genitalia, between the specimens examined except for the body color as noted.

**Stenomiera (Stenomiera) angustiforceps** Sabrosky
(Figs. 2g, 4)

**Stenomiera angustiforceps** Sabrosky 1965: 216.

**Stenomiera sp. 2**: Tamaki 1997: 147.


Distribution.—Nepal (Sabrosky 1965),
India (Sabrosky 1977), and Japan (Honshu and Ryukyus: Fig. 4).

Remarks.—This species is distinguished from congeners by the following combination of characters: wing entirely hyaline (Fig. 2g); wing vein $R_{2+3}$ terminated before wing apex (Fig. 2g); anterior orbital seta distinctly shorter than posterior orbital seta; postocellar seta present; scutum scarcely covered with whitish pruinescence, yellow in ground color, with pair of longitudinal brown vittae laterad of dorsocentral seta; postabdomen yellow.

Tamaki (1997) reported *Stenomicra* sp. 2
based on a female specimen. We examined his specimen and found that it belongs to this species.

**KEY TO JAPANESE SPECIES OF PERISCELIDIDAE**

(Modified from Sabrosky 1965 and Mathis and Papp 1998)

1. Two pairs of orbital setae present (Fig. 1a); ocellar seta absent; wing costa extended to apex of vein M (Fig. 2d–g); postpronotal lobe without distinct setae
   - One strong pair of orbital setae present (Mathis and Papp 1998: fig. 24.1); ocellar seta present; wing costa extended to apex of vein R1–5 (Fig. 2d); postpronotal lobe with distinct setae
      - Periscelis annulata

2. Orbital setae reclinate or laterooclinate (Grimaldi and Mathis 1993: figs. 15, 17); inner vertical seta present; supra-alar seta absent; wing crossvein bM-Cu absent, wing cells bm and dm confluent; wing cell cup present (Fig. 2e–g)
   - Anterior orbital setae procline and posterior orbital setae reclinate (Fig. 1a); inner vertical seta absent; supra-alar seta present; crossvein bM-Cu present, wing cells bm and dm separate (Fig. 2d); wing cell cup present... *Cyamops hotei*

3. Wing vein R2–3 terminated at apex of wing (Fig. 2e–f); wing cell dm long; postocellar seta absent; anterior orbital seta as long as posterior orbital seta (Malloch 1927: fig. 11)
   - Wing vein R2–3 terminated before apex of wing (Fig. 2g); wing cell dm short; postocellar setae present; anterior orbital seta distinctly shorter than posterior orbital seta (Malloch 1927: fig. 2)
      - Stenomictra angustiforceps

4. Wing infuscate, light gray, with four transverse hyaline bands (Fig. 2f)
   - Stenomictra fascipennis

   - Wing infuscate, light yellow, with hyaline at basal ½ (Fig. 2e)
   - Stenomictra albibasis

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LARGIDEA DAVISI KNIGHT, A RARELY COLLECTED PLANT BUG
(HEMIPTERA: MIRIDAE: DERAEOCORINAE) ASSOCIATED WITH PITCH
PINE IN THE NORTHEASTERN UNITED STATES

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Abstract.—Described in 1917 and known previously only from Cape Cod, Massachusetts, and Long Island and near New York City, New York (ca. 14 specimens), the deraeocorine mirid Largidea davisi Knight is newly reported from Connecticut, Maine, New Hampshire, New Jersey, Pennsylvania, and Rhode Island. Additional records are given for Massachusetts and New York. This univoltine predator was found only on pitch pine (Pinus rigida Mill.), typically in extensive and remnant pine barrens. The gall-forming margarodid scale Matsucoccus gallicolus Morrison is suggested as prey of this late-season plant bug.

Key Words: Insecta, Miridae, Deraeocorinae, Clivinematini, new records, Pinus rigida, pine barrens, Matsucoccus scales

Largidea davisi Knight is the only eastern member of a Nearctic genus of plant bugs. The other nine species of Largidea are essentially restricted to western North America (one Illinois specimen, collected in 1895, is known of the otherwise western L. grossa Van Duzee [Knight 1941]). A mirid of the deraeocorine tribe Clivinematini. L. davisi has been termed a rare heteropteran of the northeastern fauna (Slater 1974) and has remained poorly represented in collections since its original description (Knight 1917). Here I give new distribution records for this apparently predacious plant bug, provide notes on its seasonal occurrence and plant associations, and suggest a predator-prey relationship.

Largidea davisi Knight
(Figs. 1, 2)

This dark reddish-brown, elongate-oval mirid, 6.0–6.5 mm long, can be recognized by the matted, pale yellow pubescence on its body; its short rostrum that is extended only to or slightly beyond the posterior margin of the forecoxae; the incrassate (♀) or linearly thickened (♂) second antennal segment, with the third and fourth segments short (0.37 mm) and thin; the coarsely and densely punctate pronotum with an impressed line, smooth and hook-shaped, from the anterolateral angle to the posterior margin of the calli; and the broad, flattened basal tarsomere that is extended under the second tarsomere. For a diagnosis and description of the tribe Clivinematini, see Ferreira’s (2000) taxonomic review.

Distribution

Historical.—Described from Promised Land, eastern Long Island, New York (Knight 1917). L. davisi later was recorded from Hyannis Port, Massachusetts, on Cape Cod (Knight 1923). Massachusetts was omitted as a state record in Carvalho’s (1957) catalog but was included by Henry
and Wheeler (1988) in the most recent catalog of North American Heteroptera. The only other published records are from New York: Yaphank (Long Island) and Bear Mountain, north of New York City (Leonard 1928).

New records.—All specimens were collected from pitch pine by the author or (Connecticut) with T.J. Henry. Roman numerals denote nymphal instars. Voucher material has been deposited in the collections of the Pennsylvania Department of Agriculture, Harrisburg, and the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM).


Seasonality

Except for a male collected on 10 August 1899 at Hyannis Port, Massachusetts, all other adults of L. davisi have been taken in September. The collection of equal numbers of males and females (5 of each) in Ulster County, New York, on 5 September 2001 and four males and one female on 4 September 2002 suggests that adults had been present for only a week or 10 days. Mirids typically are protandrous, the males appearing slightly earlier than the females and not living as long (Wheeler 2001). My latest collection of a male was 27 September in Dauphin County, Pennsylvania. The type series includes a pair taken in copula on 24 September 1910 (USNM collection).

Despite extensive collecting of mirids on pitch pine from May to September, I found only four nymphs: a fourth instar on 12 August at Concord, New Hampshire, two fifth instars on 21 August in Ulster County, New York, and a fifth instar (see Fig. 1) on 7 September in York County, Maine. Collections of L. davisi suggest that adults mostly appear from late August to early September. Assuming the date of 10 August given for the male taken on Cape Cod, Massachusetts, in 1899 is correct (Knight 1923), this plant bug sometimes appears earlier in the season. The presence of late instars in mid- to late August suggests that overwintered eggs do not hatch until after mid-July.

Plant and Prey Associations

The mostly Neotropical tribe Clivinematini comprises 17 genera and 83 described species. Even though scant biological data are available, clivinematines are assumed to be predacious (Ferreira 1998). Two species of Clivinema and an Ambraeius species feed on soft scales (Coccidae): a Hemicerocoris species preys on soft scales (Cocceidae) (Ferreira 1998, Wheeler 2001). The habits of Largidea species are unknown, although Kelton (1980)
speculated that *L. shoshonea* Knight feeds on aphids.

Label data accompanying specimens of *Largidea* indicate that seven species are found on pines (*Pinus* spp.). Species of *Largidea* and its sister genus, the Neotropical *Adlargidea*, likely are restricted to developing on pines (Feireira 1998).

I have collected mirids from all species of *Pinus* occurring in the Northeast and have found *L. davisi* only on pitch pine (*P. rigida* Mill.). “Pine,” recorded as the host at the type locality on Long Island, almost certainly refers to pitch pine. W.T. Davis and G.P. Engelhardt, who in 1910 collected the type specimens of this plant bug at Promised Land, Long Island, collected other heteropterans that year from pitch pine at Promised Land (see Davis 1911). Specimens known historically from other localities—Cape Cod, Massachusetts; Bear Mountain, New York; and Yaphank, Long Island, New York—likely also were collected from *P. rigida*.

The habits of *L. davisi* on pitch pine have not been determined. A potential prey species on pitch pine is the margarodid scale *Matsucoccus gallicolius* Morrison. This pine-bast scale is found mainly on pitch pine and is known from nearly all areas where *L. davisi* has been collected. The margarodid is particularly common on Cape Cod, Massachusetts, and Long Island, New York, as well as in parts of Connecticut, New Jersey, and Rhode Island (Morrison 1939. Parr 1939). The globular saclike adult females of this infrequently collected scale insect were taken with *L. davisi* at Monta-
gue, Massachusetts, and in Dauphin, Luz-erne, and Pike counties in Pennsylvania. In Luzerne County, Pennsylvania, the mirid and the margarodid were collected from the same branches of pitch pine. In addition, the co-occurrence of the anholocorid Elatophilus inimicus Drake & Harris, a known predator of Matsucoccus species (e.g., Mendel et al. 1991), suggests the presence of M. gallicolus at other localities where L. davisi was found. Populations of Matsucoccus predators, such as Elatophilus species, are more likely to be detected than those of their inconspicuous prey (Morrison 1939, Mendel et al. 1991).

**DISCUSSION**

Previously published records of L. davisi evidently are based on fewer than 15 specimens: 10 from the type locality on Long Island, New York (Knight 1917); one from Hyannis Port, on Cape Cod, Massachusetts (Knight 1923); and likely only one from each of the two other localities in New York (Leonard 1928). Fifty-six adults were collected during the present survey, ranging from York County, Maine, in the north to northern Dauphin County, Pennsylvania, in the south. In elevation, L. davisi has been taken near sea level on Long Island, New York, and on Cape Cod, Massachusetts, to about 685 m near Lake Maratanka in Ulster County, New York.

Largidea davisi appears to be an unusually late-season, univoltine mirid. The distinctive nymphs and adults are unlikely to have been overlooked during earlier-season collecting at sites where I found this plant bug in September, including the Montague Sand Plains in Massachusetts, the Concord Barrens in New Hampshire, the Mohonk Preserve and Sam’s Point Dwarf Pine Ridge Preserve in New York, and pitch pine communities in Luzerne and Schuylkill counties in Pennsylvania.

Largidea davisi can be considered a characteristic, though uncommon and patchily distributed insect of northeastern pitch pine-scrub oak barrens and similar communities. It appears to be the least common of the approximately 25 mirid species that develop on pitch pine (Wheeler, unpublished data). It was found in several remnant pine barrens, such as Concord, New Hampshire, and on scattered pitch pine trees in ruderal sites along highways, in addition to being collected in the extensive pine barrens in the Shawangunk Mountains of New York and the sand plains near Montague, Massachusetts. This mirid was not found in extensive pine barrens in southern Maine, such as Waterboro and Fryeburg; the Ossipee barrens in New Hampshire; the Albany (New York) Pine Bush; and the New Jersey Pine Barrens.

Future research should focus on elucidating the feeding habits of L. davisi, obtaining more information on its seasonal history, and determining whether pines other than P. rigida serve as hosts. Clivinematines have been assumed to be predacious, the few available records of their habits indicating that scale insects serve as prey. Cinara species and other pine-associated aphids also were found on pitch pines with L. davisi, and Kelton (1980) suggested that L. shoshonea Knight might feed on aphids inhabiting jack pine, Pinus bank-siana Lamb. For certain anholocorid species of the pine-associated genus Elatophilus, Kelton (1976) and others (cited by Mendel et al. 1991) speculated that these anholocorids are generalist predators on aphids or mites. But at least five species of Elatophilus now are known to be specialized predators of Matsucoccus scales, and an intimate association among Elatophilus species, pines, and pine-bast scales has been hypothesized (Mendel et al. 1991, cf. Lattin and Stanton 1993). My hypothesis that members of the pine-associated genus Largidea prey mainly on scale insects and that L. davisi feeds on a pine-bast scale. Matsucoccus gallicolus, awaits testing.

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PSEPHENOPALPUS BROWNII, A NEW GENUS AND SPECIES OF PSEPHENINAE (COLEOPTERA: BYRRHOIDEA: PSEPHENIDAE) FROM MEXICO

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Abstract.—Psephenopalpus browni, n. gen., n. sp. is described and illustrated from specimens collected in a stream running through a cloud forest in the Mexican town of Coatepec, Veracruz (1200 m). Psephenopalpus browni can be distinguished from other Psepheninae by the body shape, antennal length, and the size proportions of the phallobase and parameres (from Pheneps) and by the pronotum, maxillary palpi, and tarsi (from Psephenotarsis, Psephenops, Psephenus). Psephenopalpus appears to be more closely related to Psephenops than to other Psepheninae. A key for American Psepheninae genera is provided.

Resumen.—Se describe e ilustra a Psephenopalpus browni, n. gen. y n. sp. con base en especímenes colectados en un arroyo de agua dulce que atraviesa un bosque nebuloso en Coatepec (1200 m snm), estado de Veracruz, México. Psephenopalpus browni se puede diferenciar de otros Psepheninae por la forma del cuerpo, la longitud de las antenas, la proporción entre la falobase y los parámeros (Pheneps); también por la forma del pronoto, longitud y forma de los palpos maxilares y la región tarsal (Psephenotarsis, Psephenops, Psephenus). Al parecer Psephenopalpus está más cercanamente relacionado a Psephenops que al resto de los Psepheninae. Se proporciona una clave para la identificación de los géneros Americanos de Psepheninae.

Key Words: Psephenidae. Psepheninae, new genus, description, key. State of Veracruz, Mexico

The subfamily Psepheninae is represented in the New World by the genera Psephenus Haldeman 1853, Psephenops Grouvelle 1898, Pheneps Darlington 1936, and Psephenotarsis Arce-Pérez 2001 (Brown 1981, Spangler 1982, Arce-Pérez and Novelo-Gutiérrez 2001, Arce-Pérez and Shepard 2001). Psephenus contains 15 species with seven in North America, two of which are also found in Mexico: four in Mesoamerica; three in Brazil; and one in Peru. Psephenops has eight species (Arce-Pérez and Novelo-Gutiérrez 2000, Bameul 2001, Arce-Pérez 2002) with a tropical distribution, including two in Mexico, one in Guatemala, one in Costa Rica, one in Haití, one in the Antilles with one subspecies, one in Colombia that is also found in Costa Rica, and one in Argentina. Pheneps has eight species (Arce-Pérez and Novelo-Gutiérrez 2001, Souza Fernandez et al. 2001) also tropical, with one in Cuba, one in Haiti, one in Surinam, one in Venezuela also found in Brazil, and another four in Brazil. Psephe-
notaris includes one species in Mexico. In this paper, a new genus and new species are reported for Mexico.

Twenty-six male specimens were collected from a stream running through a cloud forest located in the Mexican town of Coatepec, Veracruz (alt. 1,200 m), municipality of Coatepec. Individuals were initially preserved in 80% ethanol and some were pinned later. All collected material was examined. Male genitalia were extracted in ethanol, and potassium hydroxide (KOH 5%) was used to clear genitalia to make illustrations. Microphotographs were taken with a JEOL scanning electron microscope, model JSM T20 with 200× magnification.

**Psephenopalpus Arce-Pérez, new genus**

(Figs. 1, 5, 7, 12-14)

Description.—Head (Fig. 1) short, transverse; eyes spherical, very prominent. Antenna long, filiform-subserate, 11-segmented, extending beyond elytral humerus; scape and pedicel yellowish, 9 flagellar segments dark reddish brown. Maxillary palpus (Fig. 5) extremely long, extending beyond sixth antennal segment, second palpomere much longer than the other palpomeres. Pronotum (Fig. 1) subtrapezoidal, its posterior margin quite smooth, never crenulate or rugose; lateral margins rounded, unexpanded at posterior middle, disc with feeble middorsal longitudinal carina; prosternum (Fig. 5) short, slightly elevated at middle, prosternal process long with sides parallel at middle, then gradually diverging to form a lanceolate apex; mesosternum clearly grooved and slightly bifurcate apically, so procoxa and mesocoxa not far apart. Tarsi 5-segmented (Fig. 7), first four tarsomeres short, subtriangular and covered with long setae, ventral vestiture spongy, fifth tarsomere much longer than first four together, cylindrical, slender, smooth; tarsal claws long, whole, curved, lacking denticle and accessory membranes.

**Male genitalia** (Figs. 12, 13, 14): In dorsal view (Fig. 12) subrectangular, trilobate; phallobase shorter than parameres; parameres shorter than median lobe, with external apical margin sinuate to 0.40, ending in a rounded apex, lateroapical portion membranous; (Fig. 13) middle lobe scleritized, fingerlike in ventral view, (Fig. 14) dorsally convex, with sharp apex and curved in lateral view.

Remarks.—*Psephenopalpus* can be distinguished from other *Psepheninae* genera by the following characteristics: In *Phenops* the body is more slender; the maxillary palpus is short; the antennae are long reaching 0.75 the length of elytra; the pronotum and elytra lack expanded margins (Fig. 2); tarsomeres 1–2 are clearly stouter than any of the three apical tarsomeres (Fig. 8); and the phallobase is notably larger than the parameres. In *Psephenops*, the second maxillary palpomere is proportionally much shorter (Fig. 6); the pronotum is expanding laterally on the posterior half (Fig. 3); and tarsomeres 1 and 2, and occasionally 3, have wide ventral expansions that cover the apical tarsomeres (Fig. 9). In *Psephenotarsis*, the maxillary palpus is short; the antennae are short and moniliform; the pronotum is expanded laterally in the posterior half (Fig. 4); and the tarsomeres are notably triangular, flattened and widely emarginate (Fig. 10). In *Psephenus*, the maxillary palpus is short; the basal half of the pronotum is occasionally expanded; the four basal tarsomeres are slender and subcylindrical and slightly emarginate in their apices, with delicate, minute setae or papillae ventrally (Fig. 11); and the median lobe of the male genitalia is mostly membranous and shorter than or as long as the parameres.

*Psephenopalpus* appears to be more closely related to *Psephenops* than other *Psepheninae*, mainly by the pronotal carina; filiform subserate antennae; posterior margins of sternites 1 and 2 slightly sinuate or emarginate; the basal tarsomeres with spongy ventral vestiture; and in general appearance. The two may be distinguished by the following combination of characters (those of *Psephenops* in parentheses): Pronotum with lateral margins rounded and
Figs. 1–6. 1, *Psephenopalpus brownii*, adult male, dorsal aspect of head and pronotum. 2, *Pheneops cursitatus* Spangler, adult male, dorsal aspect. 3, *Psephenops mexicanus* Arce-Pérez and Novelo-Gutiérrez, adult male, dorsal aspect of head and pronotum. 4, *Psephenotarsis triangularis* Arce-Pérez and Novelo-Gutiérrez, adult male, dorsal aspect. 5, *Psephenopalpus brownii*, adult male, ventral aspect of head. 6, *Psephenops lupita* Arce-Pérez, adult male, ventral aspect of head and prosternum. (Fig. 2 from Spangler 1987; Fig. 3 from Arce-Pérez and Novelo-Gutiérrez 2000; Fig. 4 from Arce-Pérez and Novelo-Gutiérrez 2001; Fig. 6 from Arce-Pérez 2002.)
unexpanded (expanded laterally on posterior half); maxillary palpus extremely long, with the second palpomere much longer than the other palpomeres (maxillary palpus short, last palpomere larger); the basal tarsomeres with short ventral expansions (tarsomeres 1 and 2, and occasionally 3, with wide ventral expansions that cover the apical tarsomeres); and fifth tarsomere much longer than the first four together, cylindrical, slender and smooth (second tarsomere lobed ventrally, much longer than the other tarsomeres).

Etymology.—From the Greek “Psephen-” (hidden) and “palpus” (palpomeres), referring to the palpomere characteristic that distinguishes this genus from other Psepheninae.

Psephenopalpus browni Arce-Pérez, new species
(Figs. 1, 5, 7, 12, 13, 14)

Description.—Holotype male: Body oval tapered, depressed; integument reddish black, completely covered with dense vestiture of short and long reddish yellow setae with golden highlights; venter with short yellowish gray setae with golden highlights. Head, pronotum, and scutellum black; antenna and elytron dark reddish brown, elytron without striae, with light yellow mark in mid basal region; legs with yellow coxae, trochanters, and femora; tibiae and tarsi dark reddish; total length 3.85 mm, maximum humeral width 1.70 mm.

Head (Fig. 1): Black, short, transverse, covered with short vestiture, yellowish setae and long dark reddish setae; eyes spherical, very prominent; clypeus subrectangular, wider than its length, declivous at an angle of less than 90° from plane of frons, distal margin widely emarginate; labrum like clypeus but shorter; antenna long, filiform subserrate, 11-segmented, extending past elytral humerus, scape and pedicel yellowish, 9 flagellar segments dark reddish; scape larger than all other segments, slightly curved, pedicel half as long as scape; flagellum with 9 slim, subserrate segments covered with long reddish-black setae; maxillary palpus 4-segmented (Fig. 5), slightly longer than first six antennomeres combined, three basal palpomeres subcylindrical, apical palpomere ovoid; first maxillary palpomere shortest, second 7.75 times longer than first and slightly sinuate, third palpomere slightly larger than second at middle; fourth slightly longer than third but ovoid and depressed with rounded apex and large sensorial region; relative proportion of segments: 0.07, 0.54, 0.31, 0.34; all palpomeres dark reddish and covered with reddish setae; labial palpus very short (Fig. 5), 3-segmented, not extending beyond basal margin of first maxillary palpomere, two basal labial palpomeres rounded and wide, segment 3 subspherical and shorter; all palpomeres dark reddish and covered with reddish setae.

Thorax: Pronotum (Fig. 1) black and subtrapezoidal (posterior margin 1.55 mm, lateral margin 0.83 mm); anterior margin arcuate, posterior margin bisinuate and almost as wide as elytral base; lateral margins rounded and unexpanded; posterolateral angles subacute; pronotal disc with mid-dorsal longitudinal carina weakly developed near base, slight depression at each side of carina; in profile, pronotal disc convex; prosternum (Fig. 5) short and slightly elevated; long, concave, and lanceolate prosternal process reaching anterior half of mesosternum. Mesonotum with scutellum short and black, with tip broadly rounded; elytron dark reddish brown with light-colored stain in mid-basal region, lacking striae, with short yellow setae and long reddish-yellow setae. Sides parallel on basal 0.75, then gradually converging posteriorly and margins expanding slightly; length from base to apex of suture 2.80 mm, width 1.70 mm across humerus. Mesosternum reddish black with wide groove for reception of prosternal process and slightly bifurcate at apex. Metasternum reddish black, large and voluminous, with longitudinal canal, deeper apically and ending in front of metacoxae.

Legs (Fig. 7): Coxae, trochanters, and
femora yellow; tibiae and tarsi dark reddish, almost black; procoxa globose, mesocoxa conical, metacoxa transverse; femora robust with dark reddish yellow setae, tibiae slender, protibia with distinct apical posterolateral denticle, metatibia longer than femur; tarsi 5-segmented. the first four tarsomeres short and subtriangular with slight ventral expansions and covered with long setae, ventrally with spongy vestiture; first tarsomere covering half of second, vestiture of second tarsomere covering all or almost all of third, fourth tarsomere small and free or with sparse setae; fifth tarsomere much longer than all others combined (0.32 mm compared to 0.44 mm), subcylindrical and smooth, tarsomere proportions 0.14, 0.20, 0.10, 0.10, 0.44 mm; claws long, curved, without denticles or accessory membranes.

**Abdomen:** Ventrally convex, with seven sternites; first sternite slightly lifted in middlebasal region, second and third sternites flat in middle; posterior margin of sternites 1 and 2 slightly sinuate in middle; sixth sternite short, widely emarginate and hidden under fifth sternite; seventh sternite much smaller and oval in shape; pygidal plate oval, convex, with long, dark reddish setae.

**Genitalia** (Figs. 12, 13, 14): Trilobate, total length 0.66 mm. Parameres in dorsal view (Fig. 12) voluminous, shorter than middle lobe, with external margin sinuate at apical 0.40, ending in a rounded apex with lateroapical membrane, length 0.36 mm; penis in ventral view (Fig. 13) longer than parameres, fingerlike, widening at basal half, length 0.40 mm, with robust longitudinal sclerite sublanceolate in shape, in lateral view (Fig. 14) dorsally convex, with curved sharp apex; dorsal area of phallosome concave (Fig. 12); ventrally voluminous, subcylindrical; length 0.26 mm.

**Female:** Unknown (females of this species may be larger and bulkier than males but less frequently collected).

Variation in paratype series.—Some specimens have dark coxae, other specimens have a yellowish ventral region, mainly on the metasternum. Measurements (in mm): total body length 3.10–4; maximum width 1.45–1.77; pronotal length 0.75–0.90, basal width 1.25–1.55; elytral length 2.67–2.95.


**Etymology.**—It is with pleasure that I dedicate this species to Professor Harley P. Brown of the University of Oklahoma because of his contributions to research and knowledge of American Psepheninae.

**Habitat.**—Adult males were captured in a quick-flowing stream, on stones covered with moss and aquatic phanerogams, and near *Psephenops lupita* Arce-Pérez individuals.

**Key to New World Genera of Psepheninae Based on Adults** [Modified from Brown (1976) and White and Brigham (1996)]

1. Antenna long, filiform, extending notably beyond elytral humeri (Fig. 2); pro- and mesotarsomeres 1 and 2 markedly stouter than following three and slightly emarginate at apex (Fig. 8) ............................................ *Phenops*
   - Antenna short, moniliform or subcylindrical, scarcely or not extending beyond elytral humeri; pro- and mesotarsomeres 1 and 2 of variable length but never stouter than following three tarsomeres .......................................................... 2

2(1) Pronotum with a mid dorsal longitudinal carina (Fig. 3) ............................................ 3
   - Pronotum without carina ............................................ 4

3(2) Pronotum expanded laterally on posterior half, with a well-developed carina (Fig. 3); maxillary palp short, last palpomere longest (Fig. 6); tarsomeres 1 and 2, and occasionally 3, with wide ventral expansions that cover apical tarsomeres (Fig. 9) ............................................ *Psephenops*
   - Pronotum with lateral margins rounded, not
expanded on posterior half, with a feeble carina (Fig. 1); maxillary palpus extremely long, second palpomere much longer than other palpomeres (Fig. 5); tarsomeres without wide ventral expansions, fifth tarsomere much longer than first four together (Fig. 7)  

\[ Pseplenopalpus \text{ gen. n. } 4(2') \]

Tarsomeres 1–4 short, triangular, flattened.

deeply emarginate for reception of following tarsomere; tarsomeres 1–2 with long ventral setae or papillae, those on 2 reaching base of fifth tarsomere (Fig. 10)  

\[ \ldots \]

\[ Psephenotarsis \]

- Tarsomeres 1–4 subconical and slender, scarcely emarginate at apex; tarsomeres 1–2 usually with ventral setae or papillae that
never cover contiguous tarsomere (Fig. 11)  

\textit{Psephenus}

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\textbf{LITERATURE CITED}


A NEW SPECIES OF THE ANT GENUS ACANTHOSTICHUS MAYR (HYMENOPTERA: FORMICIDAE) FROM PARAGUAY, AND A DESCRIPTION OF THE GYNE OF A. BREVICORNIS EMERY

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Abstract.—I describe a new species of Acanthostichus from the Department of Chaco in Paraguay, Acanthostichus longinodis, described from the worker, is a member of the brevicornis species complex. It differs from the workers of all of the other South American species in having an elongate petiole, a relatively small subpetiolar process and a swollen posterior femur. I also describe the gyne of A. brevicornis Emery and provide new information on the worker.

Resumen.—Describo una nueva especie del género Acanthostichus encontrada en el departamento de Chaco, Paraguay. Acanthostichus longinodis es descrita basada en la obrera, y es miembro del complejo de especies brevicornis. Se diferencia en que el peclíolo es muy largo, el proceso subpetiolar es relativamente pequeño, y el fémur posterior es ancho. También describo la hembra de A. brevicornis Emery y presento nueva información de la obrera de esta especie.

Key Words: Neotropical, Cerapachyinae, Chaco region

The ant genus Acanthostichus Mayr is an interesting, rarely-collected group of ants. They are probably common, but rarely encountered due to their subterranean habits. Most worker specimens are collected under stones or other objects, while males are attracted to lights. The genus is found throughout the Americas, from the southern part of the United States south to Paraguay, Uruguay, and northern Argentina, and recently has been revised (Mackay 1996).

Acanthostichus longinodis Mackay, new species
(Figs. 1–4, 10)

Diagnosis.—This initially appears to be a typical South American Acanthostichus species, but can be distinguished from other South American species by the combination of the elongate petiole (Fig. 4), the small subpetiolar process (Fig. 1) and the incrasate posterior femur (Fig. 3). It can be separated from two Mexican species with elongate petioles, A. quirozi Mackay and A. skwarrae Wheeler as the sides of the petiole are sharply separated from the dorsal surface by an abrupt bend which nearly forms a carina. The elongate petiole would preclude confusion with any other species in the genus.

Description.—Worker (n = 3, all measurements in mm): HL (Head Length) 0.76–0.78, HW (Head Width) 0.58–0.60, SL (Scape Length) 0.28–0.30, SW (maximum Scape Width) 0.10–0.11, EL (maximum Eye Length) 0.04–0.05, WL (Weber’s Length, anterior edge of pronotal shoulder to posterior edge of metapleural lobe) 1.08–1.14, PL (Petiole Length) 0.35–0.40, PW (Petiole Width) 0.23–0.26, SI (Scape index,
SL/HL × 100) 35-40, CI (Cephalic Index, HW/HL × 100) 76-77, PI (Petiolar Index, PL/PW × 100) 150-153, SL/SW 2.78-2.88.

Mandible without teeth; anterior border of clypeus weakly concave, nearly straight; frontal carinæ closely spaced, slightly overhanging anterior margin of clypeus with head in full face view (Fig. 2); sides of head nearly straight, slightly widened anteriorly (Fig. 2), posterior border of head slightly concave; scape short; eye tiny, apparently composed of three ommatidia; malar groove well marked; mesosoma basically rectangular in shape as seen from side and as seen from above, narrowed posteriorly (seen from above), with narrowest part being posterior edge of propodeum; propodeal spiracle slightly below midline (Fig. 1); petiole greatly elongated (Fig. 4), anterior face nearly straight, slightly widened posteriorly; posterior femur incrassate (Fig. 3).

Moderately hairy, with erect hairs on scape, mandible, dorsal surface of head, posterior border of head, ventral surface of head, dorsal of mesosoma, dorsal of petiole, and all surfaces of gaster.

All surfaces smooth and glossy.

Ferrugineous red, appendages and gaster slightly lighter.

Distribution.—Known only from the type locality (Fig. 10).


Material examined.—Type series.

Etymology.—From Latin, longus for long and nodus for swelling, describing the elongate petiole.

Discussion.—This species would not be confused with any other South American species, based on the small subpetiolar process, the incrassate posterior femur, and the elongate petiole. The elongate petiole could cause confusion with two species from Mexico: A. qirozi and A. skvarrae. However, it can be separated from the geographically distant Mexican species as the sides of the petiole are sharply separated from the dorsal surface by an abrupt bend which nearly forms a carina.

A modified key to include this new species will be placed at www.utepe.edu/leb/antgenera.htm.

Biology.—The type series was collected under a stone.

Acanthostichus brevicornis Emery
(Figs. 5-9, 10)


This is one of the most common species in the genus, being previously found in Brazil, Argentina, and French Guiana. I report the first record from Paraguay, provide new information on the worker, and describe the gyne.

Description.—Worker: Additional measurements (n = 3): HL 0.71-1.07, HW 0.56-0.82, SL 0.30-0.40, SW 0.11-0.18, EL 0.04-0.06, WL 0.92-1.46, PL 0.29-0.47, PW 0.29-0.46, SI 37-42, CI 76-90, PI 100-106, SL/SW 2.20-2.73.

These workers from Paraguay differ from the "typical" A. brevicornis in being strongly dimorphic, increasing the range of worker size (above). Additionally the anterior face of the petiole is nearly straight as seen from above. The shape of the anterior face of the petiole in this species is variable, ranging from nearly straight to strongly concave.

Gyne: HL 1.02, HW 1.01, SL 0.43, SW 0.19, EL 0.18, WL 1.67, PL 0.62, PW 0.83, SI 42, CI 99, PI 50, SL/SW 2.25.

Subdichthadiiform, mandible without teeth (Fig. 6): anterior border of clypeus concave (Fig. 5); frontal carinæ closely spaced, posterior border of head concave, sides of head rounded; malar groove poorly
developed, extending from base of mandible slightly more than 0.1 mm, remainder of groove marked by very slight indentation; scape thickened; eye large, but failing to reach side of head by about ½ minimum diameter; ocelli absent; mesosoma basically rectangular as seen from side (Fig. 9), and as seen from above; promesonal suture poorly developed, metanotal suture marked on dorsum of mesosoma; propodeal spiracle placed above midline (Fig. 9), propodeum rounded between faces; subpetiolar process absent (Fig. 9), petiole wider than long as seen from above, slightly wider posteriorly (Fig. 8); posterior femur slightly widened (Fig. 7), much less so than that of worker; pygidium without spines.

Erect hairs sparse; few hairs along anterior border of clypeus, and on mandible, along frontal carina, dorsum of head, posterior margin of head, dorsum of mesosoma, and legs; hairs on posterior face of propodeum fine, brushlike, with similar hairs on side and posterior margin of petiole; ventral surface of petiole with thick, closely spaced hairs; gaster with similar hairs on dorsal and ventral surfaces.

All surfaces smooth and glossy.

Yellow, mandibles and clypeus slightly darker.
Material examined.—PARAGUAY, Canindeyú: Col. “11 de Septiembre”, 24°03’S 55°34’W, 19.vii.1997. A. Wild #AW0522 (7 workers, CWEM, MCZC; 1 ♀, MCZC). The full series consists of 43 workers [majority not seen]. Specimens are also deposited in the LACM (Natural History Museum of Los Angeles County), MNHP, in the collection of Sean Brady, and in the collection of Alex Wild.

Discussion.—The gynes of this genus are known from only five species: A. enmae Mackay (texanus species complex) and A. texanus Forel (texanus species complex), which are “normal”, winged gynes, with ocelli, and A. laticornis Forel (serratulus species complex), A. quadratus Emery (serratulus species complex) and now A. brevicornis Emery (brevicornis species complex), which are subdichthadiiform (lacking ocelli, lacking flight sclerites, having a distended gaster, and lacking the teeth on the
pygidium). The gyne of *A. brevicornis* easily can be separated from that of *A. quadratus*, as the malar groove is developed at least near the base of the mandible (apparently lacking in *A. quadratus*), the propodeum is rounded between the faces (with an angular process in *A. quadratus* and a carina in *A. laticornis*) and the subpetiolar process is absent (developed into a tooth in *A. quadratus* and a broad flange in *A. laticornis*). Separation from *A. laticornis* is more difficult. The gyne of *A. brevicornis* is smaller than that of *A. laticornis*. The total length of the gyne of *A. brevicornis* is less than 9 mm, the gyne of *A. laticornis* is about 11 mm. The malar groove in the gyne of *A. brevicornis* is relatively short, extending slightly more than 0.1 mm from the point of insertion of the mandible (extending about half of the distance to the eye of *A. laticornis* or 0.4 mm). The lateral clypeal angles are absent in *A. brevicornis* (convex border is present), but are well developed in *A. laticornis*. The frontal carinae of *A. brevicornis* are very closely placed, with the distance between the external margins 0.23 mm (about 0.4 mm in *A. quadratus*, 0.47 in *A. laticornis*). This suggests an additional characteristic to separate the two species complexes. The frontal carinae of the gynes of the *brevicornis* complex may be closely spaced, those of the *serratus* species group are apparently more widely spaced. As gynes have not been collected without workers, the worker characteristics would allow separation of the gynes of the two species. Since the sample size of gynes is so limited, we have very little sense of intraspecific variation, which is really needed to establish how the species differ.

Biology.—The series was nesting in the soil in grazed second growth vegetation. This species is not uncommon in that collection locality. Alex Wild (personal communication) saw it several times under logs and near the surface of the soil where he was digging. It was always found in disturbed habitats, e.g., grazed areas, lawns, nesting in red clay soil.

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A NEW FOSSIL NICOLETIIDAE (ZYGENTOMA, "APTERYGOTA") IN DOMINICAN AMBER

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Abstract.—Hemitrinemura extincta, n. sp., is described from Dominican amber (ca. 15–45 Ma). The new species is considered to be the only Neotropical representative of a genus with (?) three living species known from Papua New Guinea, Melanesia, and Polynesia. This species is the third Nicoletiidae fossil from New World amber; it is easily distinguishable from previously described taxa (two species of Trinemurodes Silvestri) by the complete praetarsus.

Key Words: biogeography, Dominican amber, Hemitrinemura extincta, Nicoletiidae, Zygentoma

Several specimens of Microcoryphia (= Archaeognatha) and Zygentoma (= Thy- sanura s. s.) have been described from Dominican amber. These include a single species of Meinertellidae (Microcoryphia), Neomachilellus (Praeneomachilellus) dominicanus Sturm and Poinar (1997) represented by a large number (ca. 100) of specimens, 3 specimens of Ctenolepisma electrans Mendes (1998) in the Lepismatidae (scaled and with lateral compound eyes), 11 specimens of Archeatelura sturmi Mendes (1997a, b) in the Ateluridae (eyeless, usually scaled, with short, droplike body and as a rule short appendages), and two species of Nicoletiidae (eyeless, usually unscaled, with thin elongate body and with long appendages), including one individual each of Trinemurodes antiquus Sturm and Mendes (1998) and T. miocenicus Sturm and Mendes (1998). A myrmecophilic relationship was suggested with A. sturmi since ants were also present in one of the amber pieces of that series (Mendes 1997b). The other fossil taxa probably had edaphic (soil and/or soil surface) habits similar to their extant relatives.

The present fossil specimen is readily distinguishable from Trinemurodes Silvestri, the only previous genus of the Nicoletiidae described from Dominican amber, by its complete praetarsus with well-developed paired claws and empodium. The occurrence of this new fossil species is quite interesting not only from the systematic point of view but also because of its geographical origin and the distribution of its closest living relatives.

MATERIALS AND METHODS

The specimen was obtained from mines in the Cordillera Septentrional of the Dominican Republic. Dating Dominican amber is still controversial with the latest proposed age of 20–15 mya based on Foraminifera (Iturralde-Vincent and MacPhee 1969) and the earliest as 45–30 mya based on coccoliths (Cépek in Schlee 1990). A
range of ages for Dominican amber may be likely since the amber fossils are associated with turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994). Dominican amber can be secondarily deposited in sedimentary rocks, which makes a definite age determination difficult (Poinar and Mastalerz 2000). Dominican amber was produced by the leguminous tree, *Hymenaea protera* Poinar (1991). A re-construction of the Dominican amber forest based on amber fossils indicated that the climate was similar to that of a present-day tropical moist forest (Poinar and Poinar 1999). The amber piece containing the fossil was reshaped and polished in order to better view the specimen. Examination was made under magnifications of up to 750×, with a combination of direct illumination (optical tubes of Hund Wetzler apparatus) and indirect lighting (with a Leitz SM-Lux optical microscope and a Wild M5A stereoscopic microscope). Also included in the same amber piece with the nicoletiid were various sized pieces of plant material. The holotype and only specimen is deposited in the Poinar Amber Collection maintained at Oregon State University (accession # T-1-13).

**DESCRIPTION**

*Hemitrinemura extincta* Mendes and Poinar, new species

(Figs. 1–16)

Diagnosis.—The new species possesses a long, thin, parallel-sided body with only setae and macrochaetae (scales lacking), a developed prostheca, simple and complete praetarsi with long, delicate, smooth claws; thin tibiae with some long, stout, spiniform ventral setae; a short and wide urotergite X; urosternites I (–)–VII entire. II–IX stylect and II–VII vesicular structures; a subgenital plate wider than long; a short typical ovipositor with thin setae only and a spinulated inner ventral area of gonapophyses IX. The new species is distinguished from other species of the genus by the degree of ap-pendage elongation. It is intermediate between the very elongated *H. subarmata* (Paclt), from Papua New Guinea (Paclt 1982), and the short, stout forms of *H. pacifica* (Carpenter) from Samoa (Polynesia) and Vanuatu (Melanesia) archipelagos and *H. gracilis* (Carpenter) from Western Samoa (Carpenter 1928).

Description.—The basal ventral portion of the abdomen is damaged and the body is twisted in a U shape position. Some air bubbles and minute opaque particles occur on the dorsolateral surface at the end of the abdomen, at the middle dorsal area of the thorax and along the body. Some areas are either deformed or difficult to study in detail due to the position of the specimen.

*Body length*: 4.1 mm; antennae length: maximum of 3.1 mm; cerci length: 2.3 mm; paracercus length (apically damaged): 2.4 mm.

*Body* (Figs. 1–4): Thin and elongate, delicate, lacking scales; setae and macrochaetae present, some near the border of the sclerites; legs long and stout, with acute or round points.

*Head* (Figs. 4–9): Almost certainly wider than long (oblique) with several macrochaetae mainly along lateral and posterior borders; antenna typical, scapus subcylindrical, ca. twice as long as wide, pedicellus not much longer than wide; flagellum with ovoid articles, each with a ring of thin setae, those of basal area round, apical ones clearly longer than wide; mandible large, apex not visible in detail; maxilla with protheca, lacinial teeth acute, dark; galea ?; maxillary palp with subcylindrical articles, apical one with 6 papillae, ca. .25 longer than preceding and ca. 3.2 times longer than wide; labial posterolateral area not visible, labial palp (only one preserved) close to amber surface, impossible to see in detail, its apical article apparently ovoid or trianguloid and more or less as long as wide, with usual papillae.

*Thorax* (Figs. 10–11): Longer than wide, with several marginal macrochaetae and some smaller discal setae and macrocha-
Figs. 4–9. *Hemitrinemura extincta*. holotype. 4. Ventral surface; damaged area of basal abdomen dotted, the air bubbles and granules in broken lines. 5. Head, dorsal. 6. Scapus and pedicellus of antenna. 7. Median flagellar chain. 8. Distal flagellar chain. 9. Maxillary palp. Scale bar: 0.1 mm. Abbreviations: a, antenna; g, galea; l, lacinia; md, mandible; mp, maxillary palp; mx, maxilla.

tae; leg I and leg II of only left side present and exclusively first one complete (right leg I and leg II and both leg III missing, only coxae preserved); femur of leg I and leg II elongate, thin (almost certainly distorted), tibiae very delicate, with short setae and ventral macrochaetae; tibia I ca. $\frac{1}{2}$ shorter than tibia II; tarsi with 4 divisions, with some strong ventral setae, praetarsus simple and complete, with long, thin lateral claws and delicate empodium (similar to claws though smaller, thinner and less arched);
tibia I, 0.16 mm long, clearly shorter than tarsus, tibia II, 0.26 mm, as long as tarsus.

Abdomen (Figs. 12–16): Tergites similar to nota, with short setae and some posterior elongate macrochaetae (3+3 on posterolateral angle of urotergites I–VIII); urotergite X very short and wide, with almost straight posterior border (macrochaetae not preserved); urosternite I polished away from amber piece, I–VII entire; II–VI with vesicles, VII with pseudovesicles; II–IX with short, delicate stylets; urostylet IX longer and stouter (ca. 0.20 mm) than urosternite VIII (ca. 0.14 mm), with some spiniform dark, long setae more conspicuous on IX; setae and macrochaetae of urosternites impossible to observe; subgenital plate elliptical, shorter than wide at base; ovipositor short, with 8–10 divisions and with thin setae only, preserved in distorted position; inner ventral area of gonapophyses IX with spinulated integument; cercus and paracercus elongate, robust, clearly longer than half body length, with short setae and strong, elongate, macrochaetae.

Etymology.—From the Latin extinctus (a) (um), killed, disappeared, suppressed, extinct, in allusion to its fossil existence.

Discussion.—The new taxon clearly shows a developed prostheca and subgenital plate and distally transformed gonapophyses IX integument, which removes it from the Protrinemurinae. The presence of entire urosternites II–VII excludes it from the Nicoletiinae as well as the Cubacubaninae. Unfortunately, the first urosternite is damaged, which makes it impossible to state accurately if this sclerite is entire (as occurs with the Subnicoletiinae) or if it is composed of one median sternite plus 1+1 coxites (as typical of the Coletiniiinae) (Mendes 1988, 1994).

The occurrence of 8 pairs of abdominal stylets (II–IX) and vesicular structures on urosternites II–VII is typical for the type genus, Coletinia Wygodzinsky 1980. However, this predominantly northern Mediterranean genus possesses a much longer ovipositor (exceeding the length of the IX stylets), a longer and more or less emarginated X urotergite and much more robust tibiae. Furthermore, the male paramera of Coletinia are entire and the ventral surface of X urotergite bear typical pegs, in contrast to the condition in Subnicoletiidae. In spite of the damaged urosternite I and absence of secondary sexual characteristics, we believe the Dominican amber fossil belongs to the Subnicoletiinae.

The Subnicoletiinae (based on Mendes 1988, 1994 and Smith 1998) consists of 10 genera with a typical Gondwanian distribution known exclusively from the Southern continents. The only genus in the family with living and fossil representatives (Sturm and Mendes 1998) is Trinemurodes Silvestri 1916, recognized by the absence of empodia. A lepismatoid-shaped body is also shared by other genera tentatively placed in this subfamily, including Hemitelura Escherich 1906, with modified scales, 4–6 pairs of vesicles and a Gondwanian distribution, Trichatelura Silvestri 1932, from the Neotropics, with 3 pairs of stylets, Trichotriura Silvestri 1918 and Trichotriuroides Mendes et al. 1994 from Western Central Africa, with a reduced number of stylets (also on VII–IX only) and distinct tergal chaetotaxy.

Subnicoletia Silvestri 1908a, a poorly described monotypical genus from the Guinea Gulf island of São Tomé (São Tomé a Príncipe Republic), has the stylets from urosternites IV–IX reduced to 6 pairs. The Australian genera Trinemura Silvestri 1908b and Subtrinemura Smith 1998, though much more similar to the fossil, show abdominal stylets on the urosternites III–IX (lacking on II) as does Metrinura Mendes 1994, known from Australia and Celebes (= Sulawesi) with one isolated species in Colombia. Hemitrinemura Mendes 1994 is the only described genus that shares similar characters with the new Dominican fossil species, namely a long, thin unscaled body, entire urosternites (from I–VII), abdominal stylets on II–IX, vesicles on II–VI, pseu-
dovesicles on VII, and a complete praetarsus, with paired claws plus empodium.

According to Smith (1998), Hemitrinemura includes not only the type species, H. subarmata (Paclt), from Papua New Guinea (Paclt 1982), but also two other species considered as possibly conspecific (Smith 1998), namely H. pacifica (Carpenter) from Samoa (Polynesia) and Vanuatu (Melanesia) archipelagos and H. gracilis (Carpenter) from Western Samoa (Carpenter 1928). As previously reported (Smith 1998) the Pacific representatives show “antennae much shorter than body total length” and “legs short and stout,” which seems to indicate a much closer similarity between H. subarmata (Paclt) and H. extincta sp.n. Indeed, both species show quite thin and elongate legs and, despite the incomplete flagellar chain in the Dominican fossil, thin and elongate antennae. Hemitrinemura subarmata, probably a troglobiont, is known only by males (Paclt 1982, Smith 1998). While the newly described species consists of one unique female; the New Guinea specimens are much larger (body + head ca. 10 mm), show longer and thinner maxillary palp articles and lack strong elongate
spines on the ventral surface of the legs. Despite possible shrinking resulting from amber preservation and even taking into account that both males of H. subarmata are almost certainly somewhat distorted by dehydration as reported by both Paclt (1982) and Smith (1998), the dissimilar characters show that H. extincta is distinct from the New Guinea species.

This is one of the few Dominican amber fossils with extant relatives having an Indo-West Pacific distribution. A Dominican amber marine water strider, Halovelia electrodominica Andersen and Poinar (1998) also had a similar disjunct distribution with extant members of the genus occurring in the Indo-West Pacific Region. Discovering a species of Hemitrinemura in Dominican amber suggests that the genus had a much more extensive distribution, including trans-Pacific, in the mid-Tertiary. The extinction of H. extincta from the New World could have been the result of climatic changes associated with cooling events that occurred in the Caribbean during the Pliocene-Pleistocene periods, a condition that probably resulted in the extinction of many clades found in Dominican amber (Poinar and Poinar 1999).

LITERATURE CITED


Smith, G. B. 1998. Review of the Australian Nicole-
THREE NEW SPECIES OF CHILEAN CADDISFLIES
(INSECTA: TRICHOPTERA)

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Abstract.—Three new species of caddisflies are described from Chile, *Mastigoptila complicornuta, n.* sp., *Mastigoptila elae, n.* sp. (Glossosomatidae), and *Smicridea (Smicridea) figueroai, n.* sp. (Hydropsychidae). The *Mastigoptila* species are characterized by asymmetrical male genitalia bearing long processes from the inferior appendages and phallic structures. The species of *Smicridea* is characterized by a pair of dorsomedial spines in the phallic.

Key Words: new species, Chile, Neotropics, caddisflies, biodiversity, taxonomy, Glossosomatidae, Hydropsychidae

Among all the South American countries, the Trichoptera fauna of Chile is perhaps the most well known. This is due mainly to the work of two researchers, the late F. Schmid, Canadian National Collection, and O. S. Flint, Jr., of the Smithsonian Institution. Schmid, in a series of papers beginning in 1955 (e.g., Schmid 1958), described many new species and genera, almost entirely from material supplied to him by the Chilean naturalist and collector Luis E. Peña. Schmid’s other significant contribution to our knowledge of the fauna was his monograph on Hydrobiosidae (Schmid 1989). Later, from about the mid-1960s to the present, Flint described much additional material, some supplied to him by Peña and other collectors, but most collected by himself during several visits to the country (e.g., Flint 1967, 1974a, 1989, 1999, 2002). A few other workers, most notably L. Navás, described additional species. Together, Schmid, Flint, and Navás described 86% of the known Chilean caddisfly fauna (91, 72, and 18 species, respectively) (see Flint et al. 1999 for additional references to the Chilean fauna).

Undoubtedly, Schmid and Flint’s interest in the fauna was influenced by its high degree of endemism; it is unlike anything in the rest of the Neotropical Region (Flint 1974b). At the species and generic level, Chile’s caddisfly fauna is almost 100% endemic, but many of its families are shared with those of Australia and New Zealand. The fauna is clearly part of the well-documented trans-Antarctic biota (Crisci et al. 1991). While the fauna is highly endemic, only about 210 species are known from the country (Flint 1974a, Flint et al. 1999); this is not very diverse by South American standards. Even so, new species are still being discovered and described as Flint’s recent papers, as well as the present one, attest.

In January of 2000, I had the pleasure of travelling to Chile with Dr. Fernando Muñoz, University of Minnesota, at the invitation of Ms. Elizabeth Araya and Mr. Ricardo Figueroa, both then researchers in the aquatic biology section of “EULA-Chile” (Europe-Latin America, a research partnership between Chile and the European Union) at the Universidad de Concepción.
We collected at several localities in the foothills of the Andes from Concepción south to Osorno, with most of the collections coming from the Río Bío Bío basin, the focus of study of the EULA researchers. The resulting material contained three new species, one each in the genera *Mastigoptila* (Glossosomatidae), *Smicridae* (Hydropsychidae), and *Microthremma* (Helicophidae). The specimens of *Microthremma* were subsequently sent to Dr. Flint for inclusion in his recent revision of the genus (Flint 2002) and were described as *M. patagonica*. In return, Dr. Flint kindly sent me specimens he collected in 1969 of a second undescribed species of *Mastigoptila* to include in this paper.

Types of the species described herein are deposited in the University of Minnesota Insect Collection, St. Paul, Minnesota (UMSP), the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (NMNH), and the Universidad de Concepción, Concepción, Chile (UDEC) as indicated below. Morphological terminology follows that of Flint (1989) for *Smicridae*, but a different interpretation from that presented by Flint (1967, 1974d) for the male genitalia of *Mastigoptila* is provided.

*Mastigoptila* Flint


The description of the two new species below brings to ten the number of species now known in the genus (Flint et al. 1999), making it the largest of the three glossosomatid genera occurring in Chile, all in the subfamily Protoptilinae and all endemic to the subregion. The other two Chilean genera, *Scotiatrichla* Schmid and *Tolhuaca* Schmid, are each monobasic. Valverde and MiserENDino (1998) described the larval stages and biology of *Mastigoptila longicornuta* from Argentina. Flint (1963) and Angrisano (1995) provided keys to the adults of the South American genera.

*Mastigoptila complicornuta* Holzenthal, new species

(Fig. 1)

Like other species in the genus, this new species has highly complex, asymmetrical male genitalia. While these fit the general ground plan of the genus, they are unlike the male genitalia of any of the described species, except perhaps *M. ecornuta* which shares with the new species a hoodlike tergum X with an absence of processes.

Male.—Length of forewing 5 mm. Body and appendages fuscous; forewings fuscous, with small patch of cream colored setae at arculus and very faint tranverse line of lighter setae over cord. Genitalia as in Fig 1. Sternum VI with prominent posteromesal process. Sternum VII with small, posteromesal point. Sternum VIII lacking process. Segment IX broadest laterally, anterior margin broadly rounded, posterior margin angular, lightly sclerotized dorsolaterally, excavated ventrolaterally, sternum produced posteriorly; in dorsal view, tergum IX with broad U-shaped excavation anteriorly, tergum forming very narrow, slightly produced sclerotized bridge; in ventral view, sternum IX with roughly V-shaped excavation anteriorly, produced posteriorly, sternum forming a heavily sclerotized narrow bridge. Tergum X hoodlike, extending over phallic apparatus, setose apically, laterally, and ventrally, lightly sclerotized dorsally, posterior margin somewhat irregular, ventral margin shelflike, produced mesally, heavily sclerotized mesobasolaterally and forming apparent articulation with segment IX; in dorsal view, tergum X irregular laterally, with broad, U-shaped excavation apically; internally with pair of hemispherical excavations and pair of terete, anteriorly directed apodemes. Inferior appendages complex, asymmetrical, fused and produced medially into broad, quadrate, truncate, apically setose process;
the inferior appendage complex fused basally with base of lightly sclerotized phallicrypt; left inferior appendage small, ear-shaped, bearing small, slender, recurved, posteriorly directed, spinelike basodorsal process; right inferior appendage larger, ear-shaped, with heavily sclerotized ridges ventrally, bearing long, slender, highly recurved, ventrally directed, spinelike, basodorsal process; with pair of very small setose processes at basolateral corners of fused inferior appendages. Phallicrypt a lightly sclerotized cup, fused basally with base of inferior appendage complex, acting as receptacle for base of phallic apparatus; bearing long, slender, highly recurved, ventrally directed, spinelike process originating from membranes of phallicrypt above base of phallic apparatus. Phallic apparatus asymmetrical, complex, tubular, with highly convoluted internal membranes basally; truncate subapically, apex flat, extended posteriorly as acutely triangular shelf; right side of phallic apparatus slightly inflated laterally, left side with small membranous setose protuberance; ventrally with setose membranous mound on right side, large internal toothlike spine on left side, medially with patch of fine microtrichia.

Female.—Unknown.

Type material.—Holotype, \( \delta \), CHILE: VIII Región del Bio-Bío: Bio-Bío: small trib. to Río Queco, 5 km E Ralco, 37°51.619'S, 71°36.257'W, el. 500 m, 16.1.2000, Holzenthal and Muñoz (UMSP). Paratypes. Same data as holotype, 4 \( \delta \) (UMSP), 2 \( \delta \) (NMNH), 2 \( \delta \) (UDEC). VII Región del Maule: Linares: Emb[alse] Bul-lileo, 36°18'S, 71°25'W, 11–12.1.1994. C and O. Flint, Jr., 2 \( \delta \) (NMNH).

Etymology.—The name is derived from the Latin word for complex and refers to the complex, intricate structure of the male genitalia. The suffix "cornuta" is in keeping with that of other names in the genus, referring to the hornlike process of tergum X in those species (absent in M. complicornuta).

*Mastigoptila elae* Holzenthal, new species

(Fig. 2)

This species is most similar to *M. ventricornuta* Flint. Both species share the possession of a prominent process on the ventral margin of tergum X and a similarly shaped inferior appendage complex. However, in the new species the process on tergum X is much larger and the medial process of the inferior appendage is more quadrate than in *M. ventricornuta*. The two species differ significantly in the structure of the phallic apparatus, which in *M. elae* has an unusual receptacle for the tip of the recurved spinelike process of the inferior appendage.

Male.—Length of forewing 3 mm. Body and appendages fuscous; forewings light fuscous, with small patch of cream colored setae at arculus and very faint transverse line of lighter setae over cord. Genitalia as in Fig. 2. Sternum VI with prominent posterosomal process. Sternum VII with small, posterosomal point. Sternum VIII lacking process. Segment IX broadest laterally, anterior margin slightly rounded, posterior margin angular, lightly sclerotized dorsolaterally, excavated ventrolaterally, sternum narrowly produced posteriorly; in dorsal view, tergum IX with broad U-shaped excavation anteriorly, tergum forming very narrow, slightly produced sclerotized bridge; in ventral view, sternum IX with roughly V-shaped excavation anteriorly, produced posteriorly, sternum forming a heavily sclerotized narrow bridge. Tergum X large, quadrate, hoodlike, extending over phallic apparatus, setose apically, laterally, and ventrally, lightly sclerotized dorsally, posterior margin truncate, produced basomesally into prominent process, not heavily sclerotized mesobasolaterally, without apparent articulation with segment IX; in dorsal view, tergum X irregular dorsolaterally, truncate apically; internally with pair of narrow, sinuous excavations and pair of te-rete, anteriorly directed apodemes. Inferior
appendages complex, asymmetrical, fused and produced medially into broad, rounded, setose process, in ventral view this process roughly triangular, apicolateral corners te- rete, excavated mesally; the inferior appendage complex large, body heavily scler- otized with sclerotized ridges and folds, fused basally with base of lightly sclero- tized phallocrypt; left inferior appendage large, broadly S-shaped, bearing very long, slender, recurved, posteriorly directed, spinelike basodorsal process; right inferior
appendage much smaller, roughly quadrate, with only very weakly developed basodorsal process; with pair of larger setose processes at basolateral corners of fused inferior appendages. Phallocrypt a very lightly sclerotized hemispherical cup, fused basally with base of inferior appendage complex, acting as receptacle for base of phallic apparatus; bearing shorter, thicker, curved, ventrally directed, spine-like process originating from membranes of phallocrypt above base of phallic apparatus. Phallic apparatus asymmetrical, complex, tubular, roughly S-shaped, with highly convoluted internal and external membranes subapically; apex flat, spatulate, extended posteriorly; right side of phallic apparatus with unique, semisclerotized, rugose, cup-like receptacle for apex of recurved basodorsal process of left inferior appendage, phallic apparatus without apparent internal spines, setae, or microtrichia.

Female.—Unknown.

Type material.—Holotype, ♂. CHILE: VII Región del Araucania: Cañón: nr. Pucon, 43°19.66′ S, 71°44.1′ W, Flint and Cekalovic (NMNH).

Etymology.—I am very happy to name this species in honor of Ms. Elizabeth Araya in recognition of her hospitality and assistance during my visit to Chile and for her continued friendship. The name is derived from Elisabeth’s nickname, “Ely.”

Smicridea McLachlan


This new species brings to 16 the number of Smicridea known from Chile. All belong to the subgenus Smicridea except one, S. murina McLachlan, in the subgenus Rhynacophylax. Of the 16 species, 11 were described by Flint in his 1989 paper where he also described the immature stages and provided a key to the males and females. The genus is the largest among the Neotropical Hydropsychidae with more than 160 described species (Flint et al. 1999).

Smicridea (Smicridea) figueroai Holzenthal, new species

(Fig. 3)

This new species seems to fall squarely within the smilodon group of Flint (1989), containing until now only the species S. re- dunca Flint and S. smilodon Flint; the new species is most similar to the latter. With those species, it shares the thin lobe on the ventral margin of tergum X and a short, compact phallus with the basal opening at a right angle to the stem and an enlarged apex bearing a pair of sclerotized spines. However, the details of the morphology of the phallic apex in S. figueroai are quite different, especially in its possession of dorsomedial spines rather than apical, ventrally directed spines in the other species.

Male.—Length of forewing 6.5—7.0 mm. Color generally pale stramineous, appendages paler, antennae annulate; dorsum of head and thorax with white setae; forewing whitish-yellow, apical two-thirds of wing faintly irrorate with light brown patches of setae, darker, larger patch at pterostigma, and series of more distinct patches of brown setae along basal half of costal margin. Eye of male in anterior aspect with diameter about two-thirds that of interocular distance. Anterolateral process of sternum V shorter than sternum; abdominal segments VI and VII each with pair of internal, elliptical, reticulate sacs, each slightly shorter than the segment in which it lies. Genitalia as in Fig. 3. Segment IX with anterior margin vertical. Tergum X deeply divided dorsally. tergite terete posteriorly in dorsal view, slightly upturned in lateral view; ventral margin with large thin lobe basad. Inferior appendage with basal segment slender, slightly inflated apicad; apical segment short, blunt. Phallus with basal opening at right angle to stem, subapically enlarged.
bulbous, especially dorsomedially, the enlarged area consisting of paired, broad, rounded lateral plates, flanking a membranous mesal region from which arises dorsomesolaterally a pair of hook-shaped, heavily sclerotized, posteriorly directed spines; phallus terminating in paired, lateral sclerites, cup- or scooplike mesally, longer than wide and projecting anteriorly well beyond bulbous subapical portion.

Female.—Unknown.

Type material.—Holotype, ♂. CHILE: VIII Región del Bió-Bío: Biobío: small trib. to Río Queco, 5 km E Ralco, 37°51.619'S, 71°36.257'W, el. 500 m, 16.i.2000, Holzenthal and Muñoz (UMSP). Paratypes. Same data as holotype, 2 ♂ (UMSP), 1 ♂ (NMNH), 1 ♂ (UDEC).

Etymology.—I take great pleasure in naming this species in honor of my friend, Ricardo Figueroa, in recognition of his generous assistance during my visit to Chile in
2000 and his continued friendship and collaboration.

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**LITERATURE CITED**


**ANOPHELES (NYSSORHYNCHUS) KONDERI GALVÃO AND DAMASCENO: NEOTYPE DESIGNATION AND RESURRECTION FROM SYNONYMY WITH ANOPHELES (NYSSORHYNCHUS) OSWALDOI (PERYASSU) (DIPTERA:CULICIDAE)**

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Abstract.—Anopheles (Nyssorhynchus) konderi Galvão and Damasceno 1942 is redescribed with illustrations of the male and female genitalia and the larval and pupal stages. A neotype for An. konderi is designated, and it is resurrected from synonymy with An. (Nys.) oswaldoi (Peryassu 1922).

**Key Words:** Anopheles konderi, Anopheles, Culicidae. taxonomy, redescription, malaria

Anopheles (Nyssorhynchus) konderi Galvão and Damasceno 1942 is similar to An. oswaldoi (Peryassu 1922) in larval, pupal and adult female characters, being distinguished by only one character in the male genitalia. During the 1940’s, several authors considered An. konderi and An. oswaldoi as distinct species and made contributions to the knowledge of their geographical distribution and biology (Causey et al. 1946; Coutinho 1946; Deane et al. 1946, 1948). However, Lane (1953) considered An. konderi a synonym of An. oswaldoi and this concept was widely accepted. Indeed, the last revisions of Anopheles subgenus Nyssorhynchus (Faran 1980, Faran and Linthicum 1981) agreed with Lane (1953). E.L. Peyton (apud Klein and Lima 1990) observed differences in the behavior and malaria transmission potential of material collected in Costa Marques, Brazil. He suggested the existence of two forms of An. oswaldoi: one was present in recently modified open areas (An. konderi), and another restricted to forested areas (An. oswaldoi). Although the species has never been formally resurrected from synonymy with An. oswaldoi or morphologically well characterized in all stages, the name An. konderi has appeared in papers since Peyton’s statement (Lounibos et al. 1997, Marrelli et al. 1999).

In the present paper, morphological and morphometric analyses of specimens of An. konderi and An. oswaldoi were conducted to distinguish these species and to redescribe the former.

**MATERIALS AND METHODS**

Progenies of females and immature stages of An. oswaldoi s.l. collected in six localities in Brazil and one in Peru were included in the present study. To obtain progenies, females were blood fed and kept in individual oviposition vials. Some eggs from each female were fixed and stored in
4% glutaraldehyde or alcoholic Bouin’s solution for morphological analyses.

We follow the terminology of Harbach and Knight (1980) for morphological features and Wilkerson and Peyton (1990) for wing spot nomenclature. Abbreviations used are as follows: M, male; F, female; G, genitalia; Le, larval exuviae; Pe, pupal exuviae. The nomenclature adopted for the dorsal and ventral polarities of eggs is that of Clements (1992) and Valle et al. (1999), which is opposite of classical studies on the external morphology of the egg. The polarity is determined in the maternal organism during ovular development: the flat side of the egg or deck is considered the dorsal side and the submerged convex inferior side is ventral.

Statistical analysis of morphometric characters was done using the Kruskal-Wallis test to verify the existence of significant differences among the samples of *An. konderi* from different localities. When morphometric characters were homogeneous between samples of *An. konderi*, they were subsequently compared with those in *An. oswaldoi*, using the Mann-Whitney test. Both the Kruskal-Wallis and the Mann-Whitney tests were done using the SPSS- Windows program version 8.0 (SPSS. Chicago), at a 5% significance level.

The characters and ratios used for statistical analysis were: Female: Length of the wing, basal dark spots on hindtarsomere II, length of maxillary palpus/forefemur, total length of palpmere 3/size of basal white scaling on the same segment, proportion of basal dark-scaled band on fore- and mid-tarsomerese II and III, length of humeral pale spot/prefemeral dark, length of subcostal pale/sector dark, length of preapical pale/preapical dark, length of apical dark/preapical pale and percentage of specimens with divided sector dark spot. Male: Length of the wing, basal dark spot on hindtarsomere II, ratio of length of parabasal seta/width of gonocoxite at base, length of the aedeagus/length of claspers; length/width of sternum VIII (measured at base), length of gonocoxite/width of gonocoxite at base, width of gonocoxite taken at the widest point/width of gonocoxite at base. Pupa: Length of metamus/length of trumpet, trumpet index (length trumpet/width trumpet), length of tracheoid/length of trumpet; length of seta 1-IV/length tegum V, and paddle index (length of paddle/width of paddle measured at the widest point). Larva: Clypeal index (distance between insertion of seta 3-C on one side/distance between insertions of setae 2-C), length of antenna/distance between base of antenna and insertion of seta 1-A, length of anal papilla/length of seta 4-X, distance between apices of lateral arms of median plate of spiracular apparatus/distance between spiracular opening (SO), percentage of specimens with seta 1-X borne on saddle, type of pecten, and number of pecten spines. The type of pecten was classified according to a formula, in which numbers were given to represent the size of spines: “0” for short spines, “1” for medium size spines (about twice as long as short spines “0”) and “2” for large and long spines (about three times as long as spine “0”).

**TAXONOMIC TREATMENT**

*Anopheles (Nyssorhynchus) konderi* Galvão and Damasceno


Female (Figs. 1A, B, C).—Head: Integument darkish brown. Interocular space with approximately 20 white long semi-decumbent fusiform scales. Vertex with numerous white erect spatulate scales. Occiput
and postgena with brown erect, spatulate scales. Postgena with elongate setae, few white spatulate scales at junction of eyes; ocular setae (8–12) long, brown. Clypeus brown, bare. Antenna: flagellum (1.14 mm) with 13 flagellomeres with darkish integument and dirty white pollinosity, flagellar whorls pale; flagellomere 1 with decumbent white scales, and distal surface with patch of white falcate scales dorsally. Pedicel integument brown, with small patch of white decumbent scales dorsally. Proboscis nearly 1.0 (0.8–1.0) length of maxillary palpus. Labial basal setae 8, brown. Labellum brown, paler than proboscis, pollinose. Maxillary palpus 1.7–2.7 mm (mean = 2.1 mm), integument dark, covered with darkish narrow spatulate scales, 1.4 [(1.1–1.8) ± 0.14, $P = 0.03$] [mean (range) ± standard error of the mean, $P$] of forefemur; palpomere 1 length 0.14–0.21 mm (mean = 0.17 mm) covered with brown spatulate scales; palpomere 2 length 0.27–0.4 mm (mean = 0.43 mm), covered with dark scales, dorsally sprinkled with few (7, 8) white scales, and with apical narrow band of white scales; palpomere 3, length 0.64–0.94 mm (mean = 0.81 mm), almost completely dark, dark-scaled area 4.8 [(2.8–8.7) ± 1.64, $P = 1.64$] times white-scaled area; palpomere 4 length 0.43–0.65 mm (mean = 0.5 mm), white-scaled dorsally, with narrow dark bands at ends; palpomere 5 length 0.22–0.31 mm (mean = 0.26 mm), completely white; ventral surface of palpomeres 1–4 dark-scaled. Cibarium (Fig. 1B) with 17 (14–21) cibarial teeth of variable form and size. Thorax: Scutum length approximately 1.0 mm; integument darkish brown with pale scales and pollinosity; setae yellowish brown, numerous; integument mottled with 3 dark spots: 2 near scutal fossa and 1 on prescutellar area. Anterior promontory with white linear, erect scales. Antealar scales white,
elongate and spatulate. Scutellum covered with small falcate grayish scales; scutellar setae brown, about 13 (11–15) long and 4 (4–9) short, distributed along caudal margin. Antepronotum with spatulate, erect, brown scales, few pale scales basally; setae short, brown. Pleural integument brown to darkish brown. Usually 4 bronze upper mesokatepisternal setae, about 7 (3–7) white upper mesokatepisternal scales, 1 brown lower mesokatepisternal seta, 2 white mesokatepisternal scales, prealar scales and setae pale; about 3 yellowish upper mesepimeral setae, lower mesepimeral scales absent; upper proepisternal setae bronzey, thin and short; 2 brown lower proepisternal setae. Legs: Integument dark. Coxae: Anterior surface of forecoxa with patch of white scales, ventral 0.5 with brownish scales, 2–4 brown setae; anterior surface of mid- and hindcoxae with pale scales transversally, Trochanters with patch of white scales, setae long and brown. Femora, tibiae and tarsi essentially dark-scaled, broadly pale grayish or light cream scales on ventral surfaces. Femora and tibiae scattered with light cream scales dorsally, principally on fore- and midlegs. Foreleg: Femur length 1.28–1.62 mm (mean = 1.45 mm); tibia, length 1.68–2.05 mm (mean = 1.86 mm); tarsomere 1, length 1.0–1.34 mm (mean = 1.18 mm) with narrow band (mean = 0.04 of tarsomere) of white scales distally; tarsomere 2, length 0.4–0.6 mm (mean = 0.5 mm) dark-scaled on basal 0.7 [(0.5–0.9) ± 0.09, P = 0.128]; tarsomere 3, length 0.2–0.5 mm (mean = 0.3 mm), dark-scaled on basal 0.3 [(0.1–0.6) ± 0.14, P = 0], remainder white; tarsomere 4, length 0.17–0.26 mm (mean = 0.21 mm), completely dark-scaled, rarely with pale scales distally: tarsomere 5, length 0.14–0.2 mm (mean = 0.17 mm), dirty white, with ring of dark scales on basal 0.41. Midleg: Femur dark, length 1.54–2.08 mm (mean = 1.74 mm), with narrow band of white scales at base; tibia dark, length 1.8–2.37 mm (mean = 1.9 mm), with few pale spines at apex; tarsomere 1 dark, length 1.2–1.7 mm (mean = 1.43 mm), with small band of white scales distally (0.04 of tarsomere); tarsomere 2, length 0.5–0.8 mm (mean = 0.66 mm), dark-scaled on basal 0.9 [(0.7–1) ± 0.06, P = 0.69]; tarsomere 3, length 0.3–0.7 mm (mean = 0.5 mm), usually completely dark (0.9 [0.7–1] ± 0.04, P = 0.45), dark-scaled, with sparse pale scales distally; tarsomere 4, length 0.29–0.34 mm (mean = 0.29 mm) usually all dark-scaled, with rare pale scales distally; tarsomere 5, length 0.17–0.21 mm (mean = 0.18 mm), dark-scaled on basal 0.4, remainder white. Hindleg: Femur length 1.5–2.1 mm (mean = 1.7 mm), with 2 distal strong yellowish setae; tibia, length 1.7–2.5 mm (mean = 2.0 mm), with small ring of white scales distally; tarsomere 1, length 2.34–2.66 mm (mean = 2.63 mm), with narrow ring of white scales distally; tarsomere 2, length 0.63–0.89 mm (mean = 0.76 mm), dark-scaled on basal 0.14 [(0.08–0.20) ± 0.036, P = 0.23], remainder white; tarsomeres 3 and 4 white, tarsomere 3, length 0.4–0.69 mm (mean = 0.58 mm); tarsomere 4, length 0.31–0.48 mm (mean = 0.41 mm); tarsomere 5, length 0.26–0.34 mm (mean = 0.26 mm), dark-scaled on basal 0.5. Wings: Length 3.0–4.0 mm (mean = 3.4 mm ± 0.207, P = 0.27), pale wing spots white, dark spots darkish brown to black. Basal pale spot plus prehumeral pale spot large, length 0.24 mm (0.20–0.26 mm), more than 2.5 of prehumeral dark; basal dark spot absent; humeral pale spot 3.6 [(1.2–9.0) ± 1.41, P = 0.19] of prehumeral dark; subcostal pale spot 0.2 [0.4–0.4] ± 0.09, P = 0.302] of sector dark: preapical pale spot (PP) 0.3 [(0.5–0.5) ± 0.09, P = 0.38] of preapical dark (PD); apical dark spot 0.4 [(0.1–1) ± 0.69, P = 0.684] of PP; accessory sector dark present in 82.4% (± 0.921, P = 0.65) of specimens examined. Size of dark spots on Costa varying within progenies and between populations (n = 51). Veins CuA, M1+2, M1+3, M1, M2 and 1A covered with sparse thin fusiform scales; veins R2+3, R3, R1 and R4+5 densely covered with linear scales. Vein R1 with 4.5 (5) dark spots. R5+R2+3 with 1–3
(2) dark spots; when only 1 dark spot present it occupies more than 0.7 of vein; when 2 dark spots present, basal white spot smaller than distal one. R2 with 1–3 (2) dark spots; when 2 dark spots present, apical spot smaller; R3 with 1–3 (2) dark spots; most frequently with 2 small spots, proximal spot smaller than distal one; R4+5 with 2 small dark spots, 1 basal and other distal. M1+2 with 1–3 dark spots, more frequently with 2 dark spots; when only 1 dark spot present it occupies more than 0.7 of vein, ventral surface of M1+2 covered with dark scales. M1 with 1.2 (2) dark spots, sometimes sprinkled with white scales; M2 with 1.2 (1) dark spots. M3+4 with 3 small dark spots. CuA with 1 small dark spot distally; 1A with 2 dark spots; CuP with 1 small distal dark spot. R4+5, separating from R2+3 on level of distal 0.33 of sector dark spot. M3+4 0.33 longer than CuP. Cell R2 0.7 of cell M1. Cell M1 0.5 of M1+2. Remigium with integument pale. Halter: Length 0.35 mm; integument of scabellum, pedicel and ventral surface of capitellum pale, remainder of capitellum and distal 0.35 of pedicel dark. Abdomen: Integument dark brown, pollinosity grayish, scales falcate. Terga: tergum I with abundant brown setae; terga II–VII with posterolateral tufts of broad erect spatulate dark scales and distal median patches of grayish to cream scales in roughly triangular shape; tergum VIII covered with abundant cream scales; posterolateral setae numerous and long. Sterna with few brown setae; sternum I without white scales; sterna II–VII with white, spatulate scales laterally; posteromedian area with patch of spatulate brown scales. Sternum VIII length/width = 1.0 (0.5–1.5). Genitalia (Fig. 1C): Sternum IX, length/width = 0.6 (0.2–1.0); cercus elongate, with spatulate brown scales dorsally, and dark scales and setae ventrally; 2 postgenital setae, inserted close together, strong, length 6.2 (4.6–10) distance between them; postgenital setae generally slightly smaller than cercus, length of postgenital seta/length of cercus = 0.7 (0.5–1.0); insula bare.

Male (Figs. 2D, E, F).—Similar to female except for sexual and few other differences as follow. Head: Interocular space with about 20–26 long white setae. Antenna strongly verticilate, length 1.5–1.9 mm (mean = 1.7 mm), flagellomeres with integument grayish, heavily plumose, setae long and pale. Proboscis length 1.9–2.4 mm (mean = 2.2 mm), maxillary palpus 1.0 (0.9–1.0) length of proboscis. Maxillary palpus: palpomere 1 as in female; palpomeres 2 and 3 with one narrow band of white scales distally, palpomere 4 white-scaled on dorsal surface, with dark bands of dark scales at ends; setae of different lengths, some developed setae inserted basally surpass palpomere 5; palpomere 5 covered dorsally with pale scales, setae pale and dark; palpomeres 4 and 5 expanded, with dark scales on ventral surface. Thorax: Lower mesokatespisternal scales (8–10) white. Legs: Hindtarsomere 2 dark-scaled on basal 0.15 [(0.10–0.20) ± 0.020, P = 0.054]. Wing: Length 3.3 mm [(2.9–3.7 mm) ± 0.21, P = 0.16]; subcostal dark spot 0.4 of sector dark; dark spots on internal veins smaller than in female. Halter: Length 0.16–0.27 mm (mean = 0.24 mm). Abdomen: Sternum VIII roughly trapezoidal in shape, moderately elongate, ratio length/width = 0.8 [(0.1–1.3) ± 0.14, P = 0.11]. Genitalia: (Fig. 2D, E, F). Lobes of sternum IX as wide as long, length 0.65 mm (0.4–0.8 mm). Parabasal seta 0.8 [(0.5–1.6) ± 0.14, P = 0.01] width of gonocoxite. Gonocoxite elongate, length 3.3 [(1.7–4.7) ± 0.66, P = 0.009] width at base, expanded on basal 0.5 [width 1.5 (1.0–2.1) ± 0.26, P = 0 width at base], outer surface strongly convex, inner surface concave, long setae on tergal surface extending to ventrolateral surface. Ventrolateral surface with numerous long spatulate scales, dorsomesal surface with narrow linear patch of small, short setae. Gonostylus moderately shorter than gonocoxite, length (0.85) of gonocoxite, strongly curved, with internal spicules beyond middle; gonostylar claw spiniform and blunt. Ventral lobe of claspsate with
apical lobe moderately sclerotized, narrow, lobe length 3 times its width at base, with conspicuous median sulcus; refringent structure moderate in size; setae short and strong; basal lobule expanded laterally, with numerous long and strong setae distributed along basal margin. Dorsal lobe of claspers with pedicel moderately narrow, apex round, narrower than base, apex with 3.4 moderately broad leaflets. Phallosome: Aedeagus length 1.3 [(1.0–1.6) ± 0.21, \( P = 0.104 \)] length of claspers; weakly rounded at apex, length of apex of aedeagus about 0.4 (0.3–0.6) of width, apical aedeagal sclerite narrow and curved in elbow-like lateral projections. Paraproct weakly sclerotized, narrow distally and expanded at base.

Pupa (Fig. 2A, B, C).—Position and development of setae as figured; range and modal number of branches in Table 1. Integument brown, sclerotized. Cephalothorax: Integument more pigmented than abdomen. Trumpet: length 0.63 mm (0.52–0.9 mm), laticorn, pigmented and spiculose, tragus elaborate, trumpet index 2.3 [(1.6–5.7) ± 0.06, \( P < 0.0001 \)], meetus length 0.2 [(0.1–0.4) ± 1.36, \( P = 0.53 \)] of trumpet length; pinna 0.12–0.28 mm (mean = 0.21 mm); tracheoid length 0.4 [(0.2–0.7) ± 0.40, \( P = 0.4 \)] of the trumpet length. Abdomen: Seta 1-IV strongly sclerotized, length 0.35–0.55 mm (mean = 0.46 ± 0.06); seta 1-IV moderately developed, 1.6 (1.1–2.2) length of tergum V; tergum V length 0.23–0.39 mm (mean = 0.29 mm); seta 9-II minute; 9-III–VIII thick, short, dark brown. Paddle: pale, slightly paler than abdomen, ovate, slightly longer than wide, index 1.1–1.7 (1.4) ± 0.24; external margin spiculose, paddle marginal spicules more developed on distal 0.5; midrib distinct.

 Larva (Fig. 3).—Position and development of setae as in Fig. 3; range and modal number of branches in Table 2. Head: Integument pale, collar strongly pigmented. Antenna: length 1.0 mm (0.93–1.17 mm), antenna length 4.9 [(2.8–8.5) ± 1.19, \( P = 0.22 \)] distance from insertion of seta 1-A to base; ventral surface of antenna with short spicules, less numerous distally; seta 1-A inserted 0.2 mm (0.1–0.4 mm) from base of antenna, with 3–10 (5) branches; length of seta 1-A 0.7–1.5 (1.0) times width of antenna at point of insertion; seta 4-A bifurcate; setae 2.3, 5, 6–A usually tapered at apex; 2.3-A almost same size; 5-A short, half size of 2.3-A, 6-A slightly shorter than 5-A. Setae 2-C widely separated, clypeal index 1.4 (0.8–1.9) ± 0.27; setae 2.3-C almost same size, branched, branches usually dendritic. Ventromentum pale, with 3 teeth on each side of 2 central more developed teeth. Dorsomentum dark, strongly sclerotized, with 4 teeth on each side of one central more developed tooth. Thorax: Seta 1-P palmate; 1–3-P arising from distinct tubercles; 11-P single or double, much shorter than 9, 10, 12-P but much more developed than 1-M.T; 3-T weakly developed, palmate. Abdomen: Integument pale. Seta 1-I palmate, with 9–24 (14) moderately developed, weakly pigmented branches; 1-II–VII palmate, leaflets usually broad, well developed and strongly pigmented; 1-X usually inserted outside saddle (86.3% of specimens examined). Saddle incomplete. Anal gills hyaline, length 0.43 mm (0.28–0.63 mm), 0.9 [(0.6–1.4) ± 0.19] length of seta 4-X. Posterior margin of segment X with numerous short spicules. Spiracular apparatus: Lateral arms of median plate developed, elongate, projecting toward spiracular process or spiracular opening; distance between apices of lateral arms 1.3 [(0.8–1.8) ± 1.17] of distance between \( \text{SO}_3 \). Pecten with 16 [(12–20) ± 4.76, \( P = 0.036 \)] spines. Three types of pecten were found: type I = 2-0-2(n)-0-2(n)-0; type II = 0(n)-2(n)-1-2(n)-0 and Type III = 1(n)-2-0-2(n)-0-2(n)-0. The most common formula was type I [formula = 2-0-2(n)-0-2(n)-0-0], in which “n” is the variable number of repetitions of a kind of spine in the pecten. Egg (Fig. 4).—Boat-shaped in both dorsal and lateral views; ventral view almost flat. Length 421 \( \mu \text{m} \) (379–520 \( \mu \text{m} \)); width
Table 1. Pupal setal branching for *A.n. konderi*: range (mode), of six Brazilian populations (Coari, Porto Velho, Candeias do Jamari, Senador Guiomar, Sena Madureira and Linhares) and one Peruvian (Yurimaguas).

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Fig. 3. *Anopheles konderi*, larva (drawn from specimens BR097(2)-10 and BR097(2)-8, Costa Marques, Brazil). A, Head, a1—dorsomentum, a2—ventromentum. B, Thorax and abdominal segments I–VI. C, Abdominal segments VII–X. D, Spiracular apparatus. Scales in mm.
Table 2. Larval setal branching for *A. konderi*: range (mode), of six Brazilian (Coari, Porto Velho, Candeias do Jamari, Senador Guiomar and Linhares) and one Peruvian population (Yurimaguas).

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P = plumose
130 μm (114–170 μm): length 3.4 (2.4–3.8) of width. Floats moderately wide, about 0.87 (0.74–0.9) of total egg length, with approximately 36 (35–38) float ridges; float occupying nearly 0.33 of dorsal surface; deck narrow, hardly visible on posterior end in most of examined eggs but much wider on anterior end. Anterior deck enclosed by frill. Anterior end broadly rounded; posterior end somewhat pointed.

Type material.—Neotype male by present designation, with slide mounts of 1) associated larval and pupal exuviae, and 2) male genitalia, from the progeny brood of a female captured on animal bait at the type locality of *An. konderi*, data as follow: south margin of Solimões River at Coari (3°57’S, 63°12’W), State of Amazonas, Brazil, specimen 1629, 15-VIII-1998, C. Flores-Mendoza coll., deposited at Instituto Oswaldo Cruz (IOC), Rio de Janeiro, Brazil.

Material examined.—*Anopheles konderi*: a total of 763 specimens, consisting of 188 M, 285 F, 116 Pe, 116 Le, 98 MG and 25 FG, were studied, as follows: BRAZIL: State of Amazonas, Coari, Travessia, 17–23-VIII-1998, progeny brood of female captured on animal bait. C. Flores-Mendoza and F.Souza colls., 11M, 12MG, 7MPeLe, 11F, 4FG, 4FPeLe. State of Rondônia, Porto Velho, São Miguel at Madeira River (8°55’S, 64°12’W), 28-IV-1996, progeny brood of female captured on human bait, D.Lima coll., 11M, 11MG, 5MPeLe, 11F, 6FG, 6FPeLe; Candeias de Jamari, Samuel Hydroelectric Dam (8°55’S, 64°08’W), 2-V-1997, progeny brood of female captured on human bait. C.Flores-Mendoza and M.Marrelli colls., 11M, 11MG, 7MPeLe, 11F, 4FG, 4FPeLe; Costa Marques and vicinity (12°28’S 64°16’W), various dates 1989–1992, progeny broods of females captured on human bait with the following specimen numbers (BR = Brazil, collection number, (progeny brood number), all deposited in the Smithsonian Institution, National Museum of Natural History), J.B. Lima and T.A.Klein colls.: BR095(1) 3M, 1MG, 5F, 1PeLe; BR097(2) 1M, 1MG, 1PeLe; BR100(1) 1M, 1MG, 5F; BR100(2) 1M, 1MG, 5F; BR103(3) 2M, 1MG, 5F; BR103(4) 2M, 1MG, 5F; BR103(5) 2M, 2MG, 5F, 1PeLe; BR112(1) 1M, 1MG, 5F; BR112(5) 2M, 1MG, 4F; BR119(1) 2M, 1MG, 2F; BR119(2) 1M, 1MG, 5F; BR119(6) 1M, 1MG, 5F; BR120(2) 1M, 1MG, 1F; BR125(1) 1M, 1MG, 5F; BR133(2) 2M, 1MG, 5F; BR136(2) 2M, 1MG, 5F; BR144(1) 2M, 1MG, 3F.
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18F;
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anophelines
were
An. konderi. In Porto Velho, using human
bait, only 17 An. konderi were captured
(among 270 anophelines), whereas in
Samuel it accounted for 40 specimens out
of 152 anophelines caught. In Senador
Guiomar, no An. konderi was found among
485 anophelines collected on human bait,
whereas three females belonging to this
species were obtained from a horse (among
110 anophelines). In Munichis, 10% of
1,207 anophelines collected using a horse-,
baited Shannon trap were An. konderi; no
specimens were captured on human bait at
this locality.

Larvae of An. konderi have most often
been found in shaded or partially shaded
pools, small streams, and temporary lakes
formed during the flooding of rivers. These
sites usually have emergent vegetation and
sometimes contain muddy water rich in
decomposed plant debris. In Coari, 48 and 44
out of 93 anopheline larvae collected in a
small stream that received the flow of a
waste drainage pipe were An. konderi and
An. (Ano.) mattrigossensis Lutz & Neiva,
respectively. Larvae of An. konderi have
been found together with An. (Nys.) nunez-
tovari Gabaldon, An. (Ano.) mediopuncta-
tus s.l. (Theobald), An. (Nys.) rangeli Gab-
aldon, Cova-Garcia and Lopes, An. (Ano.)
punctimacula Dyar and Knab and An.
(Ano.) mattigossensis (Galvão and Da-
masceno 1942, Deane et al. 1948).

Medical importance.—The role of An.
konderi in malaria transmission is unknown,
primarily because females belonging to this
species could not be distinguished from
those of An. oswaldoi. Experimental infecc-
tions with Plasmodium vivax suggested that
An. konderi is less susceptible than An.
oswaldoi (Marrelli et al. 1999).
DISCUSSION

Throughout it range from Southeastern Brazil to the Amazon Valley it is possible that many literature records referring to *An. oswaldoi* are actually *An. konderi*. Precise identifications can only be verified by examination of the male genitalia. The two species are sympatric at most collection sites. However, along the Solimões and Amazon Rivers in the state of Amazonas it is our impression that either only *An. konderi* is present, or it is at least much more abundant than *An. oswaldoi*. At present only *An. oswaldoi* is reported from Venezuela, northern Colombia, Panama and Costa Rica, while only *An. konderi* has been found in Peru.

Morphological and morphometric analyses of *An. konderi* from seven localities in Brazil and Peru showed that it is a highly variable species since variation was detected between specimens from the same locality and from the same progeny brood. In females, 11 out of 13 morphometric measurements analyzed did not show statistically significant differences ($P > 0.05$). The ratios length of palpus/hind femur ($P = 0.003$) and length of dark-scaled band on foretarsomere III/total length of tarsomere III were significantly variable ($P = 0.001$). Three out of seven morphometric measurements or ratios taken from the male genitalia were significantly different: length of parabasal seta/width of gonocoxite at base ($P = 0.001$), length of gonocoxite/width of gonocoxite at base ($P = 0.009$), width of gonocoxite taken at the widest point/width of gonocoxite at base ($P = 0.001$). The five ratios or indices evaluated in the pupa were homogeneous between populations, whereas three out of seven morphological characters and ratios analyzed in the larva were heterogeneous: length of anal papilla/length of seta 4-X ($P = 0.001$), percentage of specimens with seta 1-X born on saddle ($P = 0.035$) and type of pecten ($P = 0.037$). The eggs oviposited by *An. konderi* females from five different localities in Brazil and Peru were morphologically similar. However, the mean length and width of eggs from these localities (length $= 421 \mu m$, width $= 130 \mu m$) are smaller than those found by Lounibos et al. (1997) for specimens from Alto Linares, Bolivia (length $= 520 \mu m$; width $= 197 \mu m$).

*Anopheles konderi* is closely related to *An. oswaldoi* and therefore will key out with *An. oswaldoi* in the keys to females and larvae in the most recent revisions of the Albimanus Section of *Anopheles* subgenus *Nyssorhynchus* (Faran 1980, Faran and Linthicum 1981). No diagnostic morphological or morphometric differences were found between the pupae or eggs of these species. However, they are readily distinguished by the shape of the aedeagus. In *An. oswaldoi*, the aedeagus is ovate and sclerotized at the apex, the length of the apex of the aedeagus is about 1.2 (0.8–2.1) of the width, while in *An. konderi* the aedeagus is weakly rounded at apex, the length of apex of aedeagus is about 0.4 (0.3–0.6) of width, and the apical aedeagal sclerite is narrow and curved into elbow-like lateral projections. Males of *An. konderi* key out to *An. evansae* Brethes in the key for male genitalia in Faran and Linthicum (1981), but *An. konderi* can be distinguished from *An. evansae*, as well as from the other *Nyssorhynchus* of the Albimanus Section, by the shape of the aedeagus. The morphological and morphometric characters of the females and larvae of these species are also very similar. Statistical analysis showed some morphometric differences between females of these species: in *An. oswaldoi* foretarsomere 2 is dark-scaled on 0.6 (0.4–0.8) $\pm 0.1$ (while it is 0.7 [0.5–0.9] $\pm 0.09$ in *An. konderi*, $P < 0.0001$), hindtarsomere 2 dark-scaled on 0.11 (0.08–0.16) $\pm 0.026$ (while it is 0.14 [0.08–0.20] $\pm 0.036$ in *An. konderi*, $P < 0.0001$), subcostal pale spot 0.3 (0.003–0.5) $\pm 0.1$ of sector dark (0.2 [0–0.4] $\pm 0.09$ in *An. konderi*, $P < 0.0001$), preapical pale 0.4 (0.2–1.0) $\pm 0.2$ of preapical dark (0.3 [0–0.5] $\pm 0.09$ in *An. konderi*, $P = 0.009$), acces-
sory sector dark present in 82.4% (± 0.921, \( P = 0.65 \)) of specimens examined (around 60% in *An. konderi*).

**ACKNOWLEDGMENTS**

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TWO NEW GALL-INDUCING SAPHENISTA WALSINGHAM
(LEPIDOPTERA: TORTRICIDAE: COCHYLINI) FROM COSTA RICA

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Abstract.—Saphenista muerta, n. sp., and S. bimaculata, n. sp., were reared from galls they induced on stems of Monnina crepinii Chodat (Polygalaceae) and Ageratina ixiocladon (Benth.) R.M. King & H. Rob (Asteraceae) respectively. Galls were discovered in a high elevation (3,000 m) oak forest on Cerro de la Muerte, Costa Rica. We present photographs of the imagos, habitat, and host; illustrations of the male and female genitalia, and descriptions of the galls.

Resumen.—Saphenista muerta y S. bimaculata nov. spp., fueron criados de agallas que se encontraban en tallos de Monnina crepinii Chodat (Polygalaceae) y Ageratina ixiocladon (Benth.) R.M. King & H. Rob (Asteraceae), respectivamente. Estas especies fueron recolectados en un bosque de roble en Cerro de la Muerte, Costa Rica; alrededor de 3,000 m.s.n.m. Se presenta fotografías de adultos, hábitat, y planta hospedera; ilustraciones de genitalia de macho y de hembra; y descripciones de las agallas.

Key Words: Ageratina, Asteraceae, Central America, gall-inducer, high elevations, Monnina, Polygalaceae, Tortricinae

Cochylini are an undisputably monophyletic group currently recognized as a tribe within the Tortricinae (Tortricidae) (Horak and Brown 1991, Horak 1998). Historically, the group has been treated by various authors as a family (e.g., Phaloniidae by Clarke (1968) and others, and Cochylidae by Powell (1983)), subfamily (Cochynae). or subtribe (e.g., Cochylidii by Kuznetsov and Stekolnikov (1973), and Rawowski and Becker (1983)). The most convincing apomorphy supporting its monophyly is the loss of the gnathos in the male genitalia. Although an uncus is present in nearly all species, it is well developed in the most primitive members of the tribe (e.g., Trachysmia), and hence its shared loss cannot be considered an autapomorphy for the entire tribe. Cochylini includes about 930 described species (Brown 2002) assigned to about 55 genera, and occurs in all faunal regions worldwide. The larvae feed internally in flower heads, seed capsules, stalks, and roots, and most species associated with Asteraceae (Powell 1980). Cochilini larvae (e.g., Pogue 1988, Pogue and Friedlander 1987) are characterized by the presence of an anal fork (plesiomorphic condition), the occurrence of SD1 and D1 on the same pinaculum on abdominal segment 9 (shared with most Olethreutinae), conspicuously enlarged pinacula (a convergent character
with some internal-feeding Graphitini), reduced number of crochets on the prolegs (convergent with many tortricids), and a bi-setose L-group on abdominal segment 9 (putative autapomorphy for the tribe).

The genus *Saphenista* (Cochylini) was described by Walsingham (1914) on the basis of several plesiomorphic characters. Based on the North American members, Pogue (1986) identified two autapomorphies for the genus: (1) valva widened basally, gradually narrowed to a rounded apex; and (2) a pocket at the base of the valva with an associated costal groove that opens to the inside. He (Pogue 1986) also identified the presence of the hindwing costal fold and 3-segmented maxillary palpus as holoplastic characters. In addition, all *Saphenista* have a distinctive transtilla with an elongate mesal process broadening distally into a Y-shaped projection. The genus includes about 75 species and occurs in all faunal regions except the Ethiopian (Pogue 1986). Only a few larval host plants have been reported for *Saphenista*, and all but one are in the Asteraceae.

The discovery of two undescribed species of *Saphenista* in stem galls during a survey of gall-inducing Lepidoptera in Costa Rica is noteworthy, and we take this opportunity to describe these two species and comment briefly on their life histories.

The galls, which were induced by the moth species described herein were collected from the stems of *Monnina crepinii* Chodat (Polygalaceae) and *Ageratina ixiocladon* (Benth.) R.M. King & H. Rob (Asteraceae), in a high elevation oak forest at Villa Mills (3,000 m), Cerro de la Muerte, in the provinces of San José and Cartago, Costa Rica. Species of *Monnina* are shrubs or small trees (Fig. 5) found in cloud forests. Flowers are papilionaceous and blue to bluish-purple in color; leaves are uniformly alternate. In Costa Rica, *M. crepinii* has been collected between 1,800–3,000 m on both the Atlantic and Pacific regions of the central cordillera (INBio database 1977). *Ageratina ixiocladon* is a tropical shrub (Fig. 6) that grows 3–4 m tall, and like *M. crepinii*, is usually found in partially open areas with limited sunlight (Fig. 4). In Costa Rica, *A. ixiocladon* is known from high elevations, about 2,500 m on both the Atlantic and Pacific slopes of the central cordillera (INBio database 1977).

The forests of these high regions as described by Hartshorn (1983) and Kappelle (1996) are tropical montane rain forests or tropical montane cloud forests that are dominated by a few plant species. The transitional zone is dominated mainly by *Quercus costaricensis* Liebm and *Q. copeyensis*, C.H. Muller (Fagaceae). Other plant species in moderate abundance are *Micronia biperulifera* Cogniaux (Melastomataceae), *Vaccinium consangueinum* Klotzsch (Ericaceae), *Weinmannia pinnata* Linnaeus (Cunoniaceae), *Schefflera rodriguesiana* D.G. Frodin (Araliaceae), and *Chusquea* spp. (Poaceae).

The climate is characterized by a wet and a dry season. The dry season lasts from December or January to April. During this time of the year, rain is infrequent, although the humidity remains high and dense fog is common. The wet season lasts from April to November or December. Heavy rains are common during these months, and the area receives an average annual rainfall of 2,812 mm. The average temperature for this area is 10.9°C and sometimes can reach −3°C during the dry season.

Galls were collected in the field, placed in plastic bags, and taken to an air-conditioned room where the temperature was kept between 16–18°C. Kornerup and Wanscher (1978) is used as a color standard for description of the adult vestiture. Genitalia were dissected as described by Clarke (1941), except mercurochrome and chlorazol black were used as stains. Adults were examined with dissecting and compound microscopes. Measurements were made using a calibrated ocular micrometer. All specimens of this study are deposited in Instituto Nacional de Biodiversidad (INBio), Santo Domingo de Heredia, Costa
Rica. Vouchers of Monnica crepinii and Ageratina ixiocladon are deposited in Herbario de la Universidad de Costa Rica, Escuela de Biología, San José, Costa Rica.

*Saphenista muerta* Nishida and Adamski, new species
(Figs. 1, 3, 7)

Diagnosis.—*Saphenista muerta* appears most similar to *S. eneiema* Razowski, 1990, from Costa Rica. It differs by having a forewing pattern that is darker, a socius that is broader, a valva that is narrower, an aedeagus with a longer apical spinelike process, and a vesica with a stout cornutus.

Description.—**Head:** Frontoclypeus and vertex brownish yellow; outer surface of labial palpus pale yellowish brown, with third segment pale gray intermixed with white scales; inner surface white intermixed with
few pale-gray scales; scape and basal 8–10 flagellomeres of antenna brownish yellow intermixed with gray scales, distal flagellomeres gray. Proboscis present.

Thorax: Tegula and mesonotum brownish yellow, intermixed with gray scales on caudal part. Leg with coxa and femur pale brownish yellow intermixed with pale-gray and gray scales, tibia and tarsomeres dark gray intermixed with pale gray near distal end. Forewing (Fig. 1) length 7.0 mm (n = 1) all fasciae golden yellow intermixed with brownish-yellow scales; costal margin brown; costal strigulae silver, basal strigulae incomplete, distal strigulae complete; cell with a dark-brown streak about ½ length and a large dark-brown spot near distal end; fringe pale yellowish brown; undersurface brown. Hindwing pale gray, slightly darker along anterior margin; costal fold present.

Male genitalia (Fig. 7): Uncus and gnathos absent; socius elongate, setose, rounded distally; vinculum with two V-shaped parts, fused ventrally, posterior part dorsally fused with ventral articulation of valva, anterior part fused with dorsal articulation of valva; valva setose, slightly broadened basally, gradually narrowed distally forming a rounded apex; transtilla enlarged medially forming an elongate, dorsoposteriorly projecting, Y-shaped process with two apically divergent tips; juxta platelike; aedeagus basally broadened, gradually narrowed distally, distal part with an elongate, protuberant spinelike process; vesica with an elongate cornutus.

Female genitalia: Unknown.


Etymology.—The specific epithet is derived from the locality, Cerro de la Muerte, Mountain of Death, where the gall containing the holotype was collected.

Remarks.—Spindle-shaped galls (Fig. 3) were usually located near the midlength of the stem of Monnina crepinii near the nodes of the host plant. The galls are about 11 mm wide and about 20 mm in length. The stem width of the host is about 9 mm. An oval-shaped orifice (= exit hole) was covered with plant debris bounded with silk. The larva bores the central part of the pith of the stem. The larva of the holotype pupated in its gall chamber, spinning a loose cocoon, which was constructed with silk and frass. The pupa protruded prior to the emergence of the adult.

Saphenista bimacula Nishida and Adamski, new species
(Figs. 2, 8–9)

Diagnosis.—The genitalia of Sapphenista bimacula are most similar to those of S. gnathimocera Razowski, 1990, from Costa Rica; the species share a similarly shaped valva and aedeagus, but S. bimacula differs by having a narrower apical half of the valva and a stouter apical cornutus in the vesica of the aedeagus.

Description.—Head: Frontoclypeus and vertex pale yellowish orange; outer surface of labial palpus brown intermixed with pale yellowish-brown scales or pale yellowish brown intermixed with few brown scales; inner surface pale yellowish brown intermixed with some white scales; scape of antenna pale yellowish orange, basal half of flagellum pale yellowish orange, distal half gray; proboscis present.

Thorax: Tegula yellowish orange intermixed with pale yellowish-orange scales near distal margin; mesonotum missing most scales; legs with segments and tarsomeres brown with pale yellowish-brown apices. Forewing (Fig. 2) length 7.0–7.3 mm (n = 3) yellowish orange intermixed
with pale yellowish-orange scales; a single dark-brown spot near midcell with a diffuse spot of dark-brown scales beyond cell; costa with several small dark-brown spots and two large dark-brown spots, one near midlength and one near half distance between the first spot and apex; several small, dark-brown, paired, submarginal spots present; posterior margin with irregular row of dark-brown scales; undersurface dark brown with dark-brown costal strigulae separated by pale yellowish-orange scales along costa. Hindwing pale yellowish orange with several pale-brown irregular bands from midlength along costa to apex; costal fold present.

**Male genitalia** (Fig. 8): Uncus and gnathos absent; socius elongate, setose, rounded distally; vinculum with two V-shaped parts, fused ventrally, posterior part dorsally fused with ventral articulation of valva, anterior part fused with dorsal articulation of valva; valva setose, slightly broadened basally, gradually narrowed distally forming a narrowly rounded apex; transtilla enlarged medially with an elongate, dorsoposteriorly projecting, Y-shaped process with apically divergent tips; juxta platelike; apical part of aedeagus with a ventromedian lobe, distally narrowed and angled ventrally; vesica with an elongate basal cornutus, spinulate apically with a stout cornutus.

**Female genitalia** (Fig. 9): Papillae ana-les elongate, setose, divergent anteriorly; ventral arms of sterigma slightly setose apically; apophyses posteriores dilated subba-
sally, extending to near ostium; apophyses anteriores posteriorly bifurcate, one arm fused with dorsoanterior margin of stigma, one curved medioventrally, forming part of a deeply notched seventh sternum; seventh sternum partially overlaid by posterior part of sixth sternum; ductus bursae, short, cylindrical; corpus bursae ovoid, with elongate creases on side opposite ductus seminalis, undulate and spinulate medially; signum absent.

Types.—Holotype, ♂, “COSTA RICA, San José [Province], Cerro de la Muerte, Villa Mills, Senderos Georgina, 3,000 m, 22-III-2000, Col[lected] and reared by Kenji Nishida, Host plant: Ageratina sp., Gall former on stem apex”, “♀ INBio Genitalia Slide by D. Adamski No. 891” [yellow label].


Etymology.—The specific epithet, bimaculata, is derived from the Latin maculata, meaning spot, and refers to the two large spots on the costa of the forewing.

Remarks.—Galls were found on Ageratina ixiocladon near the apex of the stem near the nodes (not figured). The globose or slightly elongate galls are about 6 mm wide and 7–18 mm long. The stem of the host is about 4 mm wide. Most of the larval fecal matter is ejected outside of the gall chamber through the exit hole, which later is covered with silk. Pupation occurs within or outside the gall chamber. The pupa protruded prior to adult emergence.

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TWO NEW SPECIES OF MEALYBUGS (HEMIPTERA: COCCOIDEA: PSEUDOCOCCIDAE) FROM PATAGONIA, ARGENTINA

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Abstract.—Two new species of mealybugs, Euryoccus chubutensis and Pseudantonina vernacula, have been discovered in the Patagonia Region of Argentina collected on Nothofagus dombeyi and on a grass, probably Stipa sp. Adult females and available immature stages of each species are described and illustrated and are compared with other mealybugs from the area.

Key Words: Coccoidea, Nothofagus, Patagonia, grass, Neotropical

The mealybug fauna of Argentina appears to be inadequately described. A quick comparison of relatively well-known areas of the world gives important insight on the state of knowledge of Argentina’s fauna. The number of mealybug species reported in California (land area of about 158,000 square miles and a large diversity of habitats) is 201 (Ben-Dov 2002), the number of species in England (land area of about 50,000 square miles and a relatively uniform diversity of habitats) is 46 (Ben-Dov 2002), and even in Maryland (about 10,000 square miles and relatively uniform habitats) there are 43 species known (Ben-Dov 2002). In comparison, the number of mealybug species in Argentina (land area of about 1,000,000 square miles and quite diverse habitats) is only 46 (Ben-Dov 2002). The works of Leonardi (1911a, b), Granara de Willink (1979, 1981, 1983a, b, 1986, 1991a, b, c), Williams (1973), Williams (1985b), and Williams and Granara de Willink (1992) have added significantly to knowledge about the mealybug fauna of the country, but much remains to be discovered and recorded.

It is important to understand the mealybug fauna of Argentina, not only to fill major gaps in the knowledge base of the Pseudococcidae, but also to know the identity of species that could be pests either in Argentina or other parts of the world. With the vast temperate climate of major parts of the country it would seem likely that native mealybug species could easily adapt to the temperate climates of the heavily populated northern hemisphere areas of the world such as Europe, China, and the United States. Williams and Granara de Willink (1992) made the case that a comprehensive understanding of the mealybug fauna of Central and South America was an effective weapon for combating mealybug species that could become invasive pests in other parts of the world. Their suggestion has been substantiated by the introduction of the invasive papaya mealybug (Paracoccus marginatus
Oriental esakii broad mealybug cuniculorum rectangular but both- Meyerdirk. more blanchardii, sternlichti Australasian took campbelli non-sclerotized Results examined and work and effective biological control strategies for the cassava mealybug (Phenacoccus manihoti Matile-Ferrero) (Miller and Rossman 1995), control for the papaya mealybug has been relatively rapid (Meyerdirk, personal communication 2002). The quick response was possible primarily because the mealybug was known, well characterized, and potential areas of origin for discovering biological control agents were understood before it became an invasive pest.

Within Patagonia in Argentina most research on scale insects has focused on the mountainous, forested areas which are important as sources of wood and other biological resources. However, the steppe zone of Patagonia has numerous species of grasses and other unique vegetation and harbors a wealth of unknown mealybug species that could be important in the future. These natural pastures are especially resistant to the adversities of the harsh climate and are beneficial by maintaining soil moisture and preventing soil erosion. The grasses and low vegetation of the pampas are also important as the primary food source of sheep and cattle and provide shelter for many small mammals and numerous birds. This work examines two unusual mealybug species from Patagonia and is part of a larger study on the scale-insect biodiversity of Argentina.

Materials and Methods

Specimens were prepared following the techniques described by McKenzie (1967) and were slide mounted in Canada balsam. Illustrations were made with a drawing tube and follow the international conventions generally used for illustrating scale insects (e.g., Williams 1985c). All specimens were examined in detail and were used to formulate the ranges and means for the numeric characters. Measurements of the holotype are given separately. Ranges are given first, followed by the mean in parentheses. Specimens are deposited in the Institute and Fundacion Miguel Lillo (IMLA), of Tucumán, Argentina, and the Coccoidea Collection of the The National Museum of Natural History, Beltsville, Maryland, USA (USNM).

Results

Eurycoccus Ferris

Eurycoccus Ferris, 1950; type species, by original designation. Pseudococcus jessica Hollinger 1916 (junior synonym of E. blanchardii (King and Cockerell)).

This genus includes 14 species from most continents of the world (Afrotropical 3, Australasian 2, Nearctic 4, Oriental 2, and Palearctic 3) but has never been recorded from the Neotropical Region (Ben-Dov 2002). At present, Eurycoccus may contain several unrelated lineages, but we reluctantly decided to include the new Patagonian species in it rather than add to the confusion by describing another monotypic genus.

We have examined illustrations or specimens of all 14 Eurycoccus species (E. antiscius Williams, E. blanchardii, E. bothriochloae Williams, E. campbelli Kosztarab, E. coccineus (Newstead), E. copallinae Ferris, E. cuniculorum Williams, E. esakii (Kanda), E. glomerulus De Lotto, E. monodi Balachowsky and Ferrero, E. saudiensis Matile-Ferrero, E. sternlichti Williams, E. tamariscus Williams, E. yuccae Ferris) and note similarities that occur in nearly all species (Table 1).

The new species possesses all of these characteristics but differs by having: 1 more seta on each side of the basal segment of the labium; more numerous setae on the elyopeolabral shield; an unusual type of discoidal pore that has a broad basal sclerotized ring and a non-sclerotized area that protrudes from the ring; a rectangular ventral invaginated pocket on the intersegmental line between segments VIII and IX; no
Table 1. Distribution of characters considered important in diagnosing *Eurycoccus*.

<table>
<thead>
<tr>
<th>Eurycoccus Species</th>
<th>Large, Rotund Body</th>
<th>Coxal Pores</th>
<th>Number of Cerarii</th>
<th>With Paired Cerarian Setae</th>
<th>Ventral Tubular Ducts</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>antiscus</em></td>
<td>yes</td>
<td>no</td>
<td>1</td>
<td>yes, elongate</td>
<td>yes</td>
</tr>
<tr>
<td><em>blanchardii</em></td>
<td>yes</td>
<td>no</td>
<td>1</td>
<td>yes, conical</td>
<td>yes</td>
</tr>
<tr>
<td><em>bothriochloae</em></td>
<td>yes</td>
<td>yes</td>
<td>1</td>
<td>yes, conical</td>
<td>yes</td>
</tr>
<tr>
<td><em>campbelli</em></td>
<td>no</td>
<td>yes</td>
<td>1</td>
<td>yes, conical</td>
<td>yes</td>
</tr>
<tr>
<td><em>coccineus</em></td>
<td>yes</td>
<td>?</td>
<td>?</td>
<td>yes, elongate</td>
<td>no</td>
</tr>
<tr>
<td><em>copallinae</em></td>
<td>yes</td>
<td>?</td>
<td>1</td>
<td>yes, conical</td>
<td>yes</td>
</tr>
<tr>
<td><em>cuniculorum</em></td>
<td>yes</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td><em>esakii</em></td>
<td>yes</td>
<td>yes</td>
<td>1</td>
<td>yes, conical</td>
<td>yes</td>
</tr>
<tr>
<td><em>glomerulus</em></td>
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<td>yes</td>
<td>1</td>
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<tr>
<td><em>monodi</em></td>
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<td>1</td>
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<tr>
<td><em>saudiensis</em></td>
<td>no</td>
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<td>0</td>
<td>no</td>
<td>yes</td>
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<tr>
<td><em>sternlichti</em></td>
<td>yes</td>
<td>yes</td>
<td>1</td>
<td>yes, conical</td>
<td>yes</td>
</tr>
<tr>
<td><em>tamariscus</em></td>
<td>no</td>
<td>yes</td>
<td>1</td>
<td>yes, elongate</td>
<td>yes</td>
</tr>
<tr>
<td><em>yuccae</em></td>
<td>yes</td>
<td>yes</td>
<td>1</td>
<td>yes, elongate</td>
<td>yes</td>
</tr>
</tbody>
</table>

Tubular ducts: no elongate anal-lobe seta; and multilocular and trilocular pores with obscure loculi. Although these characters may be diagnostic of a group of mealybugs, with only a single representative of that clade we hesitate to describe it as a unique genus. Other species of *Eurycoccus* have unusual small pores similar to those on the new species (*E. cuniculorum* and *E. tamariscus*) and one lacks ventral tubular ducts (*E. coccineus*). Therefore, we are placing the new species in *Eurycoccus*.

**Key to Slide-Mounted Adult Females of the Genus Eurycoccus**

1. Tubular ducts present at least near vulva   
   2. Tubular ducts absent   
   2(1) Translucent pores present on hind coxa and femur; multilocular pores present on thorax
      - *chubutensis* Granara de Willink and Miller, n. sp.
      - Translucent pores absent from hind legs; multilocular pores absent from thorax
        3(1) Translucent pores present on hind coxae
        - Translucent pores absent from hind coxae
          5(5) Translucent pores absent from hind tibia
        - Translucent pores absent from hind pair of legs
          10(5) Dorsal oral-collar tubular ducts present
        - Dorsal oral-collar tubular ducts absent
          11(10) Translucent pores present on hind tibia
        - Translucent pores absent from hind tibia
          12(11) Ventral anal lobe with distinct anal bar; most body setae elongate, longer than diameter of spiracular atrium

- 6(5) Translucent pores absent from hind tibia; circulus present
- 7(6) Ventral multilocular pores present on anterior margin of abdominal segment VII
- 8(7) Dorsal anal lobe with concentration of about 10 flagellate setae and 2 associated conical setae; antennae 8-segmented
- 9(6) Dorsal anal lobe with pair of slightly enlarged setae and 1 2 flagellate setae
- 11(10) Translucent pores present on hind tibia
- 12(11) Ventral anal lobe with distinct anal bar; most body setae elongate, longer than diameter of spiracular atrium

- Circulus absent or small, round, usually not divided by intersegmental line
- Dorsal anal lobe with 2 or 3 slightly enlarged setae only; antennae 6- or 7-segmented
- Dorsal anal lobe without enlarged setae but with cluster of about 10 flagellate setae
- Dorsal oral-collar tubular ducts absent
- Dorsal oral-collar tubular ducts present
- Dorsal oral-collar tubular ducts absent from hind tibia
- Ventral anal lobe with distinct anal bar; most body setae elongate, longer than diameter of spiracular atrium

- *esakii* (Kanda)
- *glomerulus* De Lotto
- *cuniculorum* Williams
- *tamariscus* Williams
- *blanchardii* (King and Cockerell)
- *monodi* Balachowsky and Ferrero

- *coccineus* Williams
- *bothriochloae* Williams
- *campbelli* Kosztarab
Fig. 1. *Eurycoccus chubutensis*, fourth-instar female (adult).

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**Eurycoccus chubutensis Granara de Willink and Miller, new species**

(Figs. 1–3)

Description.—Adult female: In life very convex, body yellowish, covered with white wax. Slide-mounted specimens (Fig. 1) circular or broadly oval, holotype 3.8 mm long (paratypes 2.5–4.3(3.6) mm), and 3.1 mm wide (paratypes 2.0–3.4(2.9) mm). Antenna well developed with 7- or 8-segments. several specimens with third seg-
ment only partially divided, holotype antenna 549 μ long (paratypes 429–585(519) μ). Legs well developed with numerous setae on all segments, with translucent setae on both surfaces of hind coxa and dorsal surface of hind femur; hind trochanter+femur of holotype 460 μ long (paratypes 331–470(427) μ); femur of holotype 339 μ long (paratypes 315–352(338) μ); tibia+tarsus of holotype 398 μ long (paratypes 304–415(370) μ); tibia of holotype 281 μ long (paratypes 195–284(249) μ); tarsus of holotype 142 μ long (paratypes 133–140(137) μ); tibia considerably longer than tarsus, tibia/tarsus 2.0 in holotype (paratypes 1.4–2.0(1.8)); and claw without a denticle on plantar surface; digitules on claw with clubbed apex; tarsal digitules with thin apex, not extending to tip of claw. With 2 pairs of ostioles, each ostiole lip with many trilocular pores (much more abundant than on surrounding derm) and setae, ostiole opening with sclerotized edge. Eyes on venter near body margin, in 3 specimens a few trilocular or discoidal pores incorporated in sclerotization. Anal ring dorsal, near posterior end of body, oval, 132 μ long on holotype (paratypes 74–138(119) μ) with 3 rows of pores, outer 2 rows weakly sclerotized, and 3 pairs of setae, longest seta on holotype 93 μ long (paratypes 91–122(106) μ). Mouthparts well developed, clypeolabral shield of holotype 363 μ long (paratypes 319–385(352) μ), holotype with 14 setae on shield (paratypes 7–13(11) setae); labium 3-segmented, some specimens with narrow labium, others with structure broad, on holotype 382 μ long (paratypes 380–415(392) μ), basal segment with 4 setae on each side, middle segment with 1 seta on each side, and apical segment with 5 setae on each side and a group of 4 setae on each side along stylet canal at apex of labium; inner side of labium with 1 seta on each side in middle area of apical segment and 1 on each side near apex of apical segment. Circulus with well defined perimeter, divided by intersegmental line between segments III and IV, rectangular, holotype 144 μ wide (paratypes 98–156(136) μ). Spiracles conspicuous, anterior pair on holotype 125 μ long (paratypes 185–230(201) μ) and 82 μ wide (paratypes 185–230(201) μ), anterior pair larger than posterior pair; trilocular pores and setae in membranous opening leading to spiracle, but not in sclerotized peritreme; often with few multilocular or trilocular pores incorporated into sclerotization on middle area of spiracle.

Cerarii absent. Anal-lobe area without normal elongate anal-lobe seta, several setae at posterior apex slightly longer than remaining dorsal setae, longest on holotype 86 μ long (paratypes 49–86(72) μ).

Dorsal surface: Trilocular pores round, with obliterated internal structure, about 4 μ in diameter, abundant over surface. Cone-shaped discoidal pores slightly larger than triloculars, abundant over surface. Dorsal setae flagellate, slightly enlarged basally, numerous, ranging from 15–42 μ long, about same length over surface except on segment VIII where longest setae range from 60 to 100 μ long.

Ventral surface: Trilocular pores abundant over surface. Cone-shaped discoidal pores most numerous along body margin, nearly absent medially. Small discoidal pores uncommon. Multilocular pores about 2 times larger than triloculars, about 7 μ in diameter, present in medial and mediolateral areas from near vulva forward to area between mouthparts and front pair of legs, absent from marginal areas laterad of legs and spiracles. Setae flagellate, unusually short for mealybug, largest setae about 45 μ long. Cisanal setae not always distinguishable from other setae, about 75 μ long, about same length as dorsal setae near anal ring. Invaginated pocket present in medial area on intersegmental line of segments VIII and IX, rectangular in shape, with definite opening.

Material examined.—Holotype (IMLA) and 8 paratypes (IMLA, USNM) from Argentina, Chubut, Lago Puelo National Park, road to Los Hitos, on woody roots of Noth-

Description.—Second- (or third-) instar female (Fig. 2): Same as adult female except as follows: Body circular or broadly oval, 1.9 mm long, 1.3 mm wide. Antennae in only specimen available apparently abnormal. 6 segments on 1 side and partially divided 7 segments on other, antenna 420 μ long. Legs with hind trochanter+femur 275 μ long; femur 207 μ long; tibia+tarsus 275 μ; tibia 145 μ long; and claw 42 μ long; tibia slightly longer than tarsus, tibia/tarsus 1.1; digitules on tarsus and claw apparently broken. Each posterior lip of ostioles with many trilocular pores and 1 or 2 setae; anterior lip usually without setae. Eyes without trilocular or discoidal pores incorporated in sclerotization. Anal ring dorsal, near posterior end of body, oval. 83 μ long with 2 rows of pores, outer row weakly sclerotized, and 3 pairs of setae (1 side of specimen abnormal, with 2 setae), longest seta 80 μ long. Mouthparts with clypeolabral shield with 8 setae. 225 μ long; labium 255 μ long. Circulus 98 μ wide. Anterior spiracles 132 μ long and 55 μ wide; trilocular pores in membranous opening leading to spiracle, but not in sclerotized peritreme.

Cerarii absent. Anal-lobe area without normal, elongate anal-lobe seta, setae at posterior apex mostly broken.

Dorsal surface: Trilocular pores about 3 μ in diameter, abundant over surface. Large discoidal pores slightly larger than triloculars, without cone-shaped protrusion, abundant over surface. Small discoidal pores absent. Dorsal setae ranging from 15–22 μ long, about same length over surface except on segment VIII where longest setae about 34 μ long.

Ventral surface: Trilocular pores uncommon posteriorly and in medial areas. Large discoidal pores most numerous along body margin, nearly absent medially. Small discoidal pores absent. Multilocular pores about 2 times larger than triloculars, about 5 μ in diameter, present in medial and mediolateral areas of thorax. Setae about 34 μ long. Cisanal setae about 33 μ long. Invaginated pocket may be represented by internal, elongate oval structure visible near intersegmental line of segments VIII and IX, without definite opening.

Notes.—The single specimen of this instar is in poor condition with many of the setae broken, the median area has a large cut and hole, and the abdomen is rolled. Thus, in some instances it was necessary to extrapolate patterns from both sides of the specimen.

Material examined.—1 specimen with same data as holotype (IMLA).

Description.—First instar (sex not determined) (Fig. 3): Same as adult female except as follows: Body oval. 0.9 mm long, 0.5–0.6(0.6) mm wide. Antenna 6-segmented. 290–300(297) μ long. Legs with hind trochanter+femur 172–175(174) μ long; femur 130–142(136) μ long; tibia+tarsus 182–210(198) μ; tibia 95–100(98) μ long; claw 38 μ. Each posterior lip of ostioles with several trilocular pores; each anterior lip with or without large discoidal, several triloculars, and 0–1(0) seta. Eyes without trilocular or discoidal pores incorporated in sclerotization. Anal ring apical, oval, with 2 rows of pores, and 3 pairs of setae, longest seta 80–112(97) μ long. Mouthparts with 6 setae on clypeolabral shield: 125–142(133) μ long; labium 175–200(192) μ long. Circulus 65–78(72) μ wide. Anterior spiracle 52–75(64) μ long and 32–35(34) μ wide; trilocular pores in membranous opening leading to spiracle, but not in sclerotized peritreme.


Dorsal surface: Trilocular pores about 3 μ in diameter, abundant over surface. Large discoidal pores without conical protrusion, slightly larger than triloculars, scattered over surface. Small discoidal pores absent. Dorsal setae ranging from 15–50 μ long, longest setae in posterior areas of abdomen.

Ventral surface: Trilocular pores in small numbers in medial areas. Large disc-
Fig. 2. *Euryoccus chubutensis*, second- or third-instar female.
Fig. 3. *Eurycococcus chubutensis*, first instar (sex undetermined).
coidal pores most numerous along body margin, nearly absent medially. Small discoidal pores absent. Multilocular pores absent. Setae ranging from 18–60 μ long. Cis-anal setae about 38–54(43) μ long. Invaginated pocket absent.

Material examined.—This description is based on 3 embryos that are in poor condition with same data as holotype (IMLA).

Biology.—The species was found on the woody roots of a large specimen of *Nothofagus dombevii* (Mirb.) Oest. and was tended by the ant *Camponotus chilensis* Spinola.

Comments.—*Nothofagus* is the only genus in the family Fagaceae in the Southern Hemisphere and occurs in temperate areas of Australia, South America, New Caledonia, New Guinea, and New Zealand. Argentina has several native species of *Nothofagus*, but the scale insects that feed on them are virtually unknown. Williams (1985a) summarized available information on the *Nothofagus* scale fauna of South America. The scale-insect fauna of *Nothofagus* is probably best known in New Zealand, but even there the emphasis has been on four families, the coccids (Hodgson and Henderson 2000), erioccids (Hoy 1962), margarodids (Morales 1991), and pseudococcids (Cox 1987) and other scale families are more poorly described.

*Eurycoccus chubutensis* differs from other species of *Eurycoccus* by having multiple setae on the clypeolabral shield, 4 setae on each side of the basal labial segment, large discoidal pores with a cone-shaped projection, an unusual invaginated pocket on the venter between segments VIII and IX, and multilocular and trilocular pores with obscured locular structure, and by lacking long anal-lobe setae and tubular ducts.

*Maskelloccocus obtectus* (Maskell) shows some resemblance to *E. chubutensis* by occurring on *Nothofagus*; having reduced numbers of cerarii; and multilocular pores restricted to venter. *Eurycoccus chubutensis* differs by lacking the narrow pear-shaped body characteristic of *M. obtectus* and in lacking tubular ducts.

*Neosimmondsia hirsuta* Laing also resembles the new species because both lack cerarii, have numerous setae and trilocular pores, have translucent pores on the hind coxa, 2 pairs of ostioles, a circulus, and ventral multilocular pores on the venter only. *Neosimmondsia hirsuta* differs by having: tubular ducts; 6-segmented antenna; dorsal setae that are as long as the anal ring setae; no cone-shaped discoidals; no invaginated pocket; and elongate anal-lobe setae. *Eurycoccus chubutensis* has: no tubular ducts; 7- or 8-segmented antenna; dorsal setae that are shorter than the anal ring setae; cone-shaped discoidal pores; an invaginated pocket; and no distinct anal-lobe setae that are longer than the other setae in the area.

**Pseudantonina Green**

*Pseudantonina Green* 1922; type species, *Pseudantonina bambusae* Green 1922, by monotypy.

This genus includes 8 species (Ben-Dov 2002) that are recorded from several different zoogeographic regions (Neotropical 1, Nearctic 5, Oriental 1, and Palearctic 1) including Argentina (*Pseudantonina aeria* Williams and Granara de Willink). It is possible that two or more unrelated groups are currently placed in the genus. Confusion about the status of several of the New World species is exemplified by Hendricks and Kosztarab's (1999) treatment of *P. aeria, P. arundinariae* McConnell, *P. giganticoxa* Lobdell, and *P. texana* Ferris as “Species of Uncertain Placement.” They also indicated that *P. magnitubulata* Borchenius had been transferred to another genus, but we can find no evidence that such action has taken place. Ben-Dov (2002), continued to include them in *Pseudantonina*, and Kosztarab (1996) mentioned *P. arundinariae* and *P. giganticoxa* as members of the genus along with two new species (*P. nakaharat* Kosztarab and *P. wilkeyi*
Table 2. Distribution of characters considered important in diagnosing *Pseudantonina*.

<table>
<thead>
<tr>
<th></th>
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<td>yes</td>
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<td>absent</td>
<td>6</td>
</tr>
</tbody>
</table>

Kosztarab). Although Hendricks and Kosztarab (1999) was published after Kosztarab (1996), it was essentially the same as the Hendricks dissertation completed three years earlier (Hendricks 1993).

We have examined illustrations, descriptions, or specimens of all 8 *Pseudantonina* species (*P.aeria*, *P. arundinariae*, *P. bambusae*, *P. giganticoxa*, *P. magnatubulata*, *P. nakaharai*, *P. texana*, *P. wilkeyi*) and note similarities that occur in nearly all species (Table 2).

The new species possesses most of the characteristics commonly considered to be diagnostic of the genus and is therefore placed here until a detailed revision of *Pseudantonina* and relatives is undertaken. Other genera that share characters with *Pseudantonina* are: *Antonina* Signoret, *Acrochordonus* Cox, and *Renicia* Cokx, all of which occur on grasses. *Antonina* differs by lacking legs; *Acrochordonus* lacks pore clusters in or adjacent to the spiracular atria and has normally developed legs; and *Renicia* lacks multilocular pores.

**KEY TO SLIDE-MOUNTED ADULT FEMALES OF THE GENUS PSEUDANTONINA**

1 Multilocular pores not restricted to marginal areas of venter ........................................ 3
   - Multilocular pores forming distinct band along ventral body margin 2

2(1) Pore cluster surrounding anterior spiracles without multilocular pores: middle legs with all segments ........ *arundinariae* McConnell
   - Pore cluster surrounding anterior spiracles with multilocular pores: middle legs abortive, without all segments ... *bambusae* Green

3(1) Circulus absent .......................... 4
   - Circulus present *magnatubulata* Borchesenius
   - Translucent pores absent from hind tibiae 5
     - Translucent pores present on hind tibiae ...
       - ... *vernacula* Granara de Willink and Miller, n. sp.
   - Multilocular pores present on dorsal areas of thorax and head .......................... 7
     - Multilocular pores absent from dorsal areas of thorax and head .......................... 6
   - Anal ring small, with 2 or fewer rows of pores: trilocular pores sparsely scattered over body surfaces, absent from anterior lip of posterior ostiole ........................................... *aeria* Williams and Granara de Willink
     - Anal ring large, with 3 or more rows of pores: trilocular pores abundant over body surfaces, present on anterior lip of posterior ostiole ........................................... *texana* Ferris

7(5) Hind coxae shorter than remainder of hind leg .................................. 8
   - Hind coxae longer than remainder of hind leg ........................................ *giganticoxa* Lobdell

8(7) Anterior ostioles present: spiracles without pores in sclerotized atrium; anal-ring setae less than twice diameter of ring .......................... *nakaharai* Kosztarab
   - Anterior ostioles absent: spiracles with pores in sclerotized atrium; anal-ring setae more than twice diameter of ring ... *wilkeyi* Kosztarab

**Pseudantonina vernacula** Granara de Willink and Miller, new species
(Figs. 4–7)

Description.—Adult female: Found in grass sheath, body pink, lightly dusted with white wax.

Slide-mounted specimens (Fig. 4) oval; length of holotype 2.7 mm long (paratype 2.9 mm), and 1.8 mm wide (paratype 1.9 mm), posterior abdominal segment narrow-
Fig. 4. *Pseudantonina vernacula*, fourth-instar female (adult).
est, partially sclerotized, with prominent lobes. Antenna 6-segmented, third segment partially divided on some specimens, holotype antenna 167 µ long (paratype 172 µ). Legs small compared to many mealybugs; with few setae; hind legs with trochanter and femur enlarged, with translucent pores on both surfaces of trochanter and femur, on dorsal surface of tibia; hind coxa noticeably smaller than trochanter+femur; trochanter of holotype 83 µ long (paratype with trochanter fused with femur); femur of holotype 54 µ long; trochanter+femur of holotype 127 µ long (paratype 82 µ); tibia of holotype 37 µ (paratype 35 µ); tarsus of holotype 32 µ (paratype 55 µ), tibia+tarsus on holotype 1.1 (paratype 0.6); tibia+tarsus of holotype 68 µ (paratype 90 µ); claw sometimes present; tarsal digitules thin, slightly thickened apices; claw digitules unequal or equal depending on specimen, thin, slightly thickened apices. Mouthparts well developed (but absent on paratype), clypeolabral shield of holotype 147 µ long, holotype with 2 setae on shield; labium 3-segmented, relatively short and broad, on holotype 59 µ long, basal segment with 3 setae on each side, middle segment with 1 seta on each side, and apical segment with 2 setae on each side and a group of 3 or 4 setae on each side along stylet canal at apex of labium; inner side of labium without setae. With posterior pair of ostioles only, with lips sclerotized, usually without pores or setae, occasionally with anterior lip with 1 trilocular pore. Anal ring invaginated in pocket near posterior end of body; diameter on holotype 61 µ (paratype 72 µ), with 2 rows of pores and 6 setae, longest seta on holotype about 135 µ long, broken on paratype. Circulus absent. Spiracles large, in sclerotized invagination, peritreme large, with more than 20 multilocular pores in sclerotization of each spiracle.

Cerarii absent (depending on definition of cerarius) or reduced to 2 indistinct pairs on posterior abdominal segments. Dorsal anal-lobe conspicuous, protruding, sclerotized, with 14 slightly enlarged, curved setae, not clustered, 2 or 3 scattered trilocular pores near edge of sclerotization, and conspicuous basal sclerotization, without basal clusters of pores or auxiliary setae, sclerotization covering half of segment VIII; segment VII with 3 or 4 slightly enlarged setae, with basal, triangular shaped sclerotized area. Marginal areas of segments IV, V, and VI each with 1 slightly enlarged seta, without associated trilocular pores or sclerotization. Ventral surface of protruding lobes sclerotized in lateral and medial area with 4 small setae and cluster of multilocular pores; without elongate anal-lobe seta.

Dorsal surface: With numerous oral-collar tubular ducts on surface, length about 12 µ, diameter at dermal orifice about 2 µ, diameter at inner end about 5 µ, with glan- dular filament. Setae short, flagellate, thin varying from 10–18 µ long. Trilocular pores small, with thick walls, scattered over surface.

Ventral surface: Setae flagellate, short; setae around vulva undifferentiated; cisanal setae, short about 25 µ long, 2 pairs. Trilocular pores primarily in lateral areas, uncommon. Multilocular pores with 9 or 10 loculi forming a submarginal line from posterior spiracle to abdominal apex, also present on head and near anterior spiracles. Discoidal pores rare. Oral-collor tubular ducts similar to dorsal ducts, scattered over surface, less abundant than on dorsum.

Material examined.—Holotype adult female from: Argentina, Neuquén, on Ruta 40 between La Angostura and Confluencia, 4-1-99, on Gramineae, possibly Stipa, Granara de Willink (IMLA). Paratype female with same data in USNM.

Description.—Third-instar female (Fig. 5): Same as adult female except as follows: Slide-mounted specimen elongate oval; length 1.7 mm long, 0.6 mm wide, posterior abdominal segment with sclerotization and slightly protruding anal lobes. Antenna 6-segmented, 165 and 167 µ long. Legs well developed, without translucent pores; hind trochanter+femur 88 and 92 µ long; tibia
Fig. 5. *Pseudonotocnema vernacula*, third-instar female.
48 and 50 μ long; tarsus 50 and 51 μ long; tibia+tarsus 99 and 100 μ long; tibia/tarsus 0.9 and 1.0; tarsal digitules very different in size. 1 conspicuous and extending beyond tip of claw with small apical club, other setose without club not reaching tip of claw: claw digitules equal or unequal depending on specimen, with apical club. Mouth parts well developed, labium short and broad, with 3 segments. 50 μ long; clypeolabral shield 138 μ long. With posterior pair of ostioles only, without pores or setae. Anal ring invaginated, near apex of abdomen; diameter 45 μ; with 2 row of pores; anal ring setae with narrow apices, longest seta 62 μ long. Spiracles with enlarged peritreme, with at least 3 or 4 trilocular pores in peritreme sclerotization.

Cerarii present from segments VI to VIII: on segment VI represented by 1 slightly enlarged seta, no basal sclerotization; on segments VII with 2 or 3 associated enlarged setae and 1 trilocular pore, no basal sclerotization; on segment VIII with 4 associated setae, no trilocular pore, and basal sclerotization dispersed beyond base of cerarian setae. Anal lobes protruding, sclerotized, ventral surface with 1 small setae, with elongate anal-lobe seta 70 and 78 μ long. 2 or 3 marginal enlarged setae, and 1 trilocular pore.

Dorsal surface: With more than 3 longitudinal lines of flagellate setae on each side of abdomen excluding cerarian setae; trilocular pores most abundant along posterior body margin, with 1 or 2 on head and thoracic body margin. Setae and tubular ducts scattered over surface. Tubular ducts decreasing in size anteriorly.

Ventral surface: With 3 to 5 longitudinal lines of flagellate setae on each side of body: 2 pairs of cisanal setae, short, about 18 μ long. Quinquelocular pores absent. Trilocular pores along body margin, in spiracular atrium, absent from head. Multilocular pores present on head and thorax near legs and spiracles and along body margin of abdomen. Discoidal pores inconspicuous. 1 longitudinal line on submargin of body. Oral-collar tubular ducts present near body margin.

Material examined.—This description is based on 1 specimen with same data as holotype (IMLA).

Description.—Second-instar female? (Fig. 6): Same as adult female except as follows: Slide-mounted specimens elongate oval; length 1.0–1.1(1.1) mm long, 0.3–0.4(0.4) mm wide, posterior abdominal segment with sclerotization and slightly protruding anal lobes. Antenna 6-segmented, 150–162(157) μ long. Legs well developed, without translucent pores: hind trochanter+femur 90–92(91) μ long; tibia 58–61(60) μ long; tarsus 50–58(54) μ long; tibia+tarsus 105–112(110) μ long; tibia/tarsus 1.0–1.2(1.1); tarsal digitules very different in size. 1 conspicuous and extending beyond tip of claw with small apical club, other setose without club not reaching tip of claw: claw digitules unequal or equal depending on specimen, with apical club. Mouth parts well developed, labium short and broad, with 3 segments, 45–48(47) μ long; clypeolabral shield 115–125(119) μ long. With posterior and anterior pairs of ostioles, without pores or setae on posterior ostioles, anterior ostioles with 1 seta on posterior lip. Anal ring slightly invaginated, apical; diameter 32–35(33) μ; with 2 row of pores; anal ring setae with blunt apices, longest seta 35–41(38) μ long. Spiracles with slightly enlarged peritreme, with at least 1 trilocular pore in peritreme sclerotization.

Cerarii present from segments I or II to VIII; on segments I to VI each represented by 1 slightly enlarged seta, 1 widely spaced slender seta and 1 associated trilocular pore, no basal sclerotization; on segments VII with 2 closely associated setae and 1 trilocular pore, no basal sclerotization; on segment VIII with 2 closely associated setae, 1 trilocular pore, and basal sclerotization dispersed beyond base of cerarian setae. Anal lobes slightly protruding, sclerotization more broadly dispersed, ventral surface with 1 small seta, with elongate anal-lobe
Fig. 6. *Pseudantonina vernacula*, second-instar female ?.
Dorsal surface: With 3 longitudinal lines of flagellate setae on each side of abdomen excluding cerarian setae; trilocular pores primarily along body margin. Setae and trilocular pores more abundant on thorax and head. Tubular ducts marginal.

Ventral surface: With 3 to 5 longitudinal lines of flagellate setae on each side of body; 2 pairs of cisanal setae, short about 18 μ long. Quinquelocular pores absent. Trilocular pores along body margin, in spiracular atrium. Multilocular pores present on head and thorax near legs and spiracles and along body margin of abdomen. Discoidal pore forming 1 longitudinal line on submargin of body. Oral-collar tubular ducts present near body margin.

Material examined.—This description is based on 3 specimens with same data as holotype (IMLA).

Description.—First instar (Fig. 7): Same as adult female except as follows: Slide-mounted specimens elongate oval; length 0.7–0.9(0.8) mm long, 0.2–0.5(0.4) mm wide, posterior abdominal segment with slight sclerotization; without protruding anal lobes. Antenna 6-segmented, 140–168(160) μ long. Eye present near base of antenna. Legs well developed, without translucent pores; hind trochanter+femur 92–102(96) μ long; tibia 58–65(63) μ long; tarsus 52–65(61) μ long; tibia+tarsus 115–125(121) μ long; tibia/tarsus 1.0–1.2(1.0); tarsal digitules very different in size, 1 conspicuous and extending beyond tip of claw with small apical club, other setose without club not reaching tip of claw; claw digitules unequal or equal depending on specimen, 1 thicker than other, with apical club. Mouthparts well developed, labium short and broad, with 3 segments, 32–45(40) μ long; clypeolabral shield 90–110(104) μ long. With posterior and anterior pairs of ostioles, with 0–1(1) trilocular pore on posterior lip of each ostiole, without setae. Anal ring not invaginated, apical; diameter 28–31(30) μ; with 2 rows of pores; anal ring setae with blunt apices, longest seta 28–35(30) μ long. Spiracles without enlarged peritreme, without pores in peritreme sclerotization.

Cerarii present from segments I or II to VIII; on segments I to V each represented by 1 slightly enlarged seta, 1 widely spaced slender seta and 1 associated trilocular pore, no basal sclerotization; on segments VI and VII with 2 closely associated setae and 1 trilocular pore, no basal sclerotization; on segment VIII with 2 closely associated setae, 1 trilocular pore, and basal sclerotization restricted to area near base of cerarian setae. Anal lobes not protruding, sclerotization confined to cerarius, ventral surface with 1 small seta, with elongate anal-lobe seta 80–115(103) μ long, and without trilocular pores.

Dorsal surface: With 2 longitudinal lines of flagellate setae on each side of abdomen excluding cerarian setae and 1 longitudinal line of trilocular pores on each side of abdomen excluding pore loosely associated with cerarii. Setae and trilocular pores more abundant on thorax and head. Tubular ducts and discoidal pores absent.

Ventral surface: With 3 longitudinal lines of flagellate setae on each side of body; 2 pairs of cisanal setae, short, 18–24(21) μ long. Quinquelocular pores in submarginal longitudinal line on abdomen, also present medially on thorax and head. Trilocular pores rare, present near spiracles. Multilocular pores present on head and thorax near legs and spiracles. Discoidal pore forming 1 longitudinal line on each submargin of body. Oral-collar tubular ducts present near body margin.

Material examined.—This description is based on 10 specimens that are in reasonable condition with same data as holotype (IMLA).

Discussion
One of the more interesting findings while preparing this paper was the discovery of additional setae on the basal segment of the labium and on the clypeolabral shield. According to Kotejá (1974) all
Fig. 7. *Pseudantonina vernacula*, first instar (sex undetermined).
mealybugs have 3 setae on each side of the basal segment of the labium. In E. chubutensis there clearly are 4 in all instars examined. Although we have looked at hundreds of illustrations, descriptions, and specimens of a diverse array of mealybugs, we have not located other species with 4 setae on the basal segment of the labium but feel certain that they exist. We have, however, discovered two species that are exceptional in that they have only 2 setae on each side of the basal labial segment. i.e., Plotococcus minutus Williams and Granara de Willink (Williams and Granara de Willink 1992) and Macrocepicoccus loricanthi Morrison (Miller and Denno 1977). Unfortunately, the number and distribution of setae on the mouthparts were not considered important until the work of Koteja (1974), and many descriptions and illustrations either do not show them at all, or depict them inaccurately.

Further, most mealybug species that we have examined have a total of 2 setae on the clypeolabral shield. The few exceptions found are in the so called anomalous mealybugs such as Allomyrmococcus acariformis Takahashi (with more than 30 clypeolabral setae), Xenococcus annandalei Silvestri (with 4 such setae) (Williams 1978), and several species of Eumyrnococcus (with 4 setae) (Williams 1998). In E. chubutensis there may be from 7 to 14 setae on the clypeolabral shield in the adult female and at least 6 in the immature. It will be interesting to see if more species of South American mealybugs have this unusual characteristic.

The invaginated pocket posterior of the vulva on Euryccocus chubutensis is another structure not commonly reported in the mealybug literature. Similar structures were illustrated in Rhizoecus by Williams (1996).

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zación sistemática y nueva lista de hospederos.
DOLERUS ANATOLII, N. SP., THE FIRST PALEARCTIC MEMBER OF THE
SUBGENUS NEODOLERUS GOULET (HYMENOPTERA: TENTHREDINIDAE)

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Abstract.—A new tenthredinid, Dolerus (Neodolerus) anatolii Heidemaa and Zinovjev, n. sp., is described from the Russian Far East and South Korea. It is the first species of the subgenus Neodolerus Goulet from outside the Nearctic Region. The subgenus now includes eleven Nearctic and one Palearctic species. Shared characters between Neodolerus species and the Palearctic Dolerus (Poodolerus) vulneratus Mocsáry are discussed.


Neodolerus Goulet. 1986 (type species Dolerus sericeus Say, 1824), a subgenus of the Holarctic genus Dolerus Panzer, 1801, has been known from 11 Nearctic species. Together with the nitens group, which corresponds to Poodolerus Zhelochovtsev. 1988, it is regarded as an early lineage of Dolerus by Goulet (1986). Both are characterized by a shared apomorphic character, the relatively long sternum 9 in males (short in Selandriinae). Neodolerus is defined by the following synapomorphies: a deeply outlined furrow on the outer surface of the metatibia, a large flat surface at the posterior angle of the median lobe (small in other Selandriinae), and the markedly raised posterior medial surface of tergum 8 in the males.

Here, we describe a new species of Neodolerus from the Russian Far East and South Korea. It does not fit any Dolerus species known from the Palearctic (Zhelochovtsev 1928, 1935; Malaise 1931; Muche 1965; Haris 1996; Wei 1997; Wei and Nie 1997; Haris 2000, 2001), and it is not one of the Nearctic species treated by Goulet (1986). The species is named after the outstanding Russian symphytologist, Anatolii Nikolaevich Zhelochovtsev (1903–1976), who was the first to recognize it as a new species but never named or published on it.

Material and Methods

The description of new species is based on 3 female specimens, 2 collected in the Russian Far East and 1 in South Korea. The morphological terminology follows Goulet (1986) and Viitasaari (2002). The right half of valvula 1 (lancet) of the holotype and the left half of one paratype were dissected, processed in 10% KOH, and mounted in Canada balsam (holotype) and euparal (paratype) between rectangular cover slides. They were then placed in paper frames and pinned with the corresponding specimen. Measurements were made on all three spec-
Dol. n. sp.

pr. [prope = near] taeniatus

Fig. 1. Dolerus Anatolii, holotype female. Labels 1 & 2.

imens. The upper and lower limit for each measurement is given in the description. The line drawings of valvula 1 are from digital micrographs taken with an Olympus BX50 System Microscope and Olympus DP11 Camera. Other illustrations are from micrographs taken with an Olympus stereo-microscope SZX9 and digital camera C-4040ZOOM.

Dolerus (Neodolorus) Anatolii Heidemaa and Zinovjiev, new species
(Figs. 1–10)

Type material.—Holotype: female in coll. A. N. Zholochovtsev, Zoological Museum of Moscow State University (Russia); with three labels (labels 1 & 2 in Fig. 1.): [Sudzuch. Zap. = Judzuhe Zapovednik, now the Lazovsky Reservation. Ta-Chingou-za (= Ta-Chingou-za Bay, now Proselochnaya Bay, approximately in the middle between Valentin 44.12N: 134.30E and Preobrazheniy 42.90N: 133.91E). 24–27.06.1948, A. Sharov leg.]. "Dol. n. sp. [LB = line break] pr [= prope] taeniatus" [in pencil, authentic handwriting of A. N. Zholochovtsev]; "HOLOTYPE ♂ DOLERUS ANATOLII HEIDEMAA & ZINOVIJEV 2003" [red handwritten label]. Flagellomeres 5–7 of the right antenna are missing, the remaining flagellomeres of both antennae are glued on a piece of paper placed on the same pin as the specimen. The preparation of the right half of valvula 1 bears the handwritten code: "Dol. sp. 6493-3," and is pinned with the specimen. PARATYPES (2 ♀): 1 ♀ with two labels "RUSSIA: Primorskiy kray [LB] Sikhote-Alin Biol. Station [LB] 30 km SE Chuguevka [LB] 44.05 N 134.12 E [LB] 31.V.1983 650 m [LB] leg. A.TAEGGER" [white printed label]; "PARATYPUS ♂ DOLERUS ANATOLII HEIDEMAA & ZINOVIJEV 2003" [red handwritten label]. The preparation of the left half of valvula 1 is pinned with the specimen. Deposited in the Deutsches Entomologisches Institut, Eberswalde, Germany; 1 ♀ with two labels: "Mirugam (Pugdaesa) [128.57 E: 37.80 N] [LB] 1300m Mt. Odasan [LB] Kangwondo. Korea [LB] 28.V.1991 [LB] A. Shinohara" [white printed label, the date partially handwritten]; "PARATYPUS ♂ DOLERUS ANATOLII HEIDEMAA & ZINOVIJEV 2003" [red handwritten label]. The left flagellum, mid-tibia, and mid-tarsus are missing. Deposited in the Department of Zoology, National Science Museum (Nat. Hist.), Tokyo, Japan.

Female.—Body black. Wings hyaline, slightly infuscated towards apices. Abdomen and legs of holotype somewhat brownish, probably due to storage conditions of specimen. Body length 9.6–10.2 mm. Distance from distal margin of tegula to pterostigma 5.0–5.55 mm.

Head: Width at level of compound eyes 2.35–2.52 mm, maximum width behind eyes 2.26–2.41 mm (measured in dorsal view). Head behind eyes subparallel in dorsal view (Fig. 2). Length of head behind compound eye about 0.4× (25/60) of length of eye in dorsal view (head positioned so hind margins of lateral ocelli and com-
Compound eyes aligned). Setae from silvery to brownish silvery and from brownish silvery to brownish on labrum and mandible. Longest setae on postocellar area shorter than diameter of middle ocellus, on frons in front of middle ocellus setae about as long as ocellus diameter. Setae on parantennal field up to 0.11 mm long. Antennal setae blackish, on scape up to 0.11 mm long. Length of antennal segments measured in mm: scape (with radicula) 0.49–0.50; pedicel 0.27–0.32; flagellomere 1—0.83–0.95, 2—0.69–0.81, 3—0.60–0.70, 4—0.51–0.60, 5—0.44–0.52, 6—0.40–0.45, 7—0.38–0.45. Upper area between ocelli and compound eye somewhat depressed. Punctures behind eyes mostly separated, only some in upper third (just behind eye) fused. Punctures between compound eyes with glabrous interspaces narrower than puncture diameter, forming meshlike sculpture. Punctures on genae and temples less dense, with glabrous interspaces; puncture diameter on temples 0.02–0.06 mm. Postocellar area slightly raised, convex, with longitudinal median groove indistinct (holotype, 1 paratype) or missing (1 paratype), bordered by distinct parallel or slightly convergent postocellar furrows. OCL: 0.45–0.49, OOL: 0.55–0.59, POL: 0.28–0.31 mm. Length of left compound eye 0.67–0.73, height 0.96–1.05 mm. Posterior part of vertex with transverse depression bordered posteriorly with occipital carina. Occipital carina more distinct at vertex and gena level. Clypeus slightly asymmetric, with right lobe more prominent than left lobe (Fig. 3). Clypeus with indistinct transverse carina and irregular punctures, its slightly triangular emargination about 0.8x as deep as its length. Distance from lower margins of toruli to lower margin of clypeus 0.54–0.60 mm.

Thorax: Lateral half of median lobe with 10–14 large punctures. Middle part of median lobe laterally from median mesocutum groove longitudinally depressed. Punctures on mesocutum fine, more or less regular, with glabrous interspaces mostly wider than puncture diameter. Punctures on anterior and central parts of mesoscutellum smaller and sparser than on posterior and lateral parts. Flat surface at posterior angle of median lobe glabrous or slightly alutaceous. Setae on upper part of thorax silvery to brownish, longer than those on upper head. Punctures on mesopleuron up to 0.13 mm, often polygonal, with glabrous ridges of uneven height between them (Fig. 4). Setae on mesopleuron up to 0.14 mm long. Lateral portions of pectus surface rather flat. Pectus with small and sparse punctures in middle and posterior parts, in its anterior part punctures larger (up to 0.06 mm) and denser; pectus microsculpture indistinct, scalelike. Anterior part of thorax at border of mesopleuron and pectus without punctures, but with some scalelike microsculpture. Distance between cenchri 0.50–0.59 mm. Lateral parts of mesoscutellum appendage transversely concave, meshed. Metepimeron and metepisternum with irregular rough sculpture, their shape as in Fig. 5. Outer surface of metacoxa with numerous sparse punctures, denser and larger at base than at apex; microsculpture scalelike, rather obsolete. Basal upper corner of metacoxa glabrous.

Abdomen: Tergum 1 with at least some small punctures. Macrosculpture on next terga obsolete, indistinct punctures starting from tergum 5. Sculpticells on terga 1–5 scalelike, obsolete. Terga 1–4 dorsally almost without setae, more numerous and dense from tergum 5. Silvery-gray setae cover all sterna and lateral parts of all terga entirely. Brownish setae may be present on terga 8–9. Valvula 3 (apical sheath) in lateral view about as long (1.0–1.10 mm) as valvifer 2 (basal sheath), its shape as in Fig. 6. Longest setae of valvula 3 (sensory tuft) 0.29–0.33 mm, curved at apical third and forming ca. 30° angle in dorsal view (Fig. 7). Cercus 0.17–0.19 mm long. Setae on cercus and valvula 3 brownish. Valvula 1 (lancet) with 16 segments, apical half dorsally concave (Fig. 8). Annuli of middle segments outlined by stiff setalike sensilla; winglike processes of annuli absent; serru-
Figs. 8–10. *Dolenis anatolii*, holotype female. 8, Valvula 1 (lancet) with details of 2 serrulae. 9, Apical part of the valvula 1. 10, Basal part of the valvula 1.

lae as in Fig. 9. Apical and basal parts of valvula 1 as in Figs. 9–10. Serrulae 1–3 without teeth, the rest with approximate number of teeth as follows: 4:4; 5:5; 6:7; 7: 8:8; 9:10; 10:9; 11:8; 12:7; 13:9; 14:6; 15:4; 16:1 (serrulae numbered from base of valvula 1 to apex).

Male.—Unknown.
Host plant.—Unknown.
Distribution.—Eastern Asia: southern Russian Far East and South Korea.

**Discussion**
The holotype female of the species bears a handwritten label by A. N. Zhelochovtsev (Fig. 1.) indicating that he was planning to describe it as a new species. However, there is no indication that he noticed its resemblance to any Neartic species. Superficially, *D. anatolii* resembles *D. pachycerus* Hartig, 1837 (= *D. taenius* Zaddach, 1859), of the subgenus *Junciperus* Zhelochovtsev (= *Achaetoprion* Goulet), but it differs by the ovipositor and presence of a furrow on the metatibia. *Dolenis anatolii*, possessing the following combination of characters, does not fit any of Zhelochovtsev’s subgenera: comparatively long ovipositor, valvula 1 without lateral teeth, and
the enlarged irregular punctures on the mesopleuron. Within the subgenus Neodolerus, Dolerus anatolii is closest to D. paraspericus MacGillivray, 1908; however, D. anatolii differs by the mostly separated punctures behind the compound eyes with only some in the upper third (just behind the eyes) fused, the mesocutellar appendage transversely concave, outer surface of the metacoxa with numerous punctures, and the lamnium with 16 segments.

The host plant is known for only one Neodolerus species, Dolerus sericeus Say, which feeds on wheat and probably on other grasses (Goulet 1986, Leblanc and Goulet 1992). Until now, Neodolerus was considered endemic to North America. With the discovery of D. anatolii in the eastern Palearctic the possibility of a Palearctic origin for Neodolerus cannot completely be excluded. Presence of Neodolerus in eastern Palearctic is a sequent example reflecting the well-known relationships between the temperate fauna of eastern Asia and eastern North America. Because many scientists studying eastern Asiatic species were unaware of the eastern North American taxa, they often described new genera.

Goulet (1986) proposed that Neodolerus might be a lineage within his nitens group (Poodolerus Zhelochovtsev). Poodolerus is distributed mostly in the Palearctic (over 55 species in western Palearctic), with seven Nearctic and one Holarctic species (D. asper Zaddach, 1859), and one species introduced into North America (D. nitens Zaddach, 1859). Discussion of the phylogenetic relationships within Poodolerus is not within the scope of this paper, but it is noteworthy that characteristic features of Neodolerus occur in some species of Poodolerus, for example, in D. vulneratus Mocsáry, 1878. This species has two characters in common with Neodolerus species: the distinctly outlined furrow on the outer surface of the metatibia and the large flat triangular surface at the posterior angle of the median lobe (3 females were examined). Dolerus vulneratus is a rare Palearctic species known from Estonia (Viitasaari et al. 1998), Russian Karelia (Lindqvist 1969), Siberia, the Russian Far East (Zhelochovtsev and Zinovjev 1996), and South Korea (Haris 2001).

On the other hand, the penis valve of D. vulneratus is very different (Zhelochovtsev 1988: 181, fig. 10) from all Neodolerus species and resembles species of the Dolerus alpinus and D. affinis groups. We did not study any material of Dolerus shanghaiensis Wei and Nie (the name is preoccupied by Dolerus shanghaiensis Haris, 1996) that according to its description and illustrations of the ovipositor and penis valve first resembled a Neodolerus species. However, the specimens of its type series show no furrow on the outer surface of the metatibia (Meicai Wei, personal communication). This species most probably belongs to the subgenus Poodolerus.

Further study incorporating molecular methods may shed more light on the phylogenetic relationships between the Neodolerus and allied Poodolerus species.

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Forestry University, Zhuzhou, Hunan) informed us about the requested character states of D. shanghaiensis Wei and Nie. Martin Kärner and Taavi Virro (Institute of Zoology and Hydrobiology, University of Tartu) assisted in preparing the digital micrographs for the line drawings of the ovispositor. Our cordial thanks is extended to them.

**LITERATURE CITED**


——. 1935. Notes sur les Dolerinae (Hym.) Paléarctiques. Archives du Musée Zoologique de l’Université de Moscou II: 79–84. (In French with Russian summary.)


ACALYPTRATE DIPTERA ASSOCIATED WITH STANDS OF CAREX LACUS TRIS AND C. STRICTA (CYPERACEAE) IN NORTHEASTERN OHIO

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Abstract.—Eighty-seven species of acalyptrate Diptera were swept from stands of the sedges Carex lacustris and C. stricta in a small freshwater marsh located near the city of Kent in Portage County in northeastern Ohio. Information is presented on stand preference, seasonal distribution, and larval feeding habits for the 45 species for which more than one specimen was collected. The most species-rich families were Chloropidae (28 spp.), Ephydridae (15), and Scio myzidae (14).

Key Words: freshwater marsh, Carex, acalyptrate Diptera, Ohio, larval feeding habits

There seems to be a general impression among wetland biologists that higher flies are relatively unimportant in marshes, probably because many of the species of marsh-inhabiting cyclorrhaphous Diptera are not truly aquatic and thus are not thought to be involved in aquatic food chains leading to fish or waterfowl production (Keiper et al. 2002). However, species richness of Diptera can be high (Todd and Foote 1987a, Beaulieu and Wheeler 2002), and populations of certain species can be huge in freshwater wetlands (Larson and Foote 1997, Keiper and Walton 2000). Because of their abundance, species richness, and diversity of feeding habits, acalyptrate flies undoubtedly play important roles in marshland ecology, and probably are particularly important as food resources for small birds and mammals (King and Brazner 1999).

This is the eighth paper in a series of publications focusing on the aca lyptrate Diptera of freshwater marshes in northeastern Ohio (Todd and Foote 1987a, b; Rogers et al. 1991; Wearsch and Foote 1994; Keiper et al. 1998; Larson and Foote 1997; Foote, in press). The present study gives survey data obtained during one warm season of collecting aca lyptrate Diptera in stands of two sedge species, Carex lacustris Wild. and C. stricta Lam., in a small marsh located in northeastern Ohio. Information is given on stand preference, seasonal occurrence, and larval feeding habits of 45 of the 87 associated species.

MATERIALS AND METHODS

The freshwater marsh, “Horning Road Marsh,” utilized in this study is located 0.8 km east of the main campus of Kent State University (Portage Co.). It encompasses some 0.5 h and supports a mosaic of eight vegetation types occurring in nearly monocultural stands (Todd and Foote 1987a). Carex lacustris is a cespitose, rhizomatous, broad-leaved (8–15 mm) species that forms a nearly closed canopy over the marsh muds. In contrast, C. stricta is a narrow-leaved (2–5 mm) clumped sedge, a growth form that allows considerable light to reach the marsh surface.

Acalyptrate Diptera were obtained by sweep samples consisting of 15 back and forth movements of a standard aerial insect net through the vegetation. Sampling took
place weekly for 22 weeks between May 6 and September 29, 1989.

**RESULTS AND DISCUSSION**

A total of 93 species of acalypterate Diptera was obtained in the two stands of Carex (Table 1). Sixty-four species were found in C. lacustris, and 74 in C. stricta. In the list below, 48 species are covered in greater detail with respect to their occurrences in the two stands, relative abundances, and larval feeding habits.

**Annotated List of Selected Species**

**Family Agromyzidae**

*Cerodontha (Cerodontha) dorsalis* (Loew).—Adults of this species were more abundant in *C. lacustris*, being recorded from mid-May to mid-August. It appeared to be bivoltine, as no adults were recorded between late June and late August. The larvae are leaf miners of grasses (Spencer and Steyskal 1986). Grasses were intermixed with *C. lacustris* in this stand.

*Cerodontha (Butomomyza) subangulata* (Malloch).—Larvae are known to mine leaves of *Carex* (Spencer and Steyskal 1986).

**Family Anthomyzidae**

*Anthomyza variegata* (Loew).—Six individuals were swept from *C. lacustris*. Larvae of this stem-boring species overwinter in culms of the host plant.

*Munetopia occipitalis* Melander.—Seven specimens were taken in *C. lacustris*, and 11 in *C. stricta*. The larvae are reported to mine the stems of wetland monocots (Ferrar 1987).

**Family Chamaemyiidae**

*Plunonia elegans* Curran. *P. tibialis* Malloch. *P. transversa* Malloch.—Thirty-five adults of these three species were taken from *C. stricta* during late May and early June. Nothing is known of the larval feeding habits of any of these species, but other species of the family prey on aphids and scale insects (Sluss and Foote 1971, 1973).

**Family Chloropidae**

*Chlorops certina* Adams.—This was an abundant species between late May and mid-June in *C. lacustris*. Larvae are stem borers of several *Carex* species (Rogers et al. 1991). They reported that there is a single annual generation, with overwintering occurring as third-instar larvae in dead culms.

*Conioscinella nuda* (Adams).—This was a common species in both species of *Carex*, where its larvae fed as secondary invaders of stems damaged by phytophagous larvae of the dipterous family Scathophagidae.

*Dasyopa* sp.—One adult of this apparently new species was taken in each *Carex* stand. Nothing is known of the life history or larval feeding habits of any species of the genus.

*Elachiptera erythropleura* Sabrosky.—Taken only in *C. stricta*, the larvae of this species are secondary invaders of monocot stems damaged by other insect larvae (Vallely et al. 1969).

*Elachiptera nigriceps* (Loew).—This was an abundant species in both species of *Carex*. Its larvae feed as secondary invaders of stems damaged by phytophagous larvae (Valley et al. 1969).

*Epichlorops exilis* (Coquillett).—This was an abundant species between late May and early July in *C. lacustris* (Fig. 2), where its larvae were stem miners (Rogers et al. 1991).

*Eribolus longulus* (Loew).—A common species in wetlands, adults were abundant throughout the warm season in both sedge stands. Its larvae are secondary invaders of the stems of wetland monocots that have been damaged by phytophagous larvae (Valley and Foote 1996).

*Incertella bispina* (Malloch).—Adults were taken only in *C. lacustris*. Its larval feeding habits are unknown.

*Incertella incerta* (Becker).—This was an abundant species in both species of *Carex*. Its larvae fed as secondary invaders of stems of monocots.
Table 1. Species, numbers, and trophic guilds of acalyptrate Diptera collected in stands of *Carex lacustris* and *C. stricta* in northeastern Ohio.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number Collected in</th>
<th>Trophic Guild</th>
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<tbody>
<tr>
<td></td>
<td><em>Carex lacustris</em></td>
<td><em>Carex stricta</em></td>
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<tr>
<td>AGROMYZIDAE</td>
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<tr>
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<td>ANTHOMYZIDAE</td>
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<td><strong>SPHAEROCERIDAE</strong></td>
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<td>Chaetopsis massyla (Walker)</td>
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Number of species: 64 74
Number of individuals 1,454 1,352

Liohippelates pallipes (Loew).—This was a fairly common species in both species of Carex. Its larval feeding habits are unknown.

Oscinella frit (Linnaeus).—Adults were collected in both species of sedge, although they were far more abundant in an adjacent stand of reed canary grass, Phalaris arun-
dinacea L. Larvae are stem borers of a great variety of grasses (Ferrar 1987).

Pseudopachychaeta approximatinervis (Zetterstedt).—Only two adults were taken in each species of Carex. The larvae are seed predators of spike-rush, Eleocharis smallii (Valley et al. 1969), and other species of sedges.

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**Fig. 1.** Seasonal occurrence of species of acalyptate Diptera in Carex lacostris.
Rhopalopterum carbonaria (Loew).—This was an abundant taxon in both species of Carex. Its larvae are secondary invaders of stems previously damaged by phytophagous insect larvae (Valley et al. 1969).

Thaumatomyia glabra (Meigen).—Three adults of this species were taken in C. lacustris, whereas eight were swept from C. stricta. Larvae are predators of root-inhabiting aphids (Parker 1918).

Family Drosophilidae

Drosophila palustris Spencer.—Taken only in C. lacustris, adults of this marsh-inhabiting species were reared from larvae found in moist, decaying leaves and stems of various species of sedges.

Drosophila quinaria Loew.—This is another species of Drosophila commonly found in freshwater marshes, although I collected only one specimen. Its larvae feed on decaying plant material.

Scaptomyza pallida (Zetterstedt).—This was an abundant species throughout the collecting season, with greatest numbers being obtained in C. stricta. Its larvae are general scavengers of decaying plant material (Ferrar 1987).

Ephydridae

Coenia curvicauda (Meigen).—Usually this is a fairly common species in marshes, but I obtained only six specimens, mostly from C. lacustris. The larvae are generalized feeders on organic particulate matter, including algae and decaying plant material (Foote 1990).

Discocerina obscurella (Fallén).—Only three specimens of this normally common and widely distributed species were found in the stands of Carex. Its larvae are generalized feeders of particulate organic matter (Foote and Eastin 1974).

Hyadina albovendosa Coquillett.—Uncommon in both stands. Larvae of this species feed on Cyanobacteria (Foote 1993).

Hydrellia griseola (Fallén).—Uncommon in the sedge stands. Larvae of this species feed as leaf miners on a great variety of grasses and other wetland monocots (Deonier 1971, 1978).

Lytogaster excavata (Sturtevant and Wheeler).—Fairly common in the stand of C. stricta. Larvae of this species consume Cyanobacteria, particularly species of soil-inhabiting Cylindrospermum (Foote 1981a).

Nostima picta (Fallén).—Larvae of this
species are specialized consumers of the cyanobacterial genus *Oscillatoria* (Foote 1983).

*Notiaphila canadata* Fallén.—This was an abundant species in both stands. Its larvae feed on particulate organic matter, including algal cells, on the surface of marsh soils (Eastin and Foote 1971).

*Pelina truncatula* Loew.—An uncommon species in sedge marshes, this species is more regularly taken in stands of cattail (*Typha* spp.). Its larvae feed on such cyanobacterial genera as *Anabaena* and *Cylindrotheca* (Foote 1981b).

*Phylgria debilis* Loew.—Only one specimen of this small, inconspicuous species was found in *C. stricta*. Adults are more commonly encountered in marshes and moist meadows dominated by grasses. Larvae feed on the cyanobacterial genus *Oscillatoria* (Foote 1983).

Family Micropeltidae

*Compsobata pallipes* (Say).—Eleven specimens were swept from *C. stricta*. Larvae of a closely related species have been reared from decaying plant material (Teskay 1972).

Family Sciomyzidae

*Dictya expansa* Steyskal, *D. steyskali* Valley.—Adults of both species were taken in both sedges throughout the summer months. Larvae prey on aquatic pulmonate snails (Valley and Berg 1977).

*Elgiva sollicita* (Harris).—A common species in both sedges throughout the warm season, this species has the interesting habit of overwintering as adults in marshes. Its larvae prey unselectively on aquatic pulmonate snails (Knutson and Berg 1964).

*Pherbellia nana nana* (Fallén).—Adults were found in *C. lacustris* throughout the spring and summer months. Larvae of this species attack a great variety of small pulmonate aquatic snails that have been stranded by dropping water levels (Bratt et al. 1969).

*Sepedon borealis* Steyskal, *S. fuscipennis* Loew, *S. tenuicornis* Cresson.—All three species of *Sepedon* were encountered repeatedly in both sedge stands. Adults overwinter in marshes where their larvae prey on aquatic pulmonate snails (Neff and Berg 1966).

*Tetanocera ferruginea* Fallén.—This was not a common species in the sedges stands, as the adults seemingly preferred habitats
Fig. 4. Seasonal occurrence of individuals of acalyptrate Diptera in Carex lacustris.

possessing somewhat deeper water (e.g., cattail marshes). It was multivoltine, producing three or four generations a year. Its larvae feed on a variety of pulmonate aquatic snails (Foote 1999).

Tetanocera loewi Steyskal. — An uncommon species in both Carex stands, adults appeared in mid-June, remained at low numbers throughout July and August, and disappeared from the marsh in late September. It had a single generation a year, with overwintering occurring as unhatched first-instar larvae within the egg envelopes. Hatching took place in March, and most of the larval feeding on a variety of pulmonate aquatic snails (Physa, Lymnaea, Gyraulus, Helisoma) was completed during April and early May (Foote 1999).

Family Sepsidae

Sepsis flavimana Meigen.—This was the only species of Sepsidae that was taken repeatedly in the sedge stands, and was particularly abundant in C. stricta. Its larvae are unselective scavengers of decaying organic matter, particularly dung (Ferrar 1987).

Family Sphaeroceridae

Leptocera fontinalis (Fallén).—This was the only abundant species of the six species of Sphaeroceridae encountered in the sedge stands, being particularly common in C. stricta. Larvae of all species are thought to be scavengers of decaying organic matter (Ferrar 1987).

Family Ulidiidae

Chaetopsis aenea (Wiedemann).—This was a common species in both stands of Carex, but showed a distinct preference for C. lacustris. It first appeared and reached peak abundance in early June, and largely disappeared by late July. Larvae feed as secondary consumers in stems of monocots that have been damaged by more phytophagous species (Allen and Foote 1992).

Chaetopsis massyla (Walker).—This species was also recorded in both stands, with greatest abundance in C. lacustris in late June. Its larvae feed as secondary invaders of stems of damaged wetland plants (Allen and Foote 1992).

Occurrence in the Two Stands

Carex stricta supported a somewhat greater number of acalyptrate taxa, with some 74 species being recorded. In contrast, 64 species were taken in C. lacustris (Table 1). One possible explanation for the slightly greater species richness in C. stricta
was the fact that this tussock sedge species has a clumped distribution with open spaces between clumps. This allowed light to reach the marsh floor, resulting in greater algal growth that served as larval food for some species of Ephydridae. In contrast, Carex lacustris is a rhizomatous species that formed a more closed canopy over the marsh substrate. There was considerable sharing of species among the two species of Carex, and Sorensen’s Similarity Index (Sorensen 1948) was 0.66 meaning that 66% of the acalyprate species were found in both sedges.

Seasonal Occurrence

The number of species in both of the Carex stands peaked in June and remained fairly constant throughout the remainder of the summer (Fig. 1). Many species were found throughout the warm season, but a few species obviously were univoltine or bivoltine. For example, adults of Epichlorops exilis peaked in early June (Fig. 2). Adults of Sepedon tenuicornis overwintered in the marsh and were quite abundant again in late summer (Fig. 3). Total abundance of adult flies in the two stands peaked in early June (Fig. 4), and populations had largely collapsed by mid-October.

Guild Structure

There was obvious partitioning of food resources in the two stands of Carex, with eight trophic guilds being recorded (Table 1). The largest guild involved some 23 species that fed as generalized scavengers of decaying organic matter. The phytophagous community consisted of a leaf-mining guild containing six species, a stem-boring guild of eight species, and a seed predator guild of three species. The guild of secondary invaders consisted of 13 species whose larvae fed as scavengers on stem tissues previously macerated by more phytophagous species. An interesting guild consisted of seven species whose larvae consumed Cyanobacteria. The snail predator guild contained 14 species, and three species preyed upon other insects. The larval feeding habits of 15 species remain unknown.

Acknowledgments

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NEW NORTH AMERICAN RECORDS OF THE EUROPEAN BROOM
PSYLLID ARYTAINA GENISTAE (LATREILLE)
(STERNORRHYNCHA: PSYLLIDAE)

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Abstract.—The European psyllid Arytaina genistae (Latreille) has been unintentionally introduced into North America, probably with imported nursery stock of its principal host, Scotch broom (Cytisus scoparius; Fabaceae). Known previously in North America only from an early twentieth-century collection from Massachusetts and a record of its interception in California in nursery stock originating in Washington State, A. genistae is reported from Nova Scotia, Canada, and from North Carolina, Oregon, and Washington in the United States. Morphological characters are provided that allow it to be separated from Arytainilla spartiophila (Förster), another European broom psyllid that also is established in eastern and western North America.

Key Words: Insecta, Psyllidae, Arytaina genistae, insect distribution, adventive species, Scotch broom

Scotch broom (Cytisus scoparius [L.] Link; Fabaceae) is a common northern and western European shrub that has been widely planted and become naturalized beyond its native range. This deciduous, perennial, yellow-flowered legume was planted in Colonial American gardens (Leighton 1976) and was used as an ornamental in California and the Pacific Northwest by the mid-nineteenth century (Clark 1976, Andres and Coombs 1995). It also might have been accidentally introduced into North America with ship ballast (Lindroth 1957). In both eastern and western North America, Scotch broom has been used for erosion control along highways (Hitchcock and Cronquist 1973, Pfeiffer 1986, Dirr 1998). It has been used in the Pacific Northwest for stabilizing coastal sand dunes (Schwendiman 1977). This r-adapted shrub (Williams 1981) is considered an invasive plant in western North America and in Australia, Chile, Iran, New Zealand, and South Africa (Syrett et al. 1999).

In Great Britain and continental Europe, a diverse arthropod fauna (>240 species) is associated with Scotch broom (Syrett et al. 1999). Long-term studies of its fauna were conducted at Silwood Park, Berkshire, England, by J.P. Dempster, O.W. Richards, N. Waloff, and their colleagues and students in the 1950s and 1960s (Waloff 1968). Although an Old World lyonetidid moth was introduced into the western United States in the early 1960s to help reduce densities of Scotch broom (Frick 1964, Andres and Coombs 1995), basic studies on the ecology of broom arthropods in England mostly predated the main use of biological control against this plant in areas where it is not native (e.g., Rees and Paynter 1997, Syrett et al. 1999, Fowler et al. 2001).

Among the insects of Scotch broom that
have been accidentally introduced into North America are two species of Psyllididae, the bi- or trivoline Aritaina genistae (Latreille) and the univoltine Arytainilla spartiophila (Förster). In North America, Aritaina genistae is known only from Massachusetts (Crawford 1911, Hodkinson 1988) and Washington (California Department of Food and Agriculture 1993), whereas Arytainilla spartiophila is widely distributed in British Columbia, California, Oregon, and Washington (Waloff 1966, Syrett et al. 1999) and is known in the East from Virginia (Pfeiffer 1986). Herein, we give the first records of Aritaina genistae for Canada and the southeastern United States. We also provide morphological characters that allow these adventive psyllids to be recognized in the Nearctic fauna.

Aritaina genistae (Latreille)

The first North American record of A. genistae was given by Crawford (1911) in describing the new species Psyllopa magna based on T.D.A. Cockerell’s collection of a large series of specimens from Spartium [sic] sp. at Woods Hole, Massachusetts. The host plant likely was Scotch broom. Spartium scoparius not only is a former name for C. scoparius (Peterson and Prasad 1998), but this plant also was recorded from Woods Hole in the early twentieth century as a host for other Old World broom insects (Olsen 1918, Wheeler and Henry 1992). No collection date was given by Crawford (1911), but Cockerell, a professor at the University of Colorado, Boulder, likely collected the psyllid in 1911; that year he spent the summer at the Woods Hole Oceanographic Institution (Weber 1965). Crawford (1914) realized the psyllid from Massachusetts that he had described as new was a previously described European species. He synonymized P. magna under A. genistae and noted that this adventive species probably had been accidentally introduced into North America with nursery stock.

Records of A. genistae from western North America have not appeared in the primary literature. Waloff (1966) did not record it from Scotch broom in British Columbia or California, Hodkinson (1988) listed it only from Massachusetts in his checklist of Nearctic Psyllidae. Syrett et al. (1999) did not include it in a discussion of insects known from broom in North America, and Maw et al. (2000) did not include it in their checklist of Canadian Hemiptera. This psyllid, however, was intercepted in Santa Clara Co., California, on broom shipped from a nursery in Shelton, Washington (California Department of Food and Agriculture 1993; R.J. Gill, personal communication).


Voucher specimens have been deposited in the Cornell University Insect Collection (CUIC), Ithaca, NY.

Recognition Features

Aritaina genistae differs in several respects from Arytainilla spartiophila, the only other Scotch broom psyllid established
in North America. In Arytaina genistae, the forewing is somewhat elliptical, broadest at the middle, with a dark brown to black pattern occupying cells $r_2$ and $cu_3$, but also with small patches at the apices of cells $m_1$, $m_2$, and $cu_1$ (Fig. 1) (illustrated by Hodkinson and White 1979: 38, fig. 109; Ossiannilsson 1992: 95, fig. 406). In contrast, the forewing of Arytainilla spartiophylla is oblong-oval, broadest at the apical third, and entirely pale yellow throughout (Peiffer 1986: 215, fig. 1). The male and female terminalia of each species also are distinct, as illustrated by Hodkinson and White (1979) and Ossiannilsson (1992).

**DISCUSSION**

More specialist insect species are found on Scotch broom in the Pacific Northwest of North America than in any other region where this plant is adventive (Syrett et al. 1999). Most broom herbivores accidentally introduced into the Pacific Northwest and other regions either overwinter as eggs embedded in year-old twigs or as larvae under the bark of host shoots (Waloff 1966). Arytainilla spartiophylla, which overwinters in the egg stage and inserts its eggs into host shoots (Waloff 1968, Watmough 1968), fits the life-history pattern of most other introduced broom insects. In contrast, Arytaina genistae deposits its eggs superficially on leaves and other plant parts, and the adults overwinter on the host plant (Waloff 1968, Watmough 1968). It, therefore, might not have been predicted to be introduced with nursery stock and to become established in North America. Yet records of A. genistae from both the east and west coasts suggest multiple introductions from Europe. Alternatively, a single introduction and subsequent movement in North America with shipments of broom nursery stock could have resulted in the currently known distribution of this psyllid.

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**LITERATURE CITED**


POST-ADULT EMERGENCE DEVELOPMENT OF GENITALIC STRUCTURES IN SCHISTOCERCA STÅL AND LOCUSTA L. (ORTHOPTERA: ACRIDIDAE)

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Abstract.—The male genitalia and female ovipositor in Schistocerca americana (Drury) (Orthoptera: Acrididae: Cyrtacanthacridinae) continue to develop after adult emergence. The internal skeleton comprising the phallic complex is affected by cuticle deposition, resulting in qualitative shape changes during sexual maturation. Lateral apodemes of the ovipositor also grow in length and width during sexual maturation. Similar developmental patterns are found in the male genitalia of S. gregaria (Forskål) and Locusta migratoria (Linnaeus), suggesting the possibility that post-adult emergence genitalic development may be widespread within Acridoidea. Newly emerged individuals may be functionally incapable of copulation because the necessary structures have not been fully matured. Taxonomic use of the genitalic structures is discussed in light of the present finding.

Key Words: post-adult emergence, cuticle development, genitalia, grasshopper, taxonomy

The final molt in insect development results in the adult instar responsible for the reproduction. While there are some groups that are capable of copulating immediately after emergence (Ridley 1989), many insects have a period of sexual maturation with the adult instar. The post-emergence maturation period of Schistocerca Stål (Orthoptera: Acrididae) is about 30 days, which is very long compared to that of other insects (Norris 1954, Ridley 1988, Weis-Fogh 1952). Historically, the gonads have been considered the only developing structures responsible for delayed sexual maturation (Norris 1952, 1954, 1957). For example, Norris (1954) documented the growth of the egg-rudiments in females and underdeveloped receptaculum seminis in males of sexually immature locusts. However, physiological studies revealed that developmental changes at cuticular, muscular, and ultrastructural levels occur throughout the teneral period (Neville 1963a, Weis-Fogh 1952, Viscuso et al. 1985). Significant maturation in the adult stage is known from Orthoptera, Dermaptera, Odonata, Hemiptera, Homoptera, Hymenoptera, and Diptera (Table 1). Structures that undergo this process include muscles, corpora allata, epithelium, and both internal and external skeletal elements. The period of development can be as long as 35 days (Table 1).

The developmental changes documented until now are, however, quantitative changes that deal with the increase in thickness or volume. I demonstrate below that the genitalia undergo a qualitative change in shape during the entire period of the sexual maturation in Schistocerca americana (Drury). Also, I explore the taxonomic implications of this finding because the genitalic characters have been used extensively in descriptive taxonomy (Dirsh 1973, Eberhard 1985).
Table 1. Post-adult emergence development of different structures and their processes and timing along with orders known to have the phenomena.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Process</th>
<th>Post-emergence Timing</th>
<th>Order Found</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exoskeleton</td>
<td>Chitin layer deposition from epidermis</td>
<td>Until sexual maturity</td>
<td>Orthoptera, Dermaptera, Odonata, Hemiptera, Homoptera, Hymenoptera</td>
<td>Neville (1963b)</td>
</tr>
<tr>
<td>Thoracic apodemes</td>
<td>Resilin deposition</td>
<td>One week</td>
<td>Orthoptera</td>
<td>Neville (1963a)</td>
</tr>
<tr>
<td>Genital apodemes</td>
<td>Resilin deposition</td>
<td>12 days</td>
<td>Diptera</td>
<td>Schlein (1972)</td>
</tr>
<tr>
<td>Thoracic muscles</td>
<td>Increase in volume of mitochondria and contractile protein</td>
<td>Until sexual maturity</td>
<td>Diptera, Orthoptera</td>
<td>Bursell (1961)</td>
</tr>
<tr>
<td>Corpora allata</td>
<td>Development of nuclei and allatum-cell cytoplasm</td>
<td>Until sexual maturity</td>
<td>Orthoptera</td>
<td>Finlayson (1975)</td>
</tr>
<tr>
<td>Ejaculatory duct epithelium</td>
<td>Release of Golgi vesicles and lysis of cells</td>
<td>Until sexual maturity</td>
<td>Orthoptera</td>
<td>Weis-Fogh (1952)</td>
</tr>
<tr>
<td>Male phallos</td>
<td>Resilin deposition</td>
<td>21–35 days</td>
<td>Orthoptera</td>
<td>Odhambo (1966)</td>
</tr>
<tr>
<td>Lateral apodemes of female ovipositor</td>
<td>Resilin deposition</td>
<td>20–33 days</td>
<td>Orthoptera</td>
<td>This study</td>
</tr>
</tbody>
</table>

From laboratory colonies, the last nymphal instars of both male and female Schistocerca americana were collected and transferred to a clean cage. When the nymphs molted to adults, they were placed in separate tubular cages, approximately 7 cm in diameter and 30 cm in height, with a steel mesh for locusts to rest on, and the date of molting was labeled on the cages. Each cage contained 3 males and 1 female. Each of the experiment was immediately removed.
ber. Twenty different dimensions of male genitalia and length and width of the lateral apodemes of ovipositors were measured using ocular micrometer attached to a dissecting scope (Figs. 1–8). Because the phallic complex is comprised of several parts, the dimensions of the cingulum were measured first, and the endophallus was dissected afterwards. Terminology used here followed that of Dirsh (1956). All measurements were logarithmically transformed to normalize variance and plotted against the days after emergence using MINITAB.

RESULTS

Developmental sequence of the genitalia.—Differences between the genitalia of each specimen and those of a sexually mature male were documented in order to describe the developmental stage of a certain age. Although most individuals followed similar patterns, some seemed to develop more slowly than others. External ovipositors did not change, but internal lateral apodemes grew as muscles differentiated through time. However, it was not possible to document the cuticle deposition sequence.
of these lateral apodemes, because they were still covered with muscles. Day 1 indicates the first day after the emergence.

Day 0–1: No structure was sclerotized and the color of phallic complex was opaque and white. Epiphallus was fully formed, but the cuticle was very thin and white in color. Cingulum, ectophallic sclerite, and endophallus were not fully formed and appeared to be very fragile. The arch of cingulum in endophallus was absent.

Day 2: All parts started to be sclerotized, and structures were light brown in color. Tracheae were found within the phallus. In cingulum, the lateral parts of rami were white, whereas others parts were all brown.

Day 3: The lateral parts of rami began to be filled with cuticle and were brown.

Day 4: All structures were more robust due to cuticle deposition. In one male, the distal projection of the arch of cingulum had started to develop. It was very thin and cylindrical and appeared to originate from below both zygoma and the base of arch of cingulum.

Day 5: The structure found in one male on day 4 appeared in all males.

Day 6–7: More cuticle deposition was in process, but not much different from the day 5. The amount of cuticle deposition varied as if certain individuals had developed faster than others.

Day 8–9: The arch of cingulum became gradually thicker and larger compared to the same structure of earlier days.

Day 10: Cuticles became more rigid, and anterior projection of epiphallus was hardened.

Day 11: The anterior projection of epiphallus began to have double layers internally. The hour-glass shaped portion below zygoma became smaller. The arch of cingulum was getting thicker, but still a cylindrical shape.

Day 12–13: The arch of cingulum became gradually thicker than the same structure of earlier days, and other parts became more robust.

Day 14–16: Tip of anterior projection of epiphallus became darker, and the hour-glass shaped portion below zygoma became even smaller.

Day 17–20: Morphology of phallus was similar to that of a fully mature male. The arch of cingulum became bulbous. External coloration of locusts was brown still indicating sexual immaturity.

Day 21: Some locusts turned bright yellow, indicating sexual maturity.

Day 22–30: Most locusts turned yellow and all of these had a fully mature phallus. During this period, occasional copulation and oviposition were observed. On day 30, there were still males with brown coloration, which did not have a fully mature phallus.

Day 31–35: All the locusts were bright yellow and the phallic complex was highly sclerotized and mature.

Rate of development.—Cuticle deposition occurred throughout the parts of phallic complex during sexual maturation, resulting in an increase in thickness (Figs. 9–12). Of twenty dimensions measured, most dimensions did not result in significant changes during development. For some dimensions, however, cuticle deposition was significant enough to change the shape of the structure. In cingulum, overall size remained constant throughout maturation period (CW in Fig. 9), but the apodemes of cingulum (ApdR in Fig. 9) became thicker and wider as the insect matured (Fig. 13). Likewise, overall size of epiphallus remained constant (EpW in Fig. 10), but there was a gradual increase in size of the bulbous base of epiphallus (EpB in Fig. 10, Fig. 14). Resulting developmental patterns of dramatically changing dimensions in both cingulum and epiphallus may be represented as a curve where growth approaches an asymptote. Endophallus showed the most qualitative changes, resulting in dramatic morphological changes. Laterally, the distal projection of the arch of cingulum, which was absent for the first three days after emergence, sud-
Figs. 9–12. Logarithmically transformed measurements were plotted against days after adult-emergence to show the developmental patterns of each measured structure. In each figure, dimensions from the same genitalic structure were plotted. 9. In cingulum, entire width of cingulum (CW) remains constant whereas width of apodeme ridge (ApdR) changes. ApdR starts to mature around 14 days after emergence. 10. In epiphallus, width (EpW) remains constant whereas width of bulbous base (EpB) gradually develops over time and starts to mature around 26 days after emergence. 11. In endophallus, length of apical valve (Ap) remains constant, whereas arch of cingulum (Ac1) suddenly appears at day 4 after emergence. Arch of cingulum does not grow lengthwise after it forms, but it gradually thickens until 20 days after emergence (not shown). 12. In endophallus, both width of basal valve (Bp) and length of flexure + basal valve (Fx+Bp) gradually increase and start to mature around 10 days after emergence.

Sudden began developing four days after the emergence (Ac1 in Fig. 11, Fig. 15). It started as a thin cylindrical structure and became bulbous (Fig. 15). The only non-changing part was the length of apical valve of the penis (Ap in Fig. 11, Figs. 15, 16). Ventrally, the most significant morphological changes can be found in gonopore process and basal valve (Bp in Fig. 12, Fig. 16). These structures were not differentiated immediately after the adult emergence, but rapidly developed until ten days after emergence (Fig. 12). Overall, the size of endophallus increased during maturation mainly due to the growth of flexure and basal valve (Figs. 12, 15, 16). The distal part of endophallus remained relatively constant, and the proximal part elongated through cuticle deposition. The ejaculatory sac was present immediately after the emergence, but the cellular maturity was not measured (Figs. 15, 16). Ectopodial sclerite did not change in size except for the increase in cuticle thickness. In females, the lateral apodemes
of ovipositor continued to develop in length and width after emergence (Fig. 17). The external valves did not change in size except that the muscle mass inside the valves increased.

Post-emergence development of male genitalia in other species.—The phallic complexes of Schistocerca americana and S. gregaria are very similar, but the phallic complex of L. migratoria differ morphologically. The size of the whole insect was similar between Schistocerca and Locusta, but L. migratoria has a phallic complex three times as large as that of Schistocerca. The entire phallic complex of L. migratoria is highly sclerotized immediately after emergence, indicated by the brown color of cuticle.

Figures 18a and 19a show the development of the cingulum in S. gregaria and L. migratoria, based on specimens that were freshly molted, 2 weeks after molting, and 35 days after molting. In both cases, the apodemes of cingulum increased in width and length. The distal portion of cingulum also remained relatively unchanged, whereas the increase in cuticle deposition of the proximal portion was dramatic. In both Schistocerca species, width of the bulbous base of epiphallus in width through time. In L. migratoria, no structure increased in width, but thickness of cuticle increased through time. In both Schistocerca species, the arch of the cingulum was absent immediately after emergence and progressed from a cylindrical to a bulbous shape (Figs. 15, 18b). Both basal valve of penis and gonopore process increased in width and length. There seemed to be no equivalent structure to the arch of cingulum in L. migratoria. The apical valve of penis remained constant, but the basal valve of penis went through dramatic structural changes (Fig. 19b).

**Discussion**

Genitalia as apodemes.—This study suggests that adult grasshoppers are functionally incapable of mating during sexual maturation. Sexual maturity is here defined as a period when both males and females can functionally copulate and produce viable offspring. Each component of the phallic complex experiences a structural change that seems to be closely associated with the muscles responsible for movement during copulation. Growth of the phallic apodemes and lateral apodemes of the ovipositor in Schistocerca americana is accompanied by an increase in muscle mass. Elastic nature and cuticle deposition patterns all indicate that the male genitalia and the lateral apodemes of ovipositor probably contain resilin (Keffer and Babcock 1998, Neville 1963b, Tatham and Shewry 2002). In freshly emerged specimens, cuticle deposition has yet to occur and muscle cells have not differentiated. Timing of the complete development of genitalia and timing of sexual maturity coincide, suggesting that mature genitalia are the functional necessity of the copulation. In the colony where both sexually immature and mature specimens were reared together, copulation was observed only between bright yellow individuals, which always had fully mature genitalic structures. Until now, delayed mating has been explained only by the developmental time of soft reproductive structures such as epithelium, ejaculatory duct, and ovaries (Norris 1954, 1957). While these structures are crucial for reproduction, skeletally mature structures that are responsible for copulation, ejaculation, and oviposition are essential for organisms to function properly. This study thus proposes a new proximate causal reason for the delayed mating.

Post-emergence genitalic development is widespread.—Post-adult emergence development of genitalic structures appears to be widespread, at least in Acrididae. Schistocerca and Locusta belong to two subfamilies, Cyrtauchenidae and Oedipodinae, respectively, and their genitalic morphologies differ greatly. However, both genera follow similar developmental patterns in terms of genitalia. For example, the epiphallus, ectaphallic sclerite, and cingulum
Emergence

Maturity

Fig. 17. Graphical representation of qualitative developmental changes in *Schistocerca americana* ovipositor (left: immediately after emergence; middle: two weeks after emergence; right: sexual maturity). External ovipositor does not change, but lateral apodemes grow longer and wider.

remain relatively constant in size, and the proximal portion of endophallus experiences dramatic structural changes.

How widespread is the post-adult emergence genitalic development? Neville (1983) listed the adult insects shown to have daily growth layers in the cuticle, most of which were hemimetabolous. Although he did not specifically study the internal apodemes, he demonstrated that genital development could be found in many hemimetabolous insects. Ridley (1989) documented the time of mating after emergence for the most insect orders. Although there are some exceptions, hemimetabolous insects seem to have longer post-emergence maturation periods compared to holometabolous insects. Most holometabolous insects mate immediately after emergence (Ridley 1989), perhaps because all the necessary development occurs during the pupal stage. To date, however, there is no study that focuses on the post-adult emergence genitalic development in any insect group. This neglected area of study deserves more attention because the post-adult emergence genitalic development may in fact be very widespread.

Taxonomic use of genitalia.—Historically, the male genitalia have been used in insect taxonomy extensively (Eberhard 1985). In Acridoidea, many species have a distinct male genital morpholgy (Hubbell 1932, 1960; Dirsh 1956, 1973; Cohn and Cantrall
Figs. 18–19. Comparison of post-adult emergence developmental patterns between *Schistocerca gregaria* and *Locusta migratoria* (left: immediately after emergence; middle: two weeks after emergence; right: sexual maturity). 18a, *S. gregaria* cingulum. As in *S. americana*, apodemes of cingulum become thicker and wider. 18b, *S. gregaria* endophallus (lateral). As in *S. americana*, arch of cingulum and gonopore process are not present in freshly emerged individual, but they appear in later developmental stages. 19a, *L. migratoria* cingulum. Freshly emerged individuals have more sclerotized phallus than *Schistocerca*, but likewise apodemes of cingulum gradually develop. 19b, *L. migratoria* endophallus (lateral). Basal valves start as a small structure, but ventrally elongates over time. Arch of cingulum is not found in *Locusta*. 
In the North American grasshoppers, *Schistocerca alutacea* (Harris), *S. lineata* Scudder, and *S. rubiginosa* (Harris), male genitalia are the only reliable characters for species differentiation (Hubbell 1960). Despite its significance, however, the variability of the phallic complex within a species is rarely mentioned in the taxonomic literature (Linsley 1939, Shapiro 1978), even though morphological characters generally require a study of large samples. Perhaps, practical issues such as destruction of specimens and laborious preparation prevent taxonomists from examining a large number of specimens.

Developmental aspects need to be considered when using genitalia in taxonomy, especially in Acridoidea. Most taxonomic studies deal with museum specimens in which researchers cannot know the exact age of the specimens. Although there is a method to estimate the age based on the age ring in cuticles (Neville 1963c), it is rarely used. The fact that sexually immature grasshoppers have less developed genitalia than sexually mature ones presents a potential danger in using genitalia in taxonomy. If a species is initially defined using the less developed genitalia, a later taxonomist may interpret the same species to be different based on the fully developed genitalia. In fact, Dirsh (1974: 166) may have defined *Schistocerca braziliensis* based on immature male genitalia. His drawing of the endophallus clearly showed the characteristic of undeveloped arch of cingulum. It is also dangerous to define a species based on the length and width of apodemes because the lateral apodemes of the ovipositor clearly grow during sexual maturation. In Microlepidoptera, Busck (1931) used the length and the sclerotization of apophyses in characterizing families, but there is a possibility that these apodemes can develop after adult emergence (Neville 1983). Though these observations are based on a small number of species, if the phenomenon is widespread, one needs to be cautious about using genitalic characters, because arrested cuticle deposition in museum specimens could be misleading.

ACKNOWLEDGMENTS

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LITERATURE CITED


Finlayson, L. H. 1975. Development and degeneration,


TAXONOMIC NOTES ON NORDLANDIELLA DIAZ AND GANASPIDIUM WELD (HYMENOPTERA: FIGITIDAE: EUCOILINAE)

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Abstract.—Nordlandiella semirufa (Kieffer). n. comb., is described and figured. This represents the second species of Nordlandiella Diaz, and extends the distribution of this genus into Mexico, Arizona, Hawaii, Texas, Nicaragua, Belize, and Chile. Nordlandiella semirufa is reported here as a parasitoid of Melanagromyza sp. (Diptera: Agromyzidae), feeding in flower heads of Bidens spp. (Asteraceae) in Hawaii. The genus Ganaspidium Weld is reviewed; Ganaspidium utilis Beardsley is a new synonym of Ganaspidium nigrimanus (Kieffer). n. comb. Nordlanderia merickei Miller and Nordlanderia navajoe Miller are recognized as nomina dubia. All known species of Ganaspidium and Nordlandiella are parasitoids of Agromyzidae (Diptera).

Key Words: Nordlandiella, Ganaspidium, Melanagromyza, Eucoilinae, Figitidae, Agromyzidae, Cynipoidea

In late 1999, three specimens of an unidentified species of eucoiline were sent to me by the late J.W. Beardsley. I recognized that they belonged to Nordlandiella Diaz, 1982, and I matched these specimens to several specimens on loan from the American Entomological Institute (AEICC), Gainesville, FL and the Cornell University Insect Collection (CUIC), Ithaca, NY. These specimens, however, did not agree with the description of N. abdominalis Diaz, 1982, the only species placed in Nordlandiella. The holotype of Cothonaspis semirufa Kieffer, 1907, agrees precisely with that of the unidentified specimens collected and reared in Hawaii, as well as material from the AEICC and CUIC. Originally C. semirufa was placed in Cothonaspis Hartig, 1840 (Kieffer 1907); Weld (1952) moved this species to Trybliographa Förster, 1869. This species does not possess any of the diagnostic features of either Cothonaspis (Nordlander, 1976) or Trybliographa (Nordlander, 1981), but does possess the diagnostic features of Nordlandiella. Thus, Nordlandiella semirufa (Kieffer), n. comb., is proposed. Since the original description of C. semirufa lacks mention of a number of critical features, a redescription of the species is provided below.

The first Hawaiian specimens of Nordlandiella semirufa were collected by J.W. Beardsley and W.D. Peneira on 20 February 1996 while sweeping miscellaneous weeds and low crops at the University of Hawaii Agricultural Experiment Station farm, Waimanalo, Oahu, HI. The species was recognized by J.W. Beardsley as being a newly established immigrant to Hawaii, since no other eucoelines like it had been recorded from Hawaii previously in extensive surveys (Yoshimoto 1962; Beardsley 1986, 1988, 1989). Additional female specimens were collected by W.D. Peneira during May of 1996. Host associations were made possible by M. Ramadan, Hawaiian Depart-
ment of Agriculture, who, in April of 1996, reared several female *N. semirufa* from the puparia of an unidentified species of *Melanagromyza* Hendel (Diptera: Agromyzidae) feeding in the flower heads of *Bidens pilosa* L. (Asteraceae); these collections were made at Kunia, Oahu, HI. Additional reared material was made available for my examination by M. Trostle, Department of Entomology, Texas A&M University (College Station, TX), who reared several males and females from a species of *Melanagromyza* feeding in the flower heads of *Bidens* sp. collected on Oahu, HI.

This paper includes a review of *Ganaspidium* Weld as a follow up to Beardsley’s (1986) review of the genus. Similarly to *Nordlandiella*, all species of *Ganaspidium* have been recorded as primary parasitoids of Agromyzidae (Beardsley 1986). Current data suggests that *Ganaspidium* and *Nordlandiella* are not closely related (Fontal-Cazalla et al. 2002; Buffington, unpublished data).

Descriptive terminology follows that of Fontal-Cazalla et al. (2002) and Buffington (2002). All newly acquired specimens were either card mounted or point mounted. Examination of specimens was conducted using a Leica MZ8 stereomicroscope illuminated with fluorescent desk lamps. Scanning electron micrographs were made using a Phillips XL-30; a full set of images for *Nordlandiella* and *Ganaspidium* are available at http://www.morphbank.com (Morphbank server operated by Fredrik Ronquist, Uppsala University, Sweden). Digital stereo microscope images were made using a JVC digital camera mounted on a Zeiss SV6 stereoScope; images were optimized using Automontage© 4.0 software.

Specimens were borrowed from the following institutions:

**AEICC:** American Entomological Institute, Gainesville, FL, USA.

**BPBM:** Bernice P. Bishop Museum, Honolulu, HI, USA.

**CASCC:** California Academy of Sciences, San Francisco, CA, USA.

**CUIC:** Cornell University Insect Collection, Ithaca, NY, USA.

**EMEC:** Essig Museum Entomology Collection, University of California, Berkeley, CA, USA.

**MLPA:** Museo de La Plata, La Plata, Argentina.

**UCRC:** University of California, Riverside, Research Collection, Riverside, CA, USA.

**USNM:** National Museum of Natural History, Smithsonian Institution, Washington DC, USA.

*Nordlandiella* Diaz


Diagnosis.—Key features unique to members of this genus concern the morphology of the frons adjacent to the toruli, and the morphology of the scutellar plate: prominent single dorso-ventral groove present adjacent to outer margin of each torulus (Fig. 1, arrow); small to medium sized protuberance (Fig. 2, arrow) present in center of scutellar disk, with mid-pit (Fig. 3, arrow) located posteriorly; broad pits surround protuberance, each containing a single seta (Fig. 3).


*Nordlandiella semirufa* (Kieffer).

new combination

(Figs. 1–4)


*Trybliographa semirufa* Weld 1952: 222.

Lectotype.—For the purposes of nomenclatural stability, one of the three specimens included in Kieffer’s (1907) description is herein designated lectotype, and the remaining two specimens designated paralectotypes. LECTOTYPE. ♀. San Marcos,
Nicaragua. Coll. Baker. CASC #10604; the specimen is in good condition with the locality data label followed by Kieffer's determination label (large red label), repository label and my lectotype label. Two additional specimens, which correspond with two additional collection localities in Kieffer's (1907) description, are hereby designated as paralectotypes: BELIZE: #5640 (1 ♀) (paralectotype); NICARAGUA: San Marcos. Coll. Baker. 5654 (paralectotype); each are labeled ‘paralectotype’.

Diagnosis.—Nordlandiella semirufa has shorter grooves adjacent to the antennal socket (not extending past the midline of eye) than N. abdominalis (extending ven-
trally past midline of eye) and *N. semirufa* possesses an entirely reddish-colored metastoma (all black to chestnut colored in *N. abdominalis*).

Description.—Head: Nearly glabrous with a few scattered setae on anterior facet of mandibles and anterior margin of clypeus. Upper and lower face lacking sculpture, save for a short, deep furrow lateral to each antennal socket. Malar sulcus a single groove. Malar space smooth, lacking any protuberance. Gena smooth and rounded.

Antenna: Female with 13 segments, moniliform, slightly clavate; segments 3–12 subequal in size; segment 13 about 1.5X length of segment 12. Male with 15 segments, segment 3 modified, laterally excavated, curved outwardly.

Pronotum: Pronotal plate narrow, with a few scattered setae present dorsally; dorsally crested, bifurcate; pronotal fovea open. Junction between pronotum and mesoscutum smooth and lacking sculpture. Lateral aspect of pronotum smooth, with a few scattered setae (Fig. 2).

Mesoscutum: Smooth with very few scattered setae; lacking sculpture entirely (Fig. 3).

Mesosceps: Upper part and lower part of mesopleuron smooth and glabrous. Mesopleural triangle an indistinct shallow impression. Mesopleural carina simple; lower part of mesopleuron bordered by a simple precoxal carina.

Scutellum: Scutellar plate small, with mid-pit situated posteriorly; center of plate with a distinct protuberance (Fig. 2, arrow); pits bearing setae present on dorsal surface; posterior margin rounded. Dorsal surface of scutellum reticulate with large, irregular fovea and setae; margined slightly posteriorly and laterally; projections absent.

Metapectal-propodeal complex: Metapectus glabrous with a few scattered setae present posteriorly. Dorsal margin of spiracular groove well defined, ventral margin indistinct. Posterior margin of metapectus with a thin ridge. No other metapectal ridges present (Fig. 2). Anteroventral cavity semi-circular, setose. Propodeum with short, thin setae; propodeal carinae non-parallel, bent at junction with auxiliary propodeal carinae; auxiliary propodeal carinae indistinct. Nucha glabrous, reticulate.

Wings: Hyaline, asetose basally with an increase in setae distally; margin with distinct setal fringe (Fig. 4). R1 vein complete; radial cell always closed.

Legs: Fore- and midcoxae about equal in size; hind coxa slightly larger. All coxae variably covered in setae; mid- and hind coxae with distinct setal patches (Fig. 2). Femora and tibiae sparsely setose; tarsomeres with distinct, appressed setae.

Metasoma: Female: Distinctly larger than mesosoma. Thin hairy ring present at base of syntergum, remainder of metasoma glabrous. Micropunctures present on posterior ¼ of syntergum, and on remaining terga. Terga posterior to syntergum directed posteriorly at about 70° angle (Fig. 4). Male: as in female, but terga posterior to syntergum directed ventrally at a 90° angle.

Material examined:—BELIZE [see types].

Ecuador: Rio Chota, 10.VI.1965, 1,800 m, Luis Peña (1 ♂; AEIC). Mexico: Yautepec, Canyon d Lobos 13.III.1959, 4,000 ft, HE Evans (1 ♂ 1 ♀; CUIC); Yautepec, Canyon d Lobos 7.III.1959, 4,000 ft, HE Evans (1 ♂ 2 ♀; CUIC); Morelos, Tlayacapan, 29.X.1982, screen sweeping, J.T. Huber (1 ♀; UCRC); Chiapas, Puebla Nuevo, 20.III.1958, RC Bechtel, E.I. Schlinger (1 ♀; EMEC). Nicaragua: [see types]. USA: FLORIDA. Paradise Key, 5.IV.1951, H&M Townes (1 ♂; AEIC); Florida City, 27.III.1936 (2 ♂; AEIC); Hawaii: Oahu, Waimanalo at UH Farm, el. 60–80 ft, 20.II.1996, sweeping weeds & crops. JW Beardsley & WD Perreira, (3 ♀; BPBM, 3 ♀; UCRC); Oahu, Waimanalo at UH Farm, el. 60–80 ft, 15–22.V.1996, yellow sticky bord trap. WD Perreira, (2 ♀; BPBM); Oahu, Tantalus Dr., el. 1500', on *Bidenis pilosa* 28.V.1997, WD Perreira, (1 ♀; BPBM); Oahu, Kunia, 8.IV.1999, ex *Melanagromyza* sp. in *Bidenis pilosa* flower heads. M. Ramadan/99-137 (3 ♀; BPBM); Oahu, Honolulu Co., Pali Lookout, 8 mi W
of Jonet Hwy HI and Hwy 61, 25.VI.2001, ex Bidens sp., MK Trostle and SC Ruth (14 ♀; UCRC).

Distribution.—Neotropical and Nearctic regions: Belize, Ecuador, Mexico, Nicaragua, USA (Florida, Hawaii (Oahu) (see above list of localities).

Biology.—I have examined specimens reared from Melanagromyza spp. (Agromyzidae) infesting flower heads of Bidens pilosa L. (J.W. Beardsley and W.D. Perreira, personal communication), and Melanagromyza spp. infesting flower heads of Bidens sp. (M.K. Trostle, personal communication).

Ganaspidium Weld

Ganaspidium Weld 1955: 274. Type species, Ganaspidium pusillae Weld, by original designation.

Diagnosis.—Prominent conical protuberances present on the clypeal and malar space (Fig. 5); notaulices completely lacking (Fig. 6); hairy ring on base of metasoma present and complete. Ganaspidium can be separated from Nordlanderia Quinlan by the latter having well-developed notaulices and lacking a hairy ring at the base of the metasoma.

Discussion.—Weld (1955) proposed this genus to accommodate a new species of eucoile (G. pusillae) reared from leaf mining flies in the Winter Garden area of southern Texas. Beardsley (1986) reviewed the genus, described one new species (G. utilis Beardsley) and wrote a key to Hawaiian species. Preliminary phylogenetic data (Buffington, unpublished data) weakly supports the inclusion of Ganaspidium within the Gronotoma group of genera (sensu Fontal-Cazalla et al. 2002), a basal clade of Eucoilinae that specialize on parasitizing Agromyzidae. Ganaspidium hunteri and G. nigrimanus share a number of synapomorphic features (e.g., a broad, flat scutellar plate with a large central mid-pit; Fig. 6), whereas G. pusilla is highly autopomorph (e.g., possessing a small, narrow scutellar plate with a pair of distinct tubercles on either side of the mid-pit).

Upon comparison of the types for Eucoela nigrimanus Kieffer, 1907, and Ganaspidium utilis Beardsley, 1988, it was clear that these two species are synonymous (synonymy above). Kieffer (1907) most likely placed E. nigrimanus in Eucoila (also spelled Eucoela) due to broadness of that genus concept at the time. Weld (1952) moved E. nigrimanus to Pseudoeucoila Ashmead, which is in itself a junior synonym of Leptopilina Förster (Nordlander 1980). Type specimens for all species examined are in good condition.

Distribution.—Neotropical Region: Chile, Argentina, Panama, Costa Rica. southern Mexico. Nearctic Region: Northern Mexico, continental United States, southern Canada (all three described species). Indo-Pacific Region: Hawaii.


specimen bears the label “Disorygma” in Nordlander’s handwriting.

Notes on the Status of Nearctic Nordlanderia

Miller (1989) described two species of eucoiline wasps that were placed in *Nordlanderia* Quinlan (Quinlan 1986). Though the location of the type specimens for these two nominal species is unknown (Miller, personal communication), it is clear from the scanning electron micrographs that accompany the descriptions that these two species possess many of the diagnostic features of *Ganaspidium* but not all of the diagnostic features of *Nordlanderia* (e.g., both species lack notaulices on the metascutum and possess a complete hairy ring at base of metasoma). Therefore, *N. nava-joe* Miller and *N. merickeli* Miller are regarded as *nomina dubia* until the holotypes can be located and compared to species of *Ganaspidium*.

ACKNOWLEDGMENTS

I thank those individuals who reared specimens of *Nordlandiella semirufa* and made them available for my examination (J.W. Beardsley, W.D. Perreira, M.K. Trostle and R. Wharton). The holotypes for *Ganaspidium pusillae* and *G. hunteri* were kindly loaned to me by Cathy Apgar and Dave Smith, Systematic Entomology Laboratory, USDA (USNM); the holotype for *N. abdominalis* was kindly loaned to me by Juan Schnack for my examination by Juan Schnack of the Museo de La Plata, Argentina; the holotype for *Cothonaspis semirufa* Kieffer was kindly lent for my examination by Keve Ribar do of the California Academy of Sciences. Additionally, I thank Ms. Peggy Beardsley for making available data from the late J.W. Beardsley’s laboratory in Arcadia, CA. I thank the Heraty and Pinto labs at UC Riverside for their support in this project, as well as critical reviews of early drafts of this paper. Finally, I dedicate this paper to the late J.W. Beardsley, with whom I started this project some months prior to his death.

LITERATURE CITED


POLLEN TRANSPORT BY NORTH AMERICAN TRICHODES HERBST
(COLEOPTERA: CLERIDAE)

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Abstract.—Adults of the 11 North American species in the genus Trichodes Herbst (Coleoptera: Cleridae) readily acquire pollen while visiting flowers. On museum specimens, pollen grains are concentrated primarily on the vestiture of the pronotum and legs, although pollen is also found on the pubescence at the base of the elytra, the frons, and the ventral surface. Field observations of Trichodes ornatus (Say) in Colorado indicate that adults often move between flowers, and suggest that individual populations of these clerids may show some fidelity to particular plant species. Trichodes species may be important pollinators of native plant species in North America.

Key Words: Trichodes, Cleridae, Coleoptera, pollen, pollination, pollinator

Beetles in the genus Trichodes Herbst (Coleoptera: Cleridae) are widely known as flower visitors (Corporaal 1950, Foster 1976, Arnett and Jacques 1981). At flowers, these large, colorful clerids feed on pollen, prey on other insects, mate, and oviposit (Foster 1976; Mawdsley, unpublished observations). Although most Trichodes species are densely pubescent, the possibility that these beetles may pollinate flowers has not been previously investigated. Species in the related family Melyridae are known to be important pollinators (Grant and Grant 1965), and may be more efficient and effective than honeybees under favorable circumstances (du Toit 1990).

As a part of my ongoing investigations into the pollination ecology of beetles in the superfamily Cleroidea, I examined pinned adult specimens of North American Trichodes species in the collection of the National Museum of Natural History, Smithsonian Institution (NMNH). It quickly became apparent that almost every specimen in this large collection had pollen grains present in its vestiture. Many of the specimens were densely coated with pollen. Data from these museum specimens, combined with my own field observations on Trichodes ornatus (Say) in 1999, suggest that Trichodes species may be significant pollinators of native plant species in North America.

EXAMINATION OF MUSEUM SPECIMENS

I examined the entire collection of North American Trichodes in NMNH. Almost all of the specimens in this collection (including specimens of all 11 currently-recognized North American species of Trichodes) had at least some pollen grains trapped in the dorsal vestiture. Of the 140 specimens that were labeled as having been collected on particular species or genera of plants, all 140 bore pollen. In Table 1, I provide a list of the flowers on which these pollen-bearing clerids were collected.

Trichodes species are densely pubescent. Most specimens examined had pollen...
Table 1. Pinned specimens of North American *Trichodes* in NMNH were collected on flowers of the following plant species. All of these specimens bore pollen grains. NMNH specimens of *T. bicinctus* Greene, *T. bimaculatus* LeConte, and *T. nexus* Wolcott also bore pollen grains, but these specimens lacked information about associated plant species. Information in parentheses includes state, locality, and number of beetle specimens. Botanical nomenclature follows the online database of the Missouri Botanical Garden (http://mobot.mobot.org/W3T/Search/vast.html).

<table>
<thead>
<tr>
<th>Trichodes apivorus Germar</th>
<th>Cardius sp. (VA: Augusta Co., 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ceanothus</em> sp. (VA: Falls Church, 3; Glencarly, 5)</td>
<td><em>Erigeron</em> sp. (FL: Liberty Co., Rt 270, 5 miles W Rt. 12, 1)</td>
</tr>
<tr>
<td><em>Trichodes</em> bibalticus LeConte</td>
<td><em>Acacia greggii</em> Gray (TX: Midland, 3)</td>
</tr>
<tr>
<td><em>Castilleja sulphurea</em> Rydberg (TX: 5 miles E Gregory, 1)</td>
<td><em>Condalia obutsifolia</em> Hooker (TX: Starr Co., 8)</td>
</tr>
<tr>
<td><em>Coreopsis cardaminefolia</em> (DeCandolle) Nuttall (TX: San Antonio, 1)</td>
<td><em>Hedeoma</em> sp. (TX: Cotulla, 1)</td>
</tr>
<tr>
<td><em>Hyemenocarpus</em> sp. (TX: near Uvalde, 5)</td>
<td><em>Mouradria citriodora</em> (Vahl) Bentham (CA: Maricopa Co., 1)</td>
</tr>
<tr>
<td><em>Hymenocallis</em> sp. (AZ: Douglas, 1)</td>
<td><em>Opuntia</em> sp. (TX: Cotulla, 8)</td>
</tr>
<tr>
<td><em>Prosopis glandulosa</em> Torrey (TX: Scurry Co., Fuller Ranch 1)</td>
<td><em>Prosopis juliflora</em> (Swartz) DeCandolle (TX: Starr Co., 4)</td>
</tr>
<tr>
<td><em>Prosopis sp.</em> (TX: Guthrie Co., Lubbock Co., Lubbock, Couth Ranch, 1)</td>
<td><em>Ratibida columnaris</em> (Pursh) D. Don (TX: Cotulla, 3)</td>
</tr>
<tr>
<td><em>Rudbeckia amplexicaulis</em> Vahl (TX: Denton, 1)</td>
<td><em>Rudbeckia</em> sp. (TX: Dallas, 1)</td>
</tr>
<tr>
<td><em>Verbena encelioides</em> (Cavanilles) Gray (TX: Cotulla, 2)</td>
<td><em>Verbena encelioides</em> (Cavanilles) Bentham and Hooker (AZ: Douglas, 1)</td>
</tr>
</tbody>
</table>

*Trichodes nutalli* Kirby

*Chrysanthemum leucanthemum* L. (NY: Virgil, 1) *Heraclium lanatum* Michaux (CO: Boulder, 1) *Solidago* sp. (WI: Wapaca, 1)

*Trichodes oregonensis* Barr

*Achillea millefolium* L. (OR: Jackson Co., 12 miles NE Ashland, 9; 15 miles NE Ashland, 3; 21 miles NE Ashland, 11)

*Trichodes oresterus* Wolcott

*Condalia obutsifolia* Hooker (TX: Starr Co., 1) *Opuntia* sp. (TX: Uvalde, 1) *Prosopis* sp. (TX: Presidio, 1)

*Trichodes ornatus* (Say)

*Chrysanthemum leucanthemum* L. (ID: Spencer, 1)

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Table 1. Continued.

| Adenostema sp. (CA: West fork of San Gabriel River, 2) |
| Aronia sp. (MT: Missoula, 1) |
| Asclepias sp. (C: Hotchkiss, Rogers Mesa, 1) |
| Brassica nigra (L.) Koch (OR: Talent, 1) |
| *Ceanothus fendleri* Gray (AZ: Flagstaff, Fort Valley, 4) |
| *Ceanothus* sp. (OR: Butte Falls, 10) |
| Eucinodorus urens* (Gray) Parry (AZ: Mohave Co., 2.8 miles E Willow Beach, 1; Kingman Wash, 1; Willow Beach, 2; CA: San Bernardino Co., 1.7 miles W Parker Dam, 4; 11 miles N Earp, 1; NV: Clarke Co., 2.3 miles NW Hoover Dam, 7) |
| Follagia sp. (AZ: Grand View, Grand Canyon, 1) |
| *Hesperis lanata* Michaux (ID: Lakeview, 4) |
| *Iris* sp. (AZ: Flagstaff, 10) |
| Mentzelia involucrata Watson (CA: Riverside Co., Desert Hot Springs, 1) |
| *Opuntia* sp. (AZ: Sabino Canyon, 10) |
| Prunus demissa (Nuttall) Walpers (OR: Talent, 1) |
| *Rosa* sp. (NV: Baker, 1) |
| Rubus sp. (CO: Longview, 1) |
| Sphaeralcea sp. (NV: Mercury, Nevada Test Site, 1) |
| Taraxacum officinale* Weber (WY: Molson, 1) |
| *Trichodes peninsularis* horni Wolcott and Chapin |
| *Chrysanthemum* sp. (AZ: Maricopa Co., Phoenix, Upper Moon Valley, 1) |
| Desmanthus sp. (AZ: Nogales, 1) |
| *Guttierrezia* sp. (AZ: Douglas, 1) |
| *Verbena encelioides* (Cavanilles) Bentham and Hooker (AZ: Douglas, 1) |

*Trichodes simularis* Horn

*Chrysanthemum nauseosus* (Pallas) Britton (UT: Beaver, 1; Iron Co., 3 miles E of Cedar City, 2) *Chrysanthemum* sp. (UT: Ft. Duchesne, 1)

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grains adhering to the dense pronotal hairs and to the shorter hairs on the ventral surface of the tibiae. However, pollen grains also commonly adhered to the vestiture of the frons, the base of the elytra, the venter, and the rest of the legs, and many specimens were uniformly covered with a dense coat of pollen.

**FIELD OBSERVATIONS**

I collected adults of *Trichodes ornatus* from flowers in open woodlands of *Pinus ponderosa* Douglas in Estes Park, Larimer County, Colorado, during the last week of
June, 1999. My first collecting site was described elsewhere (Mawdsley 1999); another study area of comparable size was identified in similar forest on private land in another portion of the Estes Park valley.

Adults at both sites showed a strong preference for flowers of Potentilla diversifolia Lehmann. At the first site, 15 adults of T. ornatus were collected on flowers of P. diversifolia, while 2 adults were found on Rubus parviflorus Nuttall. At the second site, 12 adults of T. ornatus were found on P. diversifolia, while 1 adult was found on R. parviflorus. At both sites, clerids were not found on other seemingly suitable nectar and pollen sources, including flowers of Achillea lanulosa Nuttall, Gaillardia spp., and Potentilla fruticosa L., during the seven days of observation.

Adults of T. ornatus at both sites actively moved about the flowers and were often observed flying between flowers. W. F. Barr (in litt.) also indicated that Trichodes species frequently move about and between flowers while feeding.

**DISCUSSION**

My examinations of museum specimens indicate that North American Trichodes readily acquire pollen grains while visiting flowers. Given the large quantities of pollen observed on some museum specimens, and given that adult Trichodes often move between flowers, it seems likely that these clerids are responsible for at least some pollination of the flowers that they visit.

It also appears that individual populations of these beetles may preferentially visit certain flower species, as suggested by my observations on Trichodes ornatus in the Estes Park valley. Some of the data in Table 1 provide additional support for this hypothesis. There is, for example, an evident association of northern Virginia populations of T. aptivorus with Ceanothus sp.; an association of T. bicalceatus with Con-}

*dalia obtusifolia* and *Prospis juliflora* in Starr Co., Texas, and with *Opuntia* sp. at Cotulla, Texas; an association of *T. oregonomis* with *Achillea millefolium*; an association of *T. ornatus* with *Eucnide urens* in the Mojave Desert and with *Opuntia* sp. in Sabino Canyon, Arizona; and an association of *T. simulator* with *Chrysanthemum nauseosus* in Utah. Fidelity to individual plant species, even if on a local population level, would mean that these clerids are probably more effective pollinators than other, more generalist beetle species.

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**LITERATURE CITED**


SEVEN NEW SPECIES OF POLYPECTROPUS ULMER
(TRICHOPTERA: POLYCENTROPODIDAE) FROM COSTA RICA

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Abstract.—Seven new species of Polyplectropus collected during an inventory of the Trichoptera of Costa Rica are described and illustrated: Polyplectropus clauseni, Polyplectropus exilis, Polyplectropus hymenochilus, Polyplectropus klystos, Polyplectropus paradelphae, Polyplectropus perpendicularis, and Polyplectropus yolandae.

Key Words: Trichoptera, Polyplectropus, Polycentropodidae, Costa Rica, new species, taxonomy, systematics, Neotropics, biodiversity

The genus Polyplectropus Ulmer 1905 is distributed worldwide, with representatives in Africa, the Orient, New Zealand, and tropical America (Morse 2001). The defining adult character for the genus is the absence of R2 (Fork 1) in the hind wings. However, apparent differences in genitalia and larval characters between Old and New World species of Polyplectropus, leave uncertainties regarding the monophyly of Polyplectropus (Flint et al. 1999). The senior author will be addressing this issue in the future.

Notwithstanding, the genus Polyplectropus presently has 138 species (Morse 2001), 93 in the Old World and 45 in the New World, mainly in the Neotropics (Flint et al. 1999). Earlier authors, including Ross (1941, 1947), Denning (1962), and Yamamoto (1966, 1967), described several New World species under the genus Polycentropus Curtis 1835, which were later transferred to Polyplectropus by Flint (1968). Flint further synonymized the genera Ecnomodellina Ulmer 1962 (= Ecnomodes Ulmer 1911) (Flint 1968) and Cordillosycbe Banks 1913 (Flint 1967) with Polyplectropus. Bueno-Soria (1990) described 16 new species and revised the Mexican and Central American Polyplectropus species and found these to be monophyletic.

Earlier and ongoing Trichoptera inventories in Costa Rica, Nicaragua, Venezuela, and Brazil by the authors and their colleagues have yielded numerous additional new Polyplectropus species. Seven of these new species, all from Costa Rica, are described below. Previously, eight species of Polyplectropus were recorded from Costa Rica (Flint et al. 1999).

Types are deposited in the University of Minnesota, Saint Paul, Minnesota (UMSP), the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (NMNH), and the Instituto Nacional de Biodiversidad, Heredia, Costa Rica (INBIO). The terminology used in this paper has been adapted from Hamilton (1986).

Polyplectropus clauseni Chamorro-L. and Holzenthal, new species
(Fig. 1)

Polyplectropus clauseni is a member of the thilus group of Yamamoto (1967) based on its similarities to Polyplectropus deltoides (Yamamoto) 1967, especially the shape
of the intermediate appendage, the dorsolateral and the mesolateral processes of the preanal appendage, and the dorsolateral and ventromesal lobes of the inferior appendage. *Polyplectropus clauseni* can be distinguished from *P. deltoides* by the shape of the ventromesal process of the preanal appendage, which in lateral view appears bipartite, with the dorsal lobe directed dorsally and the ventral lobe directed ventrally, both similar in size and shape and bearing robust, sclerotized spines. It is also distin-

guished by the presence of median ventrolateral spines on the phallus.

Male.—Length of forewing 5.1 mm. Color of body and antennal scape yellowish brown; dorsum of head, pronotum, anterior half of mesothorax, tegula, and forewing base with long, erect brown and white setae; forewing with patches of brown, white, and golden setae, anterior edge bearing only patches of thick brown setae. Genitalia as in Fig. 1. Sternum IX, in lateral view with ventral margin nearly straight, posterior margin dorsally narrow, expanded medially, and becoming notched subventrally, anterior margin sinuate; in ventral view rectangular, posterior margin with median hump flanked by lateral indentations. Ter-
gum X membranous, broad, elongate, bearing dorsal microsetae. Intermediate appendage setose, in lateral view semicircular, expanding posteroventrally into lobe bearing apical setae; in dorsal view elongate, narrow, slightly expanded basomesally. Pre-
anal appendage apparently tripartite; dorsolateral process, heavily sclerotized, elongate, originating from dorsum of meso-
lateral process, directed anteromesally, recurved posterolaterally, tapering mesally to acute apex; mesolateral process setose, in dorsal view digitate, apex rounded and di-
rected laterally, in lateral view circular, apparently expanded into ventromesal process; ventromesal process, in lateral view appearing bipartite, with dorsal lobe directed dorsally and ventral lobe directed ven-
trally, both lobes similar in size and shape and bearing robust, sclerotized spines and pointed apices; in caudal view trapezoidal, with mesoventral corner bearing cluster of robust, sclerotized spines. Ventrolateral margin rounded with additional robust, sclerotized spines along venter. Inferior appendage divided into two lobes; dorsolat-
eral lobe setose, in lateral view oval, broad, with posterodorsal margin rounded, in ven-
tral view with lateral margin rounded, produced into narrow apex, mesal margin nar-
row, expanding into ventromesal lobe; ventromesal lobe short, setose, bearing cluster

of robust, sclerotized spines, in lateral view with ventral margin nearly straight, poste-
rior margin truncate, lobe barely exceeding origin of posterior margin of dorsolateral
lobe, in ventral view triangular, mesal margin straight, with semicircular ventromesal
hump arising from base of inferior appendage. Phallobase short, narrow, with apico-
ventral spines; phallic sclerite cylindrical with apex truncate, apex in dorsal view with median trough.

Female.—Unknown.

Type material.—Holotype, δ: COSTA RICA: Alajuela: Cerro Campana, Río Bochínche, tributary, 6 km (air) NW Dos Ríos, 10.945°N, 85.413°W, el. 600 m, 22–
gados, 11.3 km. ENE Quebrada Grande, 10.865°N, 85.423°W, el. 470 m, 7.iii.1986, Holzenthal & Fasth, 1 δ (NMNH).

Etymology.—Named in honor of Dr. Philip Clausen, Curator, University of Min-
nesota Insect Collection, in recognition of his many years of service in caring for the

collection.

Polypelectropus exilis Chamorro-L. and Holzenthal, new species

(Fig. 2)

Polypelectropus exilis is a member of the charlesi group, as defined by Bueno-Soria
(1990), and appears to be most closely related to Polypelectropus beutelspacheri
Bueno-Soria 1990, based on similarities in the shape of the preanal appendage and in
the overall shape of the inferior appendage. Polypelectropus exilis differs from P. beut-
telspacheri in the posteroventrally extended margin of the inferior appendage when
viewed laterally, in the shorter and narrower ventromesal lobe of the inferior append-
age, which is devoid of robust sclerotized apical spines, in the presence of a long, nar-
row, transparent, posteriorly directed projection originating equidistantly from both lobes of the inferior appendage, and in the mesoventrally expanded sternum IX.

Male.—Length of forewing 5.0–5.9 mm. Color of body yellowish brown, legs with long, yellowish-brown setae on femora and tarsi; dorsum of head, pronotum, and tegula with long, erect brown setae. Apex of head with cluster of whitish, stout setae; forewing covered by brown setae and scattered patches of golden setae. Genitalia as in Fig.
2. Sternum IX, in lateral view with ventral margin straight, expanded posteriorly, posterior margin nearly straight, curving ventrally, ventral margin slightly produced anteriorly; in ventral view, nearly rectangular, posterior margin produced mesoventrally. Tergum X membranous, short. Intermediate appendage digitate, setose, not exceeding tergum X, produced posteromesally in dorsal view. Preanal appendage bipartite; mesolateral process deltoid, setose, produced into mesoventral process with small papillate lobe originating midway between both processes; mesoventral process basally broad, curving posteroventrally into acute apex. Inferior appendage divided into two lobes and medial process; dorsolateral lobe, in lateral view, club-shaped, setose, expanded posteroventrally, in ventral view elongate and narrow; ventromesal lobe setose, short, one third size of dorsolateral lobe, in lateral view narrow, tapering into rounded apex, in ventral view deltoid, directed posterolaterally; medial process arising equidistant from both lobes, lightly sclerotized, tapering into acute apex, directed posteromesally, longer than ventromesal lobe (medial process broken in some paratypes). Phallobase long, apically membranous; phallic sclerite cylindrical, sclerotized, narrowing into rounded apex, constricted subapically; phallic apparatus with approximately six small phallic spines, unclear if embedded in phallic sclerite or endothecal membrane.

Female.—Unknown.

Type material.—Holotype: ♂. COSTA RICA: Cartago: Reserva Tapanti, Quebrada Segunda at administration building, 9.761°N, 83.787°W, el. 1.250 m, 9–10.v.1990, Holzenthal and Blahnik (UMSP) (UMSP000060974). Paratypes: Alajuela: Reserva Forestal San Ramón, Río San Lorcencito and tributaries, 10.216°N, 84.607°W, el. 980 m, 30.iii–1.iv.1987, Holzenthal, Hamilton, Heyn, 2 ♂ (UMSP); Puntarenas: Río Guineal, ca. 1 km (air), E. Finca Helechales, 9.076°N, 83.092°W, el. 840 m, 4.viii.1987, Holzenthal, Morse, Clausen, 3 ♂ (INBIO); same data as previous, 22.ii.1986, Holzenthal, Morse, Fasth, 4 ♂ (NMNH); Puntarenas: Río Cotón in Las Alturas, 8.938°N, 83.826°W, el. 1.360 m, 18.iii.1991, Holzenthal, Muñoz, Huisman, 1 ♂ (UMSP); Puntarenas: Río Singrí, ca. 2 km (air) S. Finca Helechales, 9.057°N, 83.082°W, el. 720 m, 21.ii.1986, Holzenthal, Morse, Fasth, 6 ♂ (UMSP).

Etymology.—Exilis is the Latin word for weak or thin, which describes the lightly sclerotized medial processes arising from both lobes of the inferior appendages of the genitalia.

*Polyplectropus hymenochilus* Chamorro-L., and Holzenthal, new species (Fig. 3)

*Polyplectropus hymenochilus* belongs to the *charlesi* group, based on similarities with *Polyplectropus mignonae* Bueno-Soria 1990, especially the shape of the ventromesal lobe of the inferior appendage and the mesolateral and mesoventral processes of the preanal appendage. However, *P. hymenochilus* can be easily distinguished from *P. mignonae* and other members of this group by the presence of a recurved dorsolateral process on the preanal appendage, by the membranous posteroventral extension of the intermediate appendage, which surrounds the phallus, and by the rod-like dorsolateral lobe of the inferior appendages, bearing a single apical spine.

Male.—Length of forewing 4.5–4.7 mm. Color of body brown, antenna and legs yellowish brown; dorsum of head, pronotum, anterior half of mesothorax, and tegula with long, erect brown and white setae, anterior edge of forewing covered with dark brown setae, remainder of wing covered with golden setae and patches of white setae. Genitalia as in Fig. 3. Sternum IX, in lateral view with ventral margin straight, posterior margin slightly sinuate, anterior margin slightly produced submedially; in ventral view, nearly rectangular with rounded anterolateral margins. Tergum X membranous and bearing microsetae on dorsum, in lat-

eral view elongate, in dorsal view with bilobed apex. Intermediate appendage digitate, setose, expanding posteroventrally into a membranous lip surrounding the phallus. Preanal appendage tripartite; dorsolateral process heavily sclerotized, elongate, originating from dorsum of mesolateral process, directed anteromesally, recurved posterolaterally, tapering mesally to acute apex; mesolateral process setose, thinly sclerotized, in dorsal view digitate, directed posterolaterally, in lateral view subquadrate, broad.
produced into setose ventromesal process; ventromesal process directed posterovertrally, with highly sclerotized apex, pointed in lateral view, truncate in caudal view. Inferior appendage divided into two lobes: dorsolateral lobe setose, in lateral view rod-like, base slightly broader than remainder two thirds, apex narrower and directed ventrally, bearing single highly sclerotized apical spine, apex directed posteromesally; ventromesal lobe short, setose, half the size of dorsolateral lobe, in lateral view rectangular, basally narrow, posterior margin truncate and bearing six highly sclerotized spines (some specimens may have less); ventromesal lobe, in ventral view, quadrate, posterior margin transverse with many visible spines, mesal margin broadening basally and becoming pleated at base. Phallus short, ventrally membranous; phallic setal cylindrical, narrowing to rounded apex, curved ventrally; endothecal membrane with approximately 20 small embedded phallic spines.

Female.—Unknown.

Type material.—Holotype: ♂. COSTA RICA: Guanacaste: Parque Nacional Guanacaste, El Hacha, Quebrada Alcornoque, 11.009°N, 85.577°W, el. 250 m. 26.vii. 1987, Holzenthal, Morse, Clausen (UMSP) (USNM000006976). Paratypes: Same data as holotype, 1 ♀ (INBIO), 1 ♀ (NMNH); Guanacaste: Parque Nacional Guanacaste, El Hacha, Quebrada Pedregal, 10.983°N, 85.539°W, el. 300 m. 27.vii. 1987, Holzenthal, Morse, Clausen, 1 ♂ (UMSP).

Etymology.—*Hymenochilus* comes from the Greek words for membrane “hymeno” and lip or rim “-chilus,” which describes the weak membranous posteroventral extension of the intermediate appendage, which surrounds the phallus.

*Polyplectropus kylistos* Chamorro-L. and Holzenthal, new species

(Fig. 4)

*Polyplectropus kylistos* is closest to *Polyplectropus charlesi* (Ross) 1941 of the *charlesi* group based on similarities in the elongate posteromesal expansion of sternum IX, the overall shape of the ventromesal lobe of the inferior appendage, and the presence of a pair of posterolaterally directed spines embedded in the endothecal membrane of the phallus. *Polyplectropus kylistos* can be distinguished from *P. charlesi* by the semicircular shape and pointed apices of both lobes of the inferior appendage, and by the presence of a membranous projection bearing a single, robust, sclerotized spine between the lobes of the inferior appendage.

Male.—Length of forewing 4.6 mm. Color in alcohol of body, legs and antenna yellowish brown; dorsum of head, pronotum, and tegula with long, erect brown setae. Genitalia as in Fig. 4. Sternum IX with ventral margin nearly straight, produced posteromesally, length of expansion almost half length of inferior appendage; anterior margin in lateral view rounded, posterior margin sinuate, anterior margin in ventral view concave. Tergum X membranous, trapezoidal with dorsal microsetae. Intermediate appendage with digitate, setose posterodorsal lobe expanded mesally and ventrally into membrane; posteromedial lobe with apical setae. Preanal appendage bipartite; mesalateral process setose, in dorsal view digitate, in lateral view nearly circular, produced ventrally into hooked ventromesal process; ventromesal process setose, in lateral view with apex rounded and produced into ventral point, ventral margin straight, in caudal view with apex concave, with lateral and mesal sclerotized points. Inferior appendage divided into two lobes; dorsolateral lobes setose, in lateral view semicircular tapering apically into posterovertrally directed spine, in ventral view produced basolaterally, tapering mesally into apical spine; ventromesal lobe broad, ventral margin rounded, produced into posteromesally directed point, basodorsal margin membranous, bearing a membranous lobe with a robust sclerotized apical spine; mesoventral lobe variable, apex truncate,
sometime bearing a spine on posterodorsal corner, in ventral view triangular, basally broad, with posteromesally directed, pointed apex. Phallus long; phallic sclerite in lateral view cylindrical, narrowing apically and bent dorsally, apex with ventrally directed, highly sclerotized point; phallic sclerite in dorsal view rectangular, apex with posteromedial projection; endothecal membrane with pair of elongate, sclerotized, posterolaterally directed spines originating at base.
Female.—Unknown.

Type material.—Holotype, \( \delta \). COSTA RICA: Guanacaste: Parque Nacional Guanacaste, Estación Pitilla, Río Orosí, 10.991°N, 85.428°W, el. 700 m, 22–25.v.1990, Holzenthal, Blahnik (UMSP) (UMSP000067800). Paratypes: Alajuela: Río Pizote, ca. 5 km (air), S. Brasilia, 10.972°N, 85.345°W, el. 390 m, 12.iii.1986, Holzenthal & Fasth, 1 \( \delta \) (UMSP), 1 \( \sigma \) (NMNH).

Etymology.—Klylistos comes from the Greek word for rolled or turned, which describes the semicircular shape of the inferior appendages.

**Polyleptropus paradelphae Chamorro-L. and Holzenthal, new species**

(Fig. 5)

*Polyleptropus paradelphae* is very similar to *Polyleptropus yolandae* n.sp. in the digitate ventromesal lobe and basally narrow and apically broad dorsolateral lobe of the inferior appendage, in the mesoventrally directed digitate dorsolateral process of the intermediate appendage, and in the general form of the tripartite preanal appendage. *Polyleptropus paradelphae* can be distinguished from *P. yolandae* by the broader ventromesal processes of the preanal appendages, which do not meet mesally. Instead, the mesal margins form an arc. It is also distinguished by the absence of a median lobe on the intermediate appendage, by the sinuate dorsolateral process of the preanal appendages, by the more elongate dorsolateral lobe of the inferior appendage, and by the wider phallus, which has an apically narrow phallic sclerite.

Male.—Length of forewing 5.0 mm. Color in alcohol of body yellowish brown. Genitalia as in Fig. 5. Sternum IX, in lateral view deltoid, ventral margin nearly straight, posterior margin sinuate. Tergum X membranous with microsetae on dorsum, in dorsal view trapezoidal. Intermediate appendage digitate, setose, directed mesoventrally. Preanal appendage tripartite; dorsolateral process heavily sclerotized, elongate, sinuate, directed anteromesally, recurved posterolaterally, curving ventrally, finally straightening posteriorly and tapering into acute apex; mesolateral process setose, in dorsal view digitate, directed posteromesally, in lateral view nearly triangular, broad basally, produced into setose ventromesal process; ventromesal process, in lateral view broad, ending in pointed anteroven-trally directed apex, in caudal view digitate, directed ventrally, mesal margin forming an arc. Inferior appendage divided into two lobes: dorsolateral lobe setose, elongate, narrow basally, broadening apically, posterior margin rounded, in ventral view with anterodorsal margin bent mesally, exposing internal margin, medial setose lobe originating from inferior mesal margin; ventromesal lobe setose, narrow, digitate, less than one third size of dorsolateral lobe, with robust, sclerotized spines present on basomesal margin; base of inferior appendage elongate, narrow, produced anteriorly. Phalus membranous, stout; phallic sclerite curved ventrally, narrowing apically, membrane present dorsally.

Female.—Unknown.

Type material.—Holotype: \( \delta \). COSTA RICA: Limón: Reserva Biológica Hitoy Cerere, Río Cerere, 9.671°N, 83.028°W, el. 90 m, 23–24.iii.1987, Holzenthal, Hamilton, Heyn, 1 \( \delta \) (UMSP).

Etymology.—Paradelphae comes from the Greek words for beside “para-” and sister “-adelpe.” This species was concealed among the specimens of *Polyleptropus yolandae*, until it was discovered by the senior author after closer examination.

**Polyleptropus perpendiculatus Chamorro-L. and Holzenthal, new species**

(Fig. 6)

*Polyleptropus perpendiculatus* belongs to the *charlesi* group with similarities to *Polyleptropus mignonae* Bueno-Soria 1990, especially the long and digitate intermediate appendage, the absence of dorsolateral process, the overall shape and round-
ed mesolateral process of the ventromesal process of the preanal appendage, and the elliptical ventromesal lobe of the inferior appendage, which bears many robust, sclerotized spines on its apex. *Polyplectropus perpendicuarius* can be distinguished from *P. mignonae* by the shape of the dorsolateral lobe of the inferior appendage, which is narrow, dorsoventrally elongate, perpendicularly produced posterad, and has a truncate apex.

Male.—Length of forewing 5.8 mm. Col-

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Fig. 5. *Polyplectropus paradelphae*, male genitalia. A. Lateral view. B. Ventral view. C. Dorsal view. D. Caudal view preanal and intermediate appendages. E. Phallus.
or of body dark brown, legs and antenna yellowish brown; dorsum of head, pronotum, tegula, and forewing base with long, erect brown setae and a few white setae; forewing with golden-brown setae, and longitudinal w-shaped patch devoid of setae in the region of the anal veins. Genitalia as in Fig. 6. Sternum IX, in lateral view, deltoid, posterior margin sinuate, anterior margin produced submedially, ventral margin near-
ly straight; sternum in ventral view ovoid, lateral margin rounded, anterior margin concave, postero-lateral corners produced posterad, posterior margin semicircular. Tergum X membranous, short, in dorsal view subquadrate. Intermediate appendage digitate, elongate, broad basally, narrow medially, truncate apex each bearing two setae, as long as or longer than inferior appendage. Preanal appendage bipartite; mesolateral process setose, in lateral view circular, slightly expanded posterad, in dorsal view nearly oval, slightly expanded laterally, produced ventrally into ventromesal process; ventromesal process setose, in lateral view rectangular, with posterior margin truncate, expanded ventrally into sclerotized point, ventral margin nearly straight; ventromesal process, in caudal view triangular, with dorsal setose lobes, lateral and mesal margins nearly straight, meeting posteriorly in a sclerotized point. Inferior appendage divided into two lobes; dorsolateral lobe setose, in lateral view elongate dorsoventrally, perpendicularly bent posteriorly, width continuous throughout length, apex truncate and bearing two robust, sclerotized spines, originating on corner, sometimes subapically; dorsolateral lobe in ventral view flattened, expanded laterally, mesal margin concave, subapically curved mesoventrally; ventromesal lobe setose, in lateral view elliptical, with elongate medial flange, apex rounded and bearing dorsal cluster of robust, sclerotized spines, in ventral view rectangular, lateral margin concave, posterior margin transverse, with robust, sclerotized spines, six visible in ventral view, nine in caudal view, mesal margin nearly straight, broadening basally. Phal1us long, largely membranous, narrowing apically; phallic sclerite cylindrical, apex nearly truncate.

Female.—Unknown.

Type material.—Holotype, ♂. COSTA RICA: Puntarenas: Tributary to Río Bella-vista in Las Alturas (road to quarry) 8.952°N, 82.848°W, cl. 1480 m, 19.iii. 1991, Holzenthal, Muñoz, Huisman (UMSP) (UMSP00060984).

Etymology.—Perpendicularis comes from the Latin word for upright or at right angles, which describes the dorsolateral lobe of the inferior appendage, which is narrow, dorsoventrally elongate and perpendicularly produced.

Polypelectropus yolandae Chamorro-L. and Holzenthal, new species

(Fig. 7)

Polypelectropus yolandae belongs to the thilus group based on similarities with Polypelectropus carolae Bueno-Soria 1990 and Polypelectropus denticulus Bueno-Soria 1990, especially the broad dorsal lobe and reduced, narrow ventromesal lobe of the inferior appendage. These species are also similar in the presence of the highly sclerotized, recurved dorsolateral process of the preanal appendage and in the overall shape of the preanal appendage and phallus. Polypelectropus yolandae can be distinguished from P. carolae and P. denticulus, and other members of the thilus group by the mesoventrally directed, digitate lobe of the intermediate appendage, by the more prolonged and rounded posterior margin of the dorsolateral lobe of the inferior appendage, and by the row of robust, sclerotized spines along the dorsal margin of the ventromesal lobe of the inferior appendage.

Male.—Length of forewing 4.8–5.0 mm. Color of body and antenna yellowish brown, legs with brown setae; dorsum of head, pronotum, anterior half of mesothorax, and tegula with long, erect brown, white, and golden setae; forewing with patches of brown, white, and golden setae, anterior edge bearing only brown setae. Genitalia as in Fig. 7. Sternum IX. In lateral view deltoid, produced anteroventrally, posterior and ventral margins straight; in ventral view nearly rectangular, posterior margin nearly straight, narrowing laterally, anteroventral corners rounded. Tergum X membranous, broad and elongate with microsetae on dorsum. Intermediate append-
age bipartite; dorsolateral process digitate, setose, directed mesoventrally, produced into a small median lobe flanking the phal-
lus laterally and bearing apical setae. Preanal appendage tripartite; dorsolateral process heavily sclerotized, elongate, orig-
inating from dorsum of mesolateral process, directed anteromesally, recurved posterolat-
erally, tapering mesally to acute apex; me-
isolateral process setose, in dorsal view digitate, directed posteromesally, in lateral view oval, broad basally, produced into se-
tose ventromesal process; ventromesal process, in lateral view, broad basally, tightly bent ventrally, narrowing medially, slightly broadening subapically, finally tapering to pointed apex; ventromesal process, in caudal view digitate, directed mesally, apex weakly recurved laterally. Inferior appendage divided into two lobes; dorsolateral lobe setose, basally narrow broadening apically, posterior margin rounded and slightly produced (in some specimens margin evenly rounded); ventromesal lobe setose, narrow, digitate, less than half length of dorsolateral lobe with robust, highly sclerotized spines present on entire length of dorsal margin; base of inferior appendage elongate, narrow, produced anteriorly. Phallos short, weakly sclerotized; phallic sclerite robust, cylindrical, narrow subapically, broadening apically, apex truncate.

Female.—Unknown.

Type material.—Holotype: ♂. COSTA RICA: Guanacaste: Parque Nacional Guanacaste, Estación Maritza, Río Tempisquito, 10.958°N, 85.497°W, el. 550 m, 30–31.viii.1990, Huisman, Blahnik, Quesada (UMSP) (UMSP000060980). Paratypes: Same data as holotype, 8 ♂ (UMSP); same data as holotype, 19–20.vii.1987, el. 1.550 m, Holzenthal, Morse, Clausen, 2 ♂ (NMNH); Guanacaste: P.N. Guanacaste, Estación Pitilla, Río Orosí, 10.991°N, 85.428°W, el. 700 m, 22–25.v.1990, Holzenthal & Blahnik, 1 ♂ (UMSP); Guanacaste: P.N. Guanacaste, Maritza, Río Tempisquito Sur, 10.95°N, 85.48°W, el. 600 m, 30.viii.1990, Huisman & Quesada, 3 ♂ (IN-BIO); Guanacaste: P.N. Guanacaste, ca. 0.7 km N. Estación Maritza, 10.96°N, 85.50°W, el. 550 m, 30.viii.1990, Huisman & Quesada, 1 ♂ (UMSP); Alajuela: Reserva Forestal San Ramón, Río San Lorenzito and tributaries, 10.216°N, 84.606°W, el. 980 m, 6–10.iii.1991, Holzenthal, Muñoz, Huisman, 2 ♂ (UMSP); Alajuela: P.N. Rincón de la Vieja, Quebrada Provisión, 10.769°N, 85.281°W, el. 810 m, 4.iii.1986, Holzenthal & Fasth, 1 ♂ (UMSP); Heredia: Rara Avis Biological Station, Quebrada Chiquiza, 10.229°N, 84.032°W, 31.iii.1989, el. 550 m, Blahnik & Solis, 1 ♂ (UMSP).

Etymology.—Named in honor of Jolanda Huismann for her contributions to the study of Trichoptera and for her collaboration in the Costa Rican inventory.

Acknowledgments

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Literature Cited


THE MOTHS (LEPIDOPTERA) AND ASSOCIATED FLORA OF KELLEYS ISLAND, LAKE ERIE

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Abstract.—We surveyed the nocturnal Lepidoptera of Kelleys Island (Ohio, Erie County) within Lake Erie from 1999–2001, and found 216 species from 20 families. A logarithmic growth curve applied to our data suggests that the number of species obtained represents 65% of the number that would theoretically be captured after ten years of effort. We also list the 212 plant species found on the island to aid future efforts of moth/host plant associations.

Key Words: moths, Lepidoptera, vegetation, survey, Ohio

With more than 11,250 species recorded for North America (Hodges et al. 1988), moths (Insecta: Lepidoptera) provide an abundant food source as adults, larvae, and pupae to other trophic levels (i.e., predators and parasites), and constitute a significant proportion of terrestrial herbivores (Price 1997). The Ohio moth fauna has received a good deal of attention during the past two decades. Regional species lists have been compiled that give excellent data on the adult distribution and flight periods (e.g., Rings et al. 1987, Rings and Metzler 1989, Summerville et al. 1999, Teraguchi and Lublin 1999a–f, Rings and Downer 2001).

Kelleys Island is one of the Lake Erie islands situated off the north coast of Ohio. A portion of the island owned by The Cleveland Museum of Natural History is known as the North Coleman Tract, and has been designated a conservation area. However, other areas of the island are under development. We began a survey of the moths of Kelleys Island in an attempt to obtain data on this species-rich group before further environmental deterioration from human activities occurs. The only moth species list was prepared by Nault et al. (1989), when they captured 11 species from three families during sweep netting. Use of light traps is a commonly used and effective technique for collecting nocturnal Lepidoptera, but transient species might be captured that do not breed in the trap area. Light trapping terrestrial insects on an island provides a more accurate look at the number of species per unit area and habitat use, as it is reasonable to assume that all specimens captured originated from the island.

We present the results of three years of light trapping for adult moths on the North Coleman Tract. Because of the strong tie between plants, moth oviposition, and larval development, we also give a listing of the vascular plants found on the island to aid future efforts of moth/host plant associations.

MATERIALS AND METHODS

Kelleys Island (OH, Erie County) is a 4.8 x 6.4 km island, positioned approximately 5 km north of the mainland city of Marblehead (Ottawa County). Moths were collected with a BioQuip® 15-watt black light trap
Table 1. Moth taxa obtained in light trap from Kelleys Island, including Hodges’ number, the months collected, and the proportion of the total catch each species represented. A plus (+) indicates that the species listed most closely approximates the actual specimen taken.

<table>
<thead>
<tr>
<th>Hodges #</th>
<th>Taxa</th>
<th>Month(s) Collected</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>372</td>
<td><strong>TINEIDAE</strong></td>
<td></td>
<td></td>
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<tr>
<td>372</td>
<td><em>Acrolophiis plumifrontella</em> (Clemens 1859)</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>373</td>
<td><em>Acrolophius popeanella</em> (Clemens 1859)</td>
<td>July–August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>1014 +</td>
<td><em>Antaeotricha leucillana</em> (Zeller 1854)</td>
<td>May–August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>1046</td>
<td><em>Callimia argenticinctella</em> Clemens 1860</td>
<td>June–August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>1387</td>
<td><em>Coleophora spissicornis</em> (Haworth 1828)</td>
<td>June–July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>1615</td>
<td><em>Walshia</em> sp.</td>
<td>June, August</td>
<td>0.03</td>
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<tr>
<td>2289</td>
<td><strong>GELECHIIDAE</strong></td>
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</tr>
<tr>
<td>2295</td>
<td><em>Trichotaphe alacella</em> Clemens 1862</td>
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<td>&lt;0.01</td>
</tr>
<tr>
<td>2295</td>
<td><em>Trichotaphe flavocostella</em> Clemens 1860</td>
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<td>2366</td>
<td><strong>PLUTELLIDAE</strong></td>
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<td><em>Plutella xylostella</em> (Linnaeus 1758)</td>
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<td>2927</td>
<td><em>Phaneta ochrocephala</em> (Walsingham 1895)</td>
<td>August</td>
<td>&lt;0.01</td>
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<tr>
<td>2937</td>
<td><em>Phaneta parrutana</em> (Clemens 1860)</td>
<td>August</td>
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<td>3116</td>
<td><em>Eucosma dorisignatana</em> (Clemens 1860)</td>
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<tr>
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<td><em>Eucosma derelecta</em> Heinrich 1929</td>
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<td>3202</td>
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<tr>
<td>3404</td>
<td><em>Dichroranpha simulana</em> (Clemens 1860)</td>
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<td>&lt;0.01</td>
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<tr>
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<td><em>Cyda pomonella</em> (Linnaeus 1758)</td>
<td>June–August</td>
<td>&lt;0.01</td>
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<tr>
<td>3507</td>
<td><em>Argyrotaenia velutinana</em> (Walker 1863)</td>
<td>August</td>
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<tr>
<td>3635</td>
<td><em>Choristoneura rosacea</em> (Harris 1841)</td>
<td>June, August</td>
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<tr>
<td>3684</td>
<td><em>Clepsis clemensiana</em> (Fernald 1879)</td>
<td>June</td>
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<tr>
<td>3693</td>
<td><em>Xenotema pallorace</em> (Robinson 1869)</td>
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<td>&lt;0.01</td>
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<td><em>Sparganothis pulcherrimana</em> (Walsingham 1879)</td>
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<td>&lt;0.01</td>
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<td><em>Platynota flavellana</em> Clemens 1860</td>
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<td><em>Harrisina americana</em> (Guerin 1824)</td>
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<tr>
<td>4661</td>
<td><em>Packardia elegans</em> (Packard 1864)</td>
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<tr>
<td>4665</td>
<td><em>Lithacodes fasciola</em> (Herrich-Schaffer 1865)</td>
<td>June</td>
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<td><em>Euclea delphinii</em> (Boisduval 1832)</td>
<td>June</td>
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<td>4743</td>
<td><strong>CRAMBIDAE</strong></td>
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<tr>
<td>4743</td>
<td><em>Neocataclysta magnificalis</em> (Hubner 1796)</td>
<td>July</td>
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<td><em>Synclita obliteralis</em> (Walker 1859)</td>
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<td>4895</td>
<td><em>Chalcoela iphitalis</em> (Walker 1859)</td>
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<td>&lt;0.01</td>
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<tr>
<td>4944</td>
<td><em>Crocidophora serrassinalis</em> Zeller 1872</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>4949</td>
<td><em>Ostrinia nubilalis</em> (Hubner 1796)</td>
<td>June</td>
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<tr>
<td>5071</td>
<td><em>Pyrausta acrionalis</em> (Walker 1859)</td>
<td>July–August</td>
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<tr>
<td>5079</td>
<td><em>Udea rubigalis</em> (Guenee 1854)</td>
<td>April–September</td>
<td>0.02</td>
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<tr>
<td>5142</td>
<td>*<em>Dicranocleis lecalis</em> (Walker 1859)</td>
<td>July</td>
<td>&lt;0.01</td>
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</tbody>
</table>
Table 1. Continued.

<table>
<thead>
<tr>
<th>Hodges #</th>
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<th>Month(s) Collected</th>
<th>Proportion</th>
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<tr>
<td>5156</td>
<td>Nomophila nearctica Munroe 1973</td>
<td>June–September</td>
<td>&lt;0.01</td>
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<tr>
<td>5159</td>
<td>Desmia funeralis (Hubner 1796)</td>
<td>June, August</td>
<td>&lt;0.01</td>
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<tr>
<td>5226</td>
<td>Polpita magniferalis (Walker 1861)</td>
<td>May</td>
<td>&lt;0.01</td>
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<tr>
<td>5280</td>
<td>Herpetogramma aeglealis (Walker 1859)</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5357</td>
<td>Crambus leachelius (Zincken 1818)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5361</td>
<td>Crambus albuelus Clemens 1860</td>
<td>June</td>
<td>0.01</td>
</tr>
<tr>
<td>5362</td>
<td>Crambus agitateur Clemens 1860</td>
<td>June–August</td>
<td>0.12</td>
</tr>
<tr>
<td>5378</td>
<td>Crambus laqueatellus Clemens 1860</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5379</td>
<td>Crambus hteolellus Clemens 1860</td>
<td>July</td>
<td>0.03</td>
</tr>
<tr>
<td>5403</td>
<td>Agriphila vulgigavella (Clemens 1860)</td>
<td>August–September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5413</td>
<td>Pediastris trisepta (Walker 1856)</td>
<td>July–September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5420</td>
<td>Microcrambus elegans (Clemens 1860)</td>
<td>July–August</td>
<td>0.06</td>
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<tr>
<td>5435</td>
<td>Fissicrambus mutabilis (Clemens 1860)</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5464</td>
<td>Urola nivalis (Drury 1773)</td>
<td>June–July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5492</td>
<td>Eoreuma densella (Zeller 1881)</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>5524</td>
<td>Hypsopygia costalis (Fabricius 1775)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

**PYRALIDAE**

| 5566     | Arta sitatalis (Grote 1875) | July | <0.01 |
| 5579     | Epipaschia zelleri (Gorte 1876) | June | <0.01 |
| 5799     | Nepheipteryx hastalis Zeller 1872 | August | <0.01 |
| 5804     | Nepheipteryx rubrisparsella (Ragonot 1887) | June, August | <0.01 |
| 5944     | Homocosa decepitormium Heinrich 1956 | July | <0.01 |
| 5946     | Phycitodes albatella (Ragonot 1887) | June | <0.01 |
| 6005     | Moodna ostrinella (Clemens 1860) | August | <0.01 |

**PTEROPHORIDAE**

| 6204     | Oidaematophorum elliottii (Fernald 1893) | June | <0.01 |

**THYATIRIDAE**

| 6235     | Habrosyne scripta (Gossbeck 1840) | July | <0.01 |

**GEOMETRIDAE**

<p>| 6270     | Proditame virginalis (Hulst 1900) | June | &lt;0.01 |
| 6322     | Melilla xanthometata (Walker 1862) | August | &lt;0.01 |
| 6353     | Semiothisa multlineata (Packard 1873) | July | &lt;0.01 |
| 6362     | Semiothisa continuata (Walker 1862) | July | &lt;0.01 |
| 6419     | Enconista dislocaria (Packard 1876) | May–July | &lt;0.01 |
| 6590     | Anavitrina palmtina (Guenee 1857) | August | &lt;0.01 |
| 6640     | Biston betularia (Linneae 1758) | August | &lt;0.01 |
| 6654     | Hypagyris unipunctata (Haworth 1809) | June | &lt;0.01 |
| 6667     | Lomographa vestitata (Guenee 1857) | June | &lt;0.01 |
| 6720     | Lyrosis imitaria (Herrich-Schaffer 1854) | June | &lt;0.01 |
| 6724     | Euchaena serratata (Drury 1770) | June | &lt;0.01 |
| 6725     | Euchaena nuzaria (Walker 1860) | June | &lt;0.01 |
| 6726     | Euchaena obtusaria (Hubner 1807–13) | August | &lt;0.01 |
| 6729     | Euchaena johnsonaria (Fitch 1869) | June, August | &lt;0.01 |
| 6740     | Xanthotype sp. | August | &lt;0.01 |
| 6753     | Pero sp. | May–August | &lt;0.01 |
| 6822     | Metarranthus duaria (Guenee 1857) | June | &lt;0.01 |
| 6826     | Metarranthus hypocharla (Herrich-Schaffer 1854) | May–June | &lt;0.01 |
| 6941     | Eusarca confusaria Hubner 1813 | May–September | 0.03 |
| 6964     | Tectacis cachexiata Guenee 1857 | June | &lt;0.01 |
| 6982     | Procoerodes transversata (Drury 1770) | September | &lt;0.01 |
| 6987     | Antepion thesorialia (Guenee 1857) | May | &lt;0.01 |
| 7009     | Nematocampa limbatia (Haworth 1807) | June | &lt;0.01 |
| 7053     | Dichorda iridaria (Guenee 1857) | May–June | &lt;0.01 |</p>
<table>
<thead>
<tr>
<th>Hodges #</th>
<th>Taxa</th>
<th>Month(s) Collected</th>
<th>Proportion</th>
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</thead>
<tbody>
<tr>
<td>7132</td>
<td>Pleuroprucha insulsaria (Guenee 1857)</td>
<td>June, August</td>
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<tr>
<td>7146</td>
<td>Haematopus grataria (Fabricius 1798)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>7159</td>
<td>Scopula limboundata (Haworth 1809)</td>
<td>June, August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>7169</td>
<td>Scopula inductata (Guenee 1857)</td>
<td>June–July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>7196</td>
<td>Eulithis sp.</td>
<td>June, July, September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>7414</td>
<td>Orthomana obtipulata (Fabricius 1794)</td>
<td>April, June, July, September</td>
<td><strong>0.02</strong></td>
</tr>
<tr>
<td>7416</td>
<td>Orthomana centrostrigaria (Wollaston 1858)</td>
<td>June–August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>7445</td>
<td>Horisme intestinata (Guenee 1857)</td>
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<td><strong>LASIOCAMPIDAE</strong></td>
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<td>Tolype velleda (Stoll 1791)</td>
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<td>Darapsa myron (Cramer 1780)</td>
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<td><strong>NOTODONTIDAE</strong></td>
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<tr>
<td>7901</td>
<td>Clostera apicalis (Walker 1855)</td>
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<td>7902</td>
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<td>Datana sp.</td>
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<td>7906</td>
<td>Datana contracta Walker 1855</td>
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<td>&lt;0.01</td>
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<td>7907</td>
<td>Datana integrerrima Grote and Robinson 1860</td>
<td>July</td>
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<tr>
<td>7908</td>
<td>Datana perspicua Grote and Robinson 1865</td>
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<td>Peridea angulosa (Smith 1797)</td>
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<td>7929</td>
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<td>Eulidea canapiegia (Walker 1856)</td>
<td>April, August</td>
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<td>7931</td>
<td>Gephystia septentrionis Walker 1855</td>
<td>August</td>
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<td>7985</td>
<td>Heterocampa subrotata Harvey 1874</td>
<td>June–July</td>
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<td>7994</td>
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<td>7995</td>
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<td>May–June</td>
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<tr>
<td>7999</td>
<td>Lochnaetes bilineata (Packard 1864)</td>
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<tr>
<td>8007</td>
<td>Schizura unicornis (Smith 1797)</td>
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<td>&lt;0.01</td>
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<td><strong>ARCTIIDAE</strong></td>
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<tr>
<td>8045.1</td>
<td>Crambidia pallida Packard 1864</td>
<td>August</td>
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</tr>
<tr>
<td>8089</td>
<td>Hypoprepia minuta (Kirby 1837)</td>
<td>June, August</td>
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</tr>
<tr>
<td>8121</td>
<td>Holomelina arnaniaca (Hubner 1827–31)</td>
<td>August</td>
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</tr>
<tr>
<td>8129</td>
<td>Pyrrharctia isabella (Smith 1797)</td>
<td>June, August</td>
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<tr>
<td>8133</td>
<td>Spilosoma latipennis Stretch 1872</td>
<td>May–June</td>
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</tr>
<tr>
<td>8137</td>
<td>Spilosoma virginica (Fabricius 1798)</td>
<td>June–August</td>
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<tr>
<td>8140</td>
<td>Hyphantria cunea (Drury 1773)</td>
<td>June</td>
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<tr>
<td>8146</td>
<td>Expantheria scribonia (Stoll 1790)</td>
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</tr>
<tr>
<td>8169</td>
<td>Apantesis sp.</td>
<td>June, August</td>
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<tr>
<td>8203</td>
<td>Halysidota tessella Smith 1797</td>
<td>June–July</td>
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</tr>
<tr>
<td>8203</td>
<td>Halysidota sp.</td>
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<tr>
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<td>Lophiocampa caryae Harris 1841</td>
<td>May–June</td>
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<tr>
<td>8230</td>
<td>Cydia tenera Hubner 1818</td>
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<tr>
<td>8231</td>
<td>Cydia orthogonia (Stretch 1873)</td>
<td>June</td>
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<tr>
<td>8238</td>
<td>Euchaetes egle (Drury 1773)</td>
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<tr>
<td>8262</td>
<td>Crenucha virginica (Esper 1794)</td>
<td>June</td>
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<tr>
<td>8267</td>
<td>Cisseps fulvicollis (Hubner 1818)</td>
<td>June</td>
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Table 1. Continued.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Months Collected</th>
<th>Proportion</th>
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<tbody>
<tr>
<td><strong>LYMANTRIIDAE</strong></td>
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<td></td>
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<tr>
<td>8316 Orgyia leucostigma (Smith 1797)</td>
<td>July</td>
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<tr>
<td>8318 Lymantria dispar (Linnaeus 1758)</td>
<td>July-August</td>
<td>&lt;0.01</td>
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<tr>
<td><strong>NOCTUIDAE</strong></td>
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<td></td>
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<tr>
<td>8322 Idia americalis (Guenee 1854)</td>
<td>June</td>
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</tr>
<tr>
<td>8323 Idia aemula Hubner 1813</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8334 Idia lubricalis (Geyer 1832)</td>
<td>July-August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8347 Zanclognatha obscuripennis (Grote 1872)</td>
<td>August</td>
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</tr>
<tr>
<td>8348 Zanclognatha pedipilalis (Guenee 1854)</td>
<td>May-June</td>
<td>&lt;0.01</td>
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<tr>
<td>8355 Chiatolita morbidalis (Guenee 1854)</td>
<td>June</td>
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<tr>
<td>8360 Macrophilo oreiferalis Walker 1859</td>
<td>June, August</td>
<td>&lt;0.01</td>
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<tr>
<td>8362 Phalaenostola metonialis (Walker 1859)</td>
<td>June, August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8363 Phalaenostola eumelasialis (Walker 1859)</td>
<td>June, September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8364 Phalaenostola larentioides Grote 1873</td>
<td>June-August</td>
<td>&lt;0.01</td>
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<tr>
<td>8368 Tetanolita floridana (Smith 1895)</td>
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<tr>
<td>8370 Blepita caradrinalis Guenee 1854</td>
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<tr>
<td>8386 Renia adspergilis (Bosc 1800)</td>
<td>June</td>
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</tr>
<tr>
<td>8393 Lascoria ambiguusalis Walker 1866</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8397 Pathis angulalis (Hubner 1796)</td>
<td>June-July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8398 Pathis asopialis (Guenee 1854)</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8465 Plathypena scabra (Fabricius 1798)</td>
<td>August-September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8479 Spargaloma sexpunctata Grote 1873</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8499 Metalectra discalis (Grote 1876)</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8534 Plustidonta compressipalpis Guenee 1852</td>
<td>May-June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8692 Zale galbanata (Morrison 1876)</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8873 + Caenurgina sp.</td>
<td>May-September</td>
<td>0.02</td>
</tr>
<tr>
<td>8769 Spiloloma lunilinea Guenee 1873</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8874 Catocola minuta Edwards 1864</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8898 Allagraphe aerea (Hubner 1802-03)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8907 Megalographa biloba (Stephens 1830)</td>
<td>April</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8908 Autographa precationis (Guenee 1852)</td>
<td>July-August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8924 Anagraphe falcifera (Kirby 1837)</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>8973 Baileya australis (Grote 1881)</td>
<td>May, July, August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9047 Lithacodia muscosa (Guenee 1852)</td>
<td>June-July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9053 Pseudostrotia carnea (Guenee 1852)</td>
<td>May, June, August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9055.1 Malaittha synochitis (Grote and Robinson 1868)</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9057 Homoplobotheria apicosa (Haworth 1809)</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9065 Leuconyxia diptheroides (Guenee 1852)</td>
<td>June</td>
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</tr>
<tr>
<td>9095 Tarachidia erastrioides (Guenee 1852)</td>
<td>June, August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9127 Spraguea leo (Guenee 1852)</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9199 Acrmonia rubricoma Guenee 1852</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9332 Apaneus vulgaris (Grote and Robinson 1866)</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9367 Apaneus dubitans (Walker 1856)</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9402 Oligia chlorostigma (Harvey 1876)</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9457 + Amphipoea americana (Speyer 1875)</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9473 Papaipema impeckowsa (Grote 1881)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9484 Papaipema baptisae (Bird 1902)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9626 Trachea delicata (Grote 1874)</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9639 Amphipyra tragopoginis (Clerck 1759)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9647 Athetis miranda (Grote 1873)</td>
<td>May, July, September</td>
<td>&lt;0.01</td>
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<tr>
<td>9650 Anorthodes tarda (Guenee 1852)</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9663 Balsa tristrigella (Walker 1866)</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9666 Spodoptera fragiperda (Smith 1797)</td>
<td>August-September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9688 Galgula partita Guenee 1852</td>
<td>April, June, July</td>
<td>0.02</td>
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</tbody>
</table>
on the North Coleman Tract from 1999–2001; the North Coleman Tract is positioned slightly west of the center of the island. The trap was placed on the edge of a glacial groove that forms a small escarpment approximately 1 m above the valley floor (Fig. 1). The black light was turned on in the late afternoon before dusk, and specimens were recovered the next morning. The immediate area around the trap was cleared to remove woody vegetation during early summer 1999 to provide a prairie remnant, leaving a forested environment surrounding the trap location.

The list of moths we obtained is indexed according to family and Hodges’ number (Hodges et al. 1988). Specimens of questionable identification were given a Hodges’ number for the species most closely approximating the specimen, and are identified on the list with a “plus” symbol (+) next to the Hodges’ number. Although a more recent classification is available (Poole 1996), we used Hodges et al. (1988)

<table>
<thead>
<tr>
<th>Hodges #</th>
<th>Taxa</th>
<th>Month(s) Collected</th>
<th>Proportion</th>
</tr>
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<tbody>
<tr>
<td>9720</td>
<td>Odeoconia cinereola (Guenee 1852)</td>
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</tr>
<tr>
<td>9893</td>
<td>Lithophane hemina Grote 1874</td>
<td>April</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>9957</td>
<td>Samira bicolorata (Guenee 1852)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10021</td>
<td>Copivaleria grotei (Morrison 1874)</td>
<td>April</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10300</td>
<td>Spiraneater grandis (Guenee 1852)</td>
<td>June</td>
<td>&lt;0.01</td>
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<tr>
<td>10368</td>
<td>Lacinipolia mediata (Grote 1873)</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10397</td>
<td>Lacinipolia renigera (Stephens 1829)</td>
<td>June–September</td>
<td>0.03</td>
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<tr>
<td>10405</td>
<td>Lacinipolia lorea (Guenee 1852)</td>
<td>June</td>
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</tr>
<tr>
<td>10438</td>
<td>Pseudaletia unipuncta (Haworth 1809)</td>
<td>April–September</td>
<td>0.02</td>
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<tr>
<td>10444</td>
<td>Leucania phragmitidicola Guenee 1852</td>
<td>June, September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10445</td>
<td>Leucania linda Franclemont 1952</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10446</td>
<td>Leucania sp.</td>
<td>June, August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10461</td>
<td>Leucania sp.</td>
<td>June, August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10462</td>
<td>Leucania pseudargyria Guenee 1852</td>
<td>June</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10488</td>
<td>Orthosia garnani (Grote 1879)</td>
<td>April</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10501</td>
<td>Crocigrapha normani (Grote 1874)</td>
<td>May</td>
<td>&lt;0.01</td>
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<tr>
<td>10524</td>
<td>Nephilodes minians Guenee 1852</td>
<td>September</td>
<td>&lt;0.01</td>
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<tr>
<td>10585</td>
<td>Orthodes cremulata (Butler 1890)</td>
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<tr>
<td>10587</td>
<td>Orthodes cynica Guenee 1852</td>
<td>May–June</td>
<td>0.04</td>
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<tr>
<td>10627</td>
<td>Tricholota signata (Walker 1860)</td>
<td>July</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10648</td>
<td>Agrotis gladiaria Morrison 1874</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10651</td>
<td>Agrotis venerabilis Walker 1857</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10663</td>
<td>Agrotis ipilon (Hufnagel 1766)</td>
<td>June, July, September</td>
<td>&lt;0.01</td>
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<tr>
<td>10674</td>
<td>Felita sp.</td>
<td>August–September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10676</td>
<td>Felita herilis (Grote 1873)</td>
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<tr>
<td>10803</td>
<td>Euxoa velleripennis (Grote 1874)</td>
<td>September</td>
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<tr>
<td>10891</td>
<td>Ochroleuca plecta (Linnaeus 1761)</td>
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<td>&lt;0.01</td>
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<tr>
<td>10942</td>
<td>Xestia sp.</td>
<td>June, September</td>
<td>0.01</td>
</tr>
<tr>
<td>10942.1</td>
<td>Xestia dolosa Franclemont 1980</td>
<td>May–June</td>
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<tr>
<td>10950</td>
<td>Xestia sp.</td>
<td>September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10955</td>
<td>Xestia badinodis (Grote 1874)</td>
<td>September</td>
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<tr>
<td>10994</td>
<td>Cerastis tenebrifera (Walker 1865)</td>
<td>April</td>
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<tr>
<td>10998</td>
<td>Choephorra fungorum Grote and Robinson 1868</td>
<td>September</td>
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</tr>
<tr>
<td>11006</td>
<td>Protolampra brunneicollis (Grote 1865)</td>
<td>September</td>
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<tr>
<td>11029</td>
<td>Abagrotis alternata (Grote 1864)</td>
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<tr>
<td>11068</td>
<td>Helicoverpa zeag (Boddie 1850)</td>
<td>August–September</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>11149</td>
<td>Schinia trifascia Hubner 1818</td>
<td>August</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>99999</td>
<td>Noctua promusa Linnaeus 1758</td>
<td>June–August</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
and their numbering system to better place those species of questionable identification. Information on host plant use was taken from Holland (1903), Rings et al. (1992), and Rings and Downer (2001). All specimens are housed at The Cleveland Museum of Natural History, Department of Invertebrate Zoology.

To obtain an estimate of the actual number of moth species on Kelleys Island, data on species accumulation over ten years from the six papers prepared by Teraguchi and Lublin (1999a–f) were combined, and the average rate of species accumulation from the six northeastern Ohio sites they sampled was determined. A logarithmic curve exhibited a good fit with their data \( y = 113.73 \ln(x) + 342.2 \), \( R^2 = 0.99 \), where \( y \) is the cumulative number of species and \( x \) is the year of collection. We applied a logarithmic, non-linear regression to the three years of species accumulation data from this study to give a preliminary estimate of the number of species anticipated after 10 years of sampling on Kelleys Island.

The Kelleys Island flora was surveyed periodically during 1975–2002. Plants were identified or categorized using Fernald (1950), Voss (1996), and Rhoads and Block (2000). Representatives of all plant species taken were mounted on herbaria sheets, and are housed at The Cleveland Museum of Natural History, Department of Botany.

Table 2. Number of moth specimens, number of species, cumulative number of species, and number of new species captured for three year survey of Kelleys Island.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. Specimens</th>
<th>No. spp</th>
<th>Cumulative spp</th>
<th>No. New spp</th>
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<tr>
<td>1999</td>
<td>573</td>
<td>105</td>
<td>105</td>
<td>—</td>
</tr>
<tr>
<td>2000</td>
<td>408</td>
<td>103</td>
<td>163</td>
<td>58</td>
</tr>
<tr>
<td>2001</td>
<td>709</td>
<td>124</td>
<td>216</td>
<td>53</td>
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</tbody>
</table>

Fig. 1. Location of Kelleys Island in Lake Erie, and position of trap (filled square) on the North Coleman Tract. Contour lines show elevation in feet above sea level, and depict northward slope of trapping area.
Table 3. The flora of Kelleys Island, with species found at the site of light trap setup on the Coleman Tract property.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Common Name</th>
<th>Coleman Tract sp.</th>
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</thead>
<tbody>
<tr>
<td>Thelypteridaceae</td>
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<td></td>
</tr>
<tr>
<td><em>Thelypteris palustris</em> Schott</td>
<td>marsh fern</td>
<td></td>
</tr>
<tr>
<td>Taxaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Taxus canadensis</em> Marsh</td>
<td>American yew</td>
<td></td>
</tr>
<tr>
<td>Cupressaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Juniperus virginiana</em> L.</td>
<td>eastern red-cedar</td>
<td></td>
</tr>
<tr>
<td>Potamogetonaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Potamogeton pectinatus</em> L.</td>
<td>sago false pondweed</td>
<td></td>
</tr>
<tr>
<td><em>Potamogeton pusillus</em> var. <em>pusillus</em> L.</td>
<td>small pondweed</td>
<td></td>
</tr>
<tr>
<td><em>Potamogeton richardsonii</em> (Benn.) <em>Rydb.</em></td>
<td>red-headed pondweed</td>
<td></td>
</tr>
<tr>
<td>Alismataceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Alisma subcordatum</em> Raf.</td>
<td>American water plantain</td>
<td>X</td>
</tr>
<tr>
<td><em>Alisma triviale</em> Pursh</td>
<td>northern water plantain</td>
<td>X</td>
</tr>
<tr>
<td>Hydrocharitaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Elodea canadensis</em> L. <em>C. Rich.</em></td>
<td>common waterweed</td>
<td></td>
</tr>
<tr>
<td><em>Vallisneria americana</em> Michx.</td>
<td>American eel-grass</td>
<td></td>
</tr>
<tr>
<td>Poaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Agrostis stolonifera</em> var. <em>palustris</em> (Huds.) Farw.</td>
<td>spreading vent</td>
<td></td>
</tr>
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<td><em>Andropogon gerardii</em> var. <em>gerardii</em> Vitman</td>
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<td><em>Bromus erectus</em> Hudson</td>
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<td><em>Dactylis glomerata</em> L.</td>
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<td><em>Elymus virginicus</em> var. <em>virginicus</em> L.</td>
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<td><em>Festuca elatior</em> L.</td>
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<td><em>Glyceria striata</em> (Lam.) A. Hitchc.</td>
<td>fowl mannagrass</td>
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<td><em>Panicum flexile</em> (Gattinger) <em>Scribn.</em></td>
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<td><em>Panicum gattingeri</em> Nash</td>
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<td><em>Panicum implicatum</em> Scribn.</td>
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<td><em>Panicum philadelphicum</em> Bernh.</td>
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<td><em>Phragmites australis</em> (Cav.) <em>Trin. Ex Steud.</em></td>
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<td><em>Poa compressa</em> L.</td>
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<td><em>Sporobolus ozarkanus</em> Fern.</td>
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<td><em>Triplasis purpurea</em> (Walt.) Chapman</td>
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<td><em>Carex aggregata</em> Mackenzie</td>
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<td><em>Carex crawei</em> Dewey</td>
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<td><em>Carex davisi</em> Schwein. &amp; Torr.</td>
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<td><em>Carex eburnea</em> Boott</td>
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<td><em>Carex flavula</em> L.</td>
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<td><em>Carex garberi</em> Fern.</td>
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<td><em>Carex granularis</em> Muhl. <em>Ex Willd.</em></td>
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<td><em>Carex lapalina</em> Wildl.</td>
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<tr>
<td><em>Carex meadii</em> Dewey</td>
<td>Mead’s sedge</td>
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<th>Coleman Tract sp.</th>
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<td>Carex molestta McKenzie</td>
<td>troublesome sedge</td>
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<td>Carex oligocarpa Willd.</td>
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<td>Carex rosea Schkuhr ex Willd.</td>
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<td>Carex shortiana Dewey</td>
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<td>Carex sparganoidei Wildl.</td>
<td>burr-reed sedge</td>
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<td>Carex stipa Muhl. Ex Willd.</td>
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<td>Carex umbellata Schkuhr ex Willd.</td>
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<td>Carex viridula Michx.</td>
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<td>Carex varipaloida Michx.</td>
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<td>Cyperus bipartius Torrey</td>
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<td>Cyperus engelmannii Steud.</td>
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<td>Cyperus odoratus L.</td>
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<td>Eleocharis compressa Sulliv.</td>
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<td>Eleocharis elliptica Kunth</td>
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<td>Eleocharis erythropytha Steud.</td>
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<td>Firmbristylis autumnalis (L.) Roemer &amp; Schultes</td>
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<td>Scirpus atrovirens Willd.</td>
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<td>Scirpus lineatus Michx.</td>
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<td>Scleria verticillata Muhl. Ex Willd.</td>
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<td>Heteranthera dubia (Jacq.) MacM.</td>
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<td>Juncus alpinus Vill.</td>
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<td>Juncus articulatus L.</td>
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<td>Juncus stueckei Reinking</td>
<td>Stuecky's rush</td>
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<td>Juncus tenuis var. uniflorus (Farw.) Farw.</td>
<td>poverty rush</td>
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<td>Juncus torreyi Coville</td>
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<td>Allium canadense L.</td>
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<td>Allium cernuum Roth</td>
<td>noding onion</td>
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<td>Allium trifolium Ait.</td>
<td>ramp</td>
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<td>Erythronium albidum Nutt.</td>
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<td>Sisyrinchium albidum Raf.</td>
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<td>Sisyrinchium angustifolium P. Mill.</td>
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<td>Sisyrinchium montanum Greene</td>
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<td>Sisyrinchium mucronatum Michx.</td>
<td>needle tip blue-eyed grass</td>
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<td>Liparis loeselli (L.) L. C. Rich.</td>
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<td>Spiranthes cernua (L.) L. C. Rich.</td>
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<td>Spiranthes magnicamporum Shevtak</td>
<td>great plains ladies'-tresses</td>
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<td>Populus deltoides Bartr. Ex Marsh</td>
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<td>Salix amygdaloides Anderss.</td>
<td>peach-leaf willow</td>
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<tr>
<td>Salix bebbiana Sarg.</td>
<td>gray willow</td>
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Table 3. Continued.

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<th>Taxa</th>
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<th>Coleman Tract sp.</th>
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<tr>
<td><em>Salix humilis</em> Marsh</td>
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<td><em>Carya ovata</em> (P. Mill.) K. Koch</td>
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<td><em>Carya glabra</em> (Miller) Sweet.</td>
<td>pignut hickory</td>
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<td><em>Juglans nigra</em> L.</td>
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<td><em>Betula pendula</em> Roth</td>
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<td><em>Betula sandbergii</em> Britt.</td>
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<td><em>Ulmus thomasii</em> Sarg.</td>
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<td><em>Ranunculus recurvatus</em> Poir.</td>
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<td><em>Arabis hirsuta</em> var. adpressipilis* (M. Hopkins) Rollins</td>
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<td><em>Cardamine coucata</em> (Michx.) O. E. Schulz</td>
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<td><em>Rorippa palustris</em> ssp. hispida* (L.) Bess. (Desv.) Jonsell</td>
<td>bog yellowcress</td>
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<td>Taxa</td>
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<td>Amelanchier spicata (Lam.) K. Koch</td>
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<td>Potentilla simplex Michx.</td>
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<td><em>Cornus amomum</em> ssp. <em>obliqua</em> (Raf.) J.S. Wilson</td>
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<td><em>Bidens bipinnata</em> L.</td>
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<td><em>Taraxacum officinale</em> Weber</td>
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Results and Discussion

We collected 1,690 moths representing 216 species from 20 families (Table 1). Noctuidae was the most species-rich family collected with 89 species taken, followed by Geometridae (33), Crambidae (24), Arctiidae (17), Notodontidae (17), and Tortricidae (14). Combined, those six families represent 89.8% of the total species taken. All other families were represented by 1–7 species.

Twenty-two (10.2%) species each represented ≥1% of the total catch. *Crambus agitatellus* (Crambidae) was the most numerous, representing 12.2% of the total catch (Table 1). This species demonstrated a moderately long flight period from June to August on Kelleys Island, and the larvae are known to feed on grasses.

Three species exhibited a long flight period spanning April through September: *Udea rubigalis* (Crambidae), *Eupethia* sp. (Geometridae), and *Pseudaleia unipunctata* (Noctuidae). Of these, only *P. unipunctata* was taken frequently, and represented approximately 2% of all moth specimens obtained. All three species are known to be highly polyphagous on a variety of plants, including woody and herbaceous forms. Ten species were limited to an early flight period spanning only April and/or May: *Plutella xylostella* (Plutellidae), *Pupa magniferalis* (Crambidae), *Antepione thisoria* (Geometridae), *Deidama inscripta* (Sphingidae), *Clostera inclusa* (Notodontidae), and the noctuids *Lithophane hemina*, *Copivaleria grotei*, *Orthosia garnani*, *Crocidura normani*, and *Cerastis tenellifera*. All ten species are restricted to feeding on trees or cultivated plants as larvae. No early flying species were taken in any abundance. Conversely, 20 moth species were restricted to a late flight period (September only) on Kelleys Island: *Crambus leachellus* (Crambidae), *Hypsopygia costalis* (Crambidae), *Prochoerodes transversata* (Geometridae), *Haematopsis grataria* (Geometridae), *Tolyph velleda* (Lasiocampidae), and the noctuids *Tetanoli floridana*, *Allagapha aerea*, *Papaipema impecuniosa*, *P. baptisiae*, *Amphipyra tragopoginis*, *Sunira bicolorago*, *Lacinipolia meditata*, *Nephelodes minians*, *Agrotis gladiaria*, *A. venerabilis*, *Xestia sp.*, *X. badinodi*, *Choephora fijorum*, *Protolampa brunneicollis*, and *Abagrotis alternata*. No late flight species represented ≥1% of the total catch. Unlike the species that are restricted to an early flight period, the 20 late flight species are all highly polyphagous on woody and herbaceous vegetation as larvae.

Yearly species accumulation data show
that 111 species were collected during the second and third year of trapping that were not collected during the first year. The third year of collecting was the most species-rich with 124 species (Table 2). Applying a logarithmic equation to the species accumulation data provided a good fit \( R^2 = 0.99 ; y = 99.2 \ln(x) + 102.1 \), and gives an estimate that 330.5 moth species are anticipated after ten years of collecting. This suggests that three years of effort have obtained 65% of the moth species on the island.

Two-hundred-thirty-eight plant species from 65 families were found on the island, and are listed in Table 3. The Cyperaceae was the most species rich family with 39 species, and Carex spp. alone accounted for 26 species. Forty-nine species (23.1%) were collected from the North Coleman Tract. Comparing the calculated estimate of the number of moth species expected after ten years of collecting indicates that there are 1.39 moth species per plant species on Kel-leys Island. This implies that multiple insect herbivores put pressure on the Kelleys Island flora. Competitive interactions or niche packing may be limiting the number of moth species that the island can support. This is the only study we are aware of that can provide a predictive ratio (approximately 1.4 lepidopteran herbivore species per plant species) for a herbivore community and its food sources.

This study shows that, even when a relatively small area of terrestrial habitat is sampled (i.e., no confounding data obtained by moths flying in from areas outside of our sampling area), moths represent a species-rich community. Rings et al. (1987) attempted to associate the moth species they accumulated during a survey conducted in northeastern Ohio with their natural host plants. They were unsuccessful and determined that this could not be done because the complete host range for most Lepidop-tera is unknown, and that moth species can be captured at great distances from their host plants using light traps. Although we conducted no rearings, the concurrent presentation of moth and plant species data from an insular environment may help other lepidopterists determine the host plant range of the moth species found during this study.

Three years of data collection provided approximately two-thirds of the moth spe-cies anticipated after ten years of effort. Surveys of the entomofauna of a given area are hampered by rare taxa that may not be captured without long-term efforts. These results underscore the need for long-term survey work when dealing with Lepidop-tera, or any other speciose insect taxa.

ACKNOWLEDGMENTS

We thank the Ohio Biological Survey for funding this study. David J. Horn (Ohio State University) helped the senior author during the early phase of this study, and Bill Coleman kindly assisted with monthly field collections. Ruth Chase and Tom Pucci (CMNH) reviewed a draft of the paper.

LITERATURE CITED


Ochlerotatus japonicus japonicus (Theobald) (Diptera: Culicidae), a New Invasive Mosquito for Georgia and South Carolina

Exotic mosquitoes pose a threat to public health and the environment. Some recently introduced species such as Aedes albopictus (Skuse) are serious pests and transmit pathogens to humans and domestic animals. Ochlerotatus japonicus japonicus (Theobald) is the most recently recognized species of exotic mosquito to become established in the continental United States (Peyton et al. 1999, Darsie 2002). Adult mosquitoes were initially reported from New York and New Jersey (Peyton et al. 1999). Larvae of Oc. japonicus were later found in natural and artificial containers such as treeholes and used tires (Andreadis et al. 2001). Scott et al. (2001) reported that Oc. japonicus was the most commonly collected rockpool-dwelling mosquito in the Delaware Water Gap National Recreation Area. Scott et al. (2001) and Andreadis et al. (2001) noted that this mosquito also inhabits rockpools in Japan. Since the discovery of wild Oc. japonicus japonicus populations in New Jersey and New York, it rapidly expanded its range to Connecticut (Andreadis et al. 2001), Pennsylvania, Ohio, Maryland (Fonseca et al. 2001), and Virginia (Harrison et al. 2002). The public health implications of this exotic mosquito are unknown, but it can transmit Japanese encephalitis virus to mice in laboratory experiments (Peyton et al. 1999). We report the discovery of populations of Oc. japonicus japonicus in Georgia and South Carolina.

We collected 13 mosquito larvae and 4 mosquito pupae from a leaf-lined rockpool adjacent to the Tallulah River, Southern Nantahalla Wilderness, Rabun County, Georgia, 34.9402°N, 83.5454°W, elevation 657 m, on 23 July 2003. In the laboratory, four adult mosquitoes emerged from the pupae within 24 hours and were identified as Oc. japonicus japonicus with the keys of Darsie (2002) and Darsie and Ward (1981). Ten of the larvae were Oc. japonicus japonicus and three were a native rockpool mosquito Ochlerotatus atropalpus (Coquillett). We sampled similar habitats in South Carolina and collected 28 Oc. japonicus japonicus and 2 Oc. atropalpus larvae from four rockpools along the Middle Saluda River, Jones Gap State Park, Greenville County, South Carolina, 35.1252°N, 82.5733°W, elevation 420 m, on 26 and 30 July 2003. The larvae collected on 30 July were infected with a symbiotic trichomyctete fungus Smittium sp. that develops in their hindguts. No other symbiotes were noted. Our collections suggest that Oc. japonicus japonicus has invaded the southern Appalachians since Darsie (2002) reported it from the Northeast and central Atlantic States. Our collection in Georgia was less than 3 km from the North Carolina border, indicating that this mosquito probably occurs in North Carolina. There are no major urban centers near either collection site and these mosquitoes probably colonized both sites without human-assisted transportation. Our collections are significant for mosquito control programs because Oc. japonicus will bite humans. This mosquito could be involved in the transmission of economically important pathogens such as West Nile encephalitis virus or Dirofilaria immitis (Leidy). Voucher specimens of larval and adult Oc. japonicus japonicus including larvae preserved in 95% ethanol for DNA analysis were deposited in the Clemson University Arthropod Collection.

We thank P. H. Adler for reviewing a draft of this manuscript.
LITERATURE CITED


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NOTE

Overwintering Cave Mosquitoes (Diptera: Culicidae) of the Arkansas and Missouri Ozarks

Some 60 species of mosquitoes occur in Arkansas and Missouri (Darsie and Ward 1981, Crockett 2002). We have long known that mosquitoes occur in Ozark caves, but few species records have been available in the literature. As a result of extensive collecting effort in Missouri caves by the Missouri Department of Conservation and in Arkansas caves by the Subterranean Biodiversity Project at the University of Arkansas we now know of four species that occur in Ozark caves.

The specimens recorded here are all females found in caves in late fall, winter, and early spring. Few mosquitoes were observed in caves during the summer months despite an equal degree of collecting effort during those months. Mated females apparently enter caves to pass the winter. Male mosquitoes are rarely collected in caves. Ives (1938) found only 8 males among 3102 specimens collected in Tennessee caves. They were all found in the early part of the hibernation period and may not have lived far into the winter.


Anopheles punctipennis adults are nocturnal, resting during the daytime in hollow trees, under rock overhangs, and in similar dark, moist shelters (Irby and Apperson 1992). Females take blood meals from mammals and birds. They rarely enter homes to feed. Females winter in buildings, cellars, hollow trees, and other well-protected shelters (Carpenter and LaCasse 1955, Horsfall 1955). In caves, they tend to congregate in the twilight zone. Movement into and out of caves is apparently governed by outdoor temperature (Ives 1938, Hess and Crowell 1949). Adult females emerge from overwintering quarters as early as February, take blood meals, and lay eggs (Breeeland et al. 1961). This species was previously recorded from Canadian caves by Peck (1988); Massachusetts subterranean habitats by Berg and Lang (1948); a New York cave by Lawlor (1935); Tennessee caves by Ives (1938); Kentucky caves by Barr (1967); Illinois caves by Peck and Lewis (1977); and Bat Cave, Crawford County, Missouri, by Craig (1977).


At dusk, *C. erraticus* females move from sheltered marsh and swamp forest sites to nearby grasslands (Snow 1955), where they take blood meals opportunistically from mammals, birds, reptiles and amphibians (Robertson et al. 1993, Williams and Meisch 1981). During the day, they rest on vegetation and in natural and man-made sheltered areas (Irby and Apperson 1992). This is the most common species found wintering in Ozark caves during the course of this study. It was previously reported from Missouri caves by Sutton (1993).


Only females of this species were seen. It is not possible to reliably determine if the specimens are *C. pipiens* or *C. quinquefasciatus*. The northern and southern house mosquitoes are commonly found in homes, and they bite humans at night. Adults rest during the daytime on vegetation and in natural and man-made sheltered areas (Irby and Apperson 1992). *Culex pipiens* comprised 89% of the 1562 mosquitoes found wintering in a small natural cave in the city of Montpellier, southern France, between October 1997 and the following March. Only four of the specimens were males (Gazave et al. 2001). *Culex pipiens* was previously recorded from Massachusetts subterranean habitats by Berg and Lang (1948), a New York cave by Lawlor (1935). Tennessee caves by Ives (1938), and Illinois caves by Peck and Lewis (1977). It was found in large numbers in a Minnesota mushroom cave in early March (Owen 1937).

*Uranotaenia sapphirina* (Osten Sacken).—MISSOURI: 1 ♀, Boone County, Hunters Cave, 1 November 1998. 1 ♀, Camden County, Moles Cave, 27 January 2003. 5 ♀, Oregon County, Long Point Cave, 1 April 1998. 1 ♀, Wright County, Little Smittle Cave, 14 November 2002.

*Uranotaenia sapphirina* adults are most active in early evening. They rest during the day in dark cavities and other protected shelters (Irby and Apperson 1992). Peterson and Smith (1945) reported this species overwintering in considerable numbers in hollow trees with *Anopheles quadrinaculatus* Say and *A. punctipennis* in Mississippi. It was collected from a cave in eastern New York State in February, along with *A. punctipennis* and *C. pipiens* (Lawlor 1935).

The cave-inhabiting mosquito species are not restricted to overwintering in caves. They will choose any convenient dark, moist, sheltered area that provides protection from freezing temperatures, such as hollow trees, mammal burrows, rock piles, wells, mine shafts, culverts, cellars, sheds, stables, and similar structures (Shemanuch 1965, Zukel 1949).

Most of the Ozark mosquitoes that have not been found in caves winter as eggs or larvae. Aside from the four species recorded here, local species that are thought to overwinter as fertilized adult females include *A. quadrinaculatus*, *Culex peckator* Dyar and Knab, *Culex restuans* Theobald, *Culex salinarius* Coquillett, *Culex tarsalis* Coquillett, *Culex territans* Walker, and *Cu-liseta inornata* (Williston). We might expect to find these overwintering in Ozark caves. Among them, *A. quadrinaculatus* (Hess and Crowell 1949, Ives 1938, Peck 1988) and *C. restuans* (Peck 1988) have been found overwintering in caves elsewhere. *Culex territans* (misidentified as *C. apicalis*) has been found overwintering in subterranean basement structures (Berg and Lang 1948). Adult female *Culex tarsalis* have been found wintering in abandoned mine.
tunnels in Colorado (Mitchell 1979, Blackmore and Dow 1962) and Nevada (Chapman 1961) and in rodent burrows in California (Mortenson 1953). Culex tarsalis and C. inornata have been found wintering in subterranean burrows of large mammals in Canada (Shemanchuk 1965). Our Aedes, Ochlerotatus and Psorophora species are thought to overwinter in the egg stage. Adult Aedes canadensis (Theobald), A. cinctus Meigen, A. vexans (Meigen), and Ochlerotatus sticticus (Meigen) have been found in Canadian caves in late spring and summer, but not in winter (Peck 1988).

The Missouri specimens recorded here are the property of the Missouri Department of Conservation, Jefferson City. They will be deposited in the Enns Entomology Museum, University of Missouri, Columbia. The Arkansas specimens are deposited in the University of Arkansas Arthropod Museum, Fayetteville.

LITERATURE CITED


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First Report of *Pryeria sinica* Moore (Lepidoptera: Zygaenidae) in North America

*Pryeria* Moore is a monotypic genus accommodating *P. sinica* Moore, 1877. It is eastern Palearctic, recorded from Russia (Far East), China, Korea, Japan, and Taiwan (Yen and Horie 1997). The holotype of *P. sinica*, deposited in The Natural History Museum, London, is from China; the holotype of *Neopryeria jezoensis* Matsumura, 1927, the only synonym of *P. sinica*, deposited in the Entomological Institute, Hokkaido University, Sapporo, Japan, is from Japan. The species has been recorded only recently in Taiwan, where it occurs primarily in the subalpine zone (Yen and Horie 1997).

*Pryeria sinica* is moderately divergent from other zygaenids in several superficial and morphological features. Although formerly associated with *Phauda* Walker (Phaudinae) (Inoue 1982), its assignment to Zygaeninae was convincingly demonstrated by Alberti (1954) and Naumann (1987, 1988). According to Naumann (1987), the genus represents the most primitive lineage of the subfamily.

Food plants of *P. sinica* appear to be restricted to Celastraceae, which contain acyanogenic compounds (Epstein et al. 1998). Two genera have been reported as host plants—*Celastrus* and *Euonymus*. Yen and Horie (1997) list specimens reared from *Celastrus punctatus* Thunb., *Euonymus sieboldianus* Blume, and *Euonymus japonica* Thunb. They indicate that the geographical range of *Celastrus punctatus*, the documented host plant in Taiwan, extends to south China and Japan, which agrees well with the distribution of *P. sinica*. Sato (1969) reported rearing larvae on *Euonymus sieboldianus*, *Euonymus alatus* (Thunb.) f. *ciliatidens* (Fr. et Sar.) and *Celastrus orbicularis* Thunb. Yen and Horie (1997) were unsuccessful in transferring larvae from *Celastrus* to *Euonymus* in the laboratory, suggesting the possibility of a degree of geographic host specialization.

Although Cave and Redlin (1996) identified *P. sinica* as an important plant pest of *Buxus* in Korea and China, this is likely an error. According to Yen (personal communication), the common name of *Pryeria sinica* in China is translated as the “buxus zygaenid moth”; however, the common name for *Buxus* and *Euonymus* is exactly the same. As a result, hosts for this species are commonly confused in the entomological literature of China. According to Yen, *Euonymus* and *Buxus* frequently occur sympatrically in the mountains of Japan and Taiwan, and he has never observed larvae of *P. sinica* on *Buxus*.

In April and May of 2001, 2002, and 2003 large infestations of larvae of *P. sinica* were reported on ornamental *Euonymus* in the city of Fairfax, Fairfax County, Virginia, U.S.A., causing severe damage to the plants. In March 2003 adult specimens were submitted to the USDA Systematic Entomology Laboratory at the National Museum of Natural History where they were identified as *P. sinica*. Subsequently, specimens were reported from Glen Burnie, Anne Arundel County, Maryland, in May 2003. The species previously was unreported from North America. The origins of the Fairfax and Glen Burnie populations are unknown, but introduction via nursery stock from the Far East seems the most likely pathway. Based on the success of *P. sinica* in northern Virginia on ornamental *Euonymus*—surviving local winter conditions and producing considerable progeny—and the degree of damage at the site of the infestation, *P. sinica* has the potential to become an important pest in situations where *Euonymus* is used in ornamental landscaping.
The life cycle of *P. sinica* has been studied in detail by several workers (e.g., Ishii et al. 1983, Shiotsu and Arakawa 1982, Shiotsu and Tsubaki 1986, Tamura 1981, Tamura and Ouchi 1977, Tsubaki 1981, Tsubaki and Shiotsu 1982, Wipking and Naumann 1992). Eggs are laid in clusters on the stems of the host plant in November and December. They are ovoid, flattened, and covered with scales from the female abdominal hair tufts. At 10–18°C, the egg stage lasts about 80 days. Larvae hatch in March and April and exhibit a group-feeding behavior (Tsubaki 1981, Tsubaki and Shiotsu 1982). They may be found on the upper or under surface of the leaves of the food plant, feeding on the leaf edges (Fig. 3). They readily drop on a line of silk when disturbed. Pupation occurs in late May, with an obligate pupal diapause that lasts until
November, when adults emerge. Adults are diurnal, with a slow, flitting flight generally 1–5 m above the ground. Adults are active from about 0900–1500 hours. They typically mate during the daytime and remain coupled for about 20 hours. Oviposition takes place during the day, usually within a few hours after copulation.

The adult of *P. sinica* is a medium-sized wasp-mimic (Fig. 1), with a forewing length of 10–13 mm in the male and 12–14 mm in the female. The wings are transparent with a few scattered black scales and a small, diffuse patch of yellow-orange scales in the basal portion of the forewing. Antennae are bipectinate in the male, non-pectinate but clubbed in the female. The distinct forewing coloration, highly reduced proboscis, and tufts of orange scales at the end of the abdomen distinguish this species from all other Zygaenidae. Additional illustrations of the adult can be found in Yen and Horie (1997) and Epstein et al. (1998).

The mature larva (Fig. 2) is 15–22 mm in length. The color is assumed to be aposematic (Johki and Hidaka 1979): a white ground color with dorsal, subdorsal, medial, and submedial black longitudinal stripes (comprised of adjacent spots), and a yellow venter. Chaetotaxy is described in detail by Yen and Horie (1997); additional illustrations of the larva can be found in Nakajima (1987) and Yen and Horie (1997).

The pupa is 8–10 mm in length, 4.0–4.5 mm in width, stout, and dorsoventrally compressed, enclosed in a tough, relatively smooth, beige, flattened, semispherical cocoon. The cocoon typically is spun within a folded leaf or between adjacent leaves on the live plant. Coloration of the pupa is similar to that of the larva with dorsal, subdorsal, submedial, and medial black longitudinal stripes (see Yen and Horie 1997 for illustrations).

The species is attacked by at least two parasitoids—*Agrothereutes minousubae* Nakanishi (Hymenoptera: Ichneumonidae) (Shiotzu and Arakawa 1982, Shiotzu and Tsubaki 1986) and *Bessa parallela* (Meigen) (= *B. selecta fugax* Rondani or *B. fugax* Rondani) (Diptera: Tachinidae) (Shima 1973). Based on laboratory studies, larvae of *P. sinica* produce an (E)-phytol that induces predation by the generalist predatory stinkbug, *Eocanthecona furcellata* (Wolff) (Hemiptera: Pentatomidae) (Yasuda 1998).

Given the widespread use of *Euonymus* as ornamentals, especially in the northeastern U.S., the potential seems high for the persistence and expansion of the present infestation in the U.S.

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**LITERATURE CITED**


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Obituary

Alexander Douglas Campbell Ferguson
1926–2002

Dr. Douglas C. Ferguson (Doug to everyone who knew him) died on 4 November 2002 following surgery on 16 October. Doug was born in Halifax, Nova Scotia, on 17 February 1926, attended local schools, and received a B.S. from Dalhousie University in 1950. His M.S. (1956) and Ph.D. (1967) were awarded by Cornell University.

He was a field assistant to J. H. McDunnough in 1946; Curatorial Assistant, Curator of Entomology, and Chief Curator (Science Division) at the Nova Scotia Museum (1949–1963); Research Associate in Entomology (Peabody Museum of Natural History) then Research Staff Biologist and Lecturer (Department of Biology) and Curatorial Associate in Entomology (Peabody Museum of Natural History). Yale University (1963–1969); and Research Entomologist, Systematic Entomology Laboratory U.S.D.A. at the National Museum of Natural History (1969–1996). Upon retirement he continued as a Collaborator of the U.S. Department of Agriculture and Research Associate of the Smithsonian Institution.

Doug’s interest in natural history began in childhood when he seriously watched birds and discovered the nests of most local species. After reading W. J. Holland’s account of sugaring for moths in The Moth Book in 1941, he tried it on the trees around his home and was thrilled to catch five species of underwing moths (Catocala) the first night. Halifax was a small city with
many collecting sites within walking or cycling distance, and it had a museum with a collection of local Lepidoptera, a library, and a helpful director. Doug’s initial involvement with the Lepidoptera increased exponentially and resulted in *The Lepidoptera of Nova Scotia, part 1, Macrolepidoptera* in 1954. He was deeply influenced by the prominent lepidopterists James McDunnough, W. T. M. Forbes, Charles Remington, and John Franclemont during his formative years.

Throughout his career Doug was an avid, knowledgeable collector. Field trips were directed to learn and document the fauna of particular areas. He collected in the southern parts of the Provinces and all States but Hawaii and several times in many. He spread and labelled an estimated 200,000+ specimens during his career. These specimens have augmented significantly the holdings of the National Museum of Natural History, the Peabody Museum of Natural History, and the Nova Scotia Museum. He was extremely interested in learning the life history of species and reared to the adult stage more than 600 species, documenting many of them with 35 mm slides of the larvae and adults.

A chance meeting in 1967 with Richard B. Dominick, a Yale alumnus and Lepidopteran enthusiast, at the Peabody Museum led to several collecting trips at The Wedge, Dick’s estate near McClellanville, South Carolina. Here began the Moths of North America project and subsequently the establishment of the Wedge Entomological Research Foundation, which funds and publishes the series. Doug enlisted the participation of John Franclemont, Eugene Munroe, and me for the project, originally projected to be a synoptic update of Holland’s moth book. Studied consideration led to the project’s present scope of an anticipated 130+ fascicles to treat the estimated 16,000+ species in the area. Doug contributed fascicles on the Saturniidae and Geometrinae and had the text and line drawings completed for a major revision of the geometrid tribes Cassymini and Macariini before his death.

Doug was an excellent field biologist who interacted and collaborated with many Lepidopterists. As well, he aided many collectors by identifying specimens and occasionally describing species whose identity was needed for economic or biologic purposes. Doug had two students: Roger Heitzman (Ennominae) and Alma Solis (Pyraloidea). He was very generous with his knowledge and would drop what he was doing to answer their questions. Doug was a quiet, thoughtful, well-read person who had many interests, history, gardening, and classical music among them. In group meetings he usually was reserved; however, he often brought a carefully reasoned and valued view to discussions.

Doug is survived by Charlotte, his wife of 49 years, daughters Stephanie and Caroline, and six grandchildren. He is held in high esteem and is sorely missed by many friends and colleagues.

Ronald W. Hodges, retired, Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture. Current address: 85253 Ridgetop Drive, Eugene, OR 97405, U.S.A. (e-mail: rw hodges@earthlink.net).
NOTICE OF NEW PUBLICATION

A Catalog of the Cecidomyiidae (Diptera) of the World

Entomological Society of Washington Memoir No. 25

This catalog, the first complete catalog of the family since 1913, lists the 5,451 species and 598 genera of living and fossil Cecidomyiidae or gall midges of the world. It provides information on species distribution, hosts, and types, and original and subsequent helpful references. Within subfamilies, genera are listed in alphabetical order but are each cross referenced in an appendix where they are arranged in an annotated classification. One new species is named, many new names, new synonyms, and new combinations are proposed, and several type species are designated. A single index lists all generic and specific names of Cecidomyiidae with their authors, as well as hosts, host family for plants, host order and family for arthropods, and order for fungi.

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PRELIMINARY SCHEDULE OF THE REGULAR MEETINGS FOR 2003–2004

October 2: Chris Desjardins (University of Maryland & Maryland Center for Systematic Entomology). Diparine Wasp Diversity and Collecting in South Africa and Australia

November 6: Stefan Cover (Museum of Comparative Zoology, Harvard University). Ant Systematics in the 21st Century: North America, a Case Study

December 4: John Strazanac (University of West Virginia). Diversity of Central Appalachian Forest Canopy Macrolepidoptera, Symphyta, and their Tachinid Parasitoids

January 8: Jonathan Mawdsley (National Fish & Wildlife Foundation). Pollination by Beetles (Insecta: Coleoptera): An Overview

February 5: Jeremy Miller (Smithsonian Institution, Entomology). The Unbearable Lightness of Being Monophyletic: Clade Stability and the Addition of Data in Erigonine Spiders

March 4: Frank Carle (Rutgers University). Evolution of Dragonflies

April 1: Caroline Chaboo (Cornell University & American Museum of Natural History). Untangling Fecal Shield Architecture in Tortoise Beetles: Behavior, Ecology, Morphology and Phylogeny (Coleoptera: Chrysomelidae: Cassidinae)

May 6: Leeanne Alonso (Conservation International). Contributions of Rapid Assessment of Insects to Biodiversity Conservation

Meetings are held at:
7:00 pm
Cathy Kerby Seminar Room (CE-340)
National Museum of Natural History
10th & Constitution Ave., Washington, D.C.

Meetings are open to the public
Please bring new literature, specimen demonstrations, ento-T-shirts, etc.

Pre-meeting dinner: R. Reagan Building Food Court, 5:30 p.m.
Refreshments served following the meetings

Jonathan Mawdsley, President
David G. Furth & John Brown,
Co-Program Chairs
INSTRUCTIONS FOR AUTHORS

General Policy.—Articles for publication are ordinarily accepted only from members of the Society and must be in English. A summary in French, German, Spanish, or Russian is acceptable. Such a summary should be placed immediately after the English abstract and may be a translation of that abstract. Manuscripts should not exceed 15 printed pages (about two and one-half double-spaced typewritten pages equal one page). Manuscripts are peer-reviewed before acceptance. Final acceptance is the responsibility of the Editor. Articles are published in the order received, not the date of acceptance. Immediate publication is available with payment of full page charges. Notes, book reviews, and obituaries are published as space is available.

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When referring to references in text, use the following: Henry (1990), (Henry 1990), (Henry 1987, 1990). (Smith 1990, Henry
1992), (Smith 1990; Henry 1990, 1991), (Miller 1990a, 1990b) where two articles are published by the same author in the same year, or Henry et al. 1990 where more than two authors are involved (do not italicize “et al.”). Citations “in press” should be cited as “in press,” not with year of expected publication.

Names of persons providing unpublished information should include initials and be referenced in the text as: W. Mathis (personal communication) [information obtained orally] or W. Mathis (in litt.) [information obtained in a writing].

Names of organisms.—The first mention of a plant or animal should include the full scientific name including the authority. Use only common names approved in Common Names of Insects and Related Organisms published by the Entomological Society of America. Spell out the entire scientific name the first time it is mentioned, thereafter abbreviate generic names; however, do not abbreviate a genus name at the beginning of a paragraph or sentence, or if two or more genera being discussed have the same first letter. Within sentences, always use the genus name or initial preceding a species name.

Taxonomic papers.—Taxonomic papers must conform to requirements of the International Code of Zoological Nomenclature. In addition, type specimens must be designated for new species described, type depositories must be clearly indicated, and new taxa must be clearly differentiated from existing taxa by means of keys or differential diagnoses. In short, these papers must conform to good taxonomic practices.

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**CONTENTS**

(Continued from front cover)

MACKAY, WILLIAM P.—A new species of the ant genus *Acanthostichus* Mayr (Hymenoptera: Formicidae) from Paraguay, and a description of the gyne of *A. brevicornis* Emery .......................... 97

MAWDSLEY, JONATHAN R.—Pollen transport by North American *Trichodes* Herbst (Coleoptera: Cleridae) .......................................................... 199

MENDES, LUIS F. and GEORGE O. POINAR, JR.—A new fossil Nicoletiidae (Zygentoma, “Apterygota”) in Dominican amber ......................................... 102

MORSE, JOHN C. and LIANFANG YANG—The world subgenera of *Glossosoma* Curtis (Trichoptera: Glossosomatidae), with a revision of the Chinese species of *Glossosoma* subgenera *Synaphophora* Martynov and *Protoglossa* Ross .................................. 52

NISHIDA, KENJI and DAVID ADAMSKI—Two new gall-inducing *Saphenista* Walsingham (Lepidoptera: Tortricidae: Cochylini) from Costa Rica ........................................ 133

SONG, HOJUN—Post-adult emergence development of genitalic structures in *Schistocerca* Stål and *Locusta* L. (Orthoptera: Acrididae) ................................................ 181

SUEYOSHI, MASAAHIRO and WAYNE N. MATHIS—A new species of *Cymops* Melander 1913 (Diptera: Periscelididae) from Japan and a review of Japanese Periscelididae .................. 74

WAGNER, DAVID L., DAVID ADAMSKI, and RICHARD L. BROWN—A new species of *Mompha* Hübner (Lepidoptera: Coleophoridae: Momphinae) from buttonbush (*Cephalanthus occidentalis* L.) with descriptions of the early stages .................................................... 1

WHEELER, A. G., JR.—*Largidea davisi* Knight, a rarely collected plant bug (Hemiptera: Miridae: Deraeocorinae) associated with pitch pine in the northeastern United States ...... 85


NOTES

BARNES, JEFFREY K.—Overwintering cave mosquitoes (Diptera: Culicidae) of the Arkansas and Missouri Ozarks ......................................................... 235

BROWN, JOHN W., MARC E. EPSTEIN, and ERIC R. DAY—First report of *Pteryia sinica* Moore (Lepidoptera: Zygaenidae) in North America ........................................ 239

REEVES, W. K. and J. A. KORECKI—*Ochlerotatus japonicus japonicus* (Theobald) (Diptera: Culicidae), a new invasive mosquito for Georgia and South Carolina ........................................ 233

OBITUARY


MISCELLANEOUS

Notice of New Publication: A Catalog of the Cecidomyiidae (Diptera) of the World .......................... 245

Preliminary Schedule of the Regular Meetings for 2003–2004 .......................................................... 246

Instructions for Authors .................................................................................................................. 247
CONTENTS

BRAILOVSKY, HARRY and ERNESTO BARRERA—Two new genera and four new species of Colpurini (Heteroptera: Coreidae: Coreinae) from New Guinea ................................. 424

BROWN, JOHN W. and RICHARD L. BROWN—A new species of Cryptaspasma Walsingham (Lepidoptera: Tortricidae: Olethreutinae) from Central America, the Caribbean, and southeastern United States, with a catalog of the world fauna of Microcorini  ................. 288

COSTA, LUIZ A. A. and THOMAS J. HENRY—Fm/v/w5 chaguenus Carvalho and Costa (Heteroptera: Miridae: Cylapinae: Fulviini): Redescription and recognition of type specimens ............................ 417


GAGNE, RAYMOND J., ALEJANDRO SOSA, and HUGO CORDO—A new Neotropical species of Clinodiplosis (Diptera: Cecidomyiidae) injurious to alligatorweed, Alternanthera philoxeroides (Amaranthaceae) ................................................................. 305

HARRINGTON, RICHARD C. and JOHN C. MORSE—A new species of Brachycentrus Curtis (Trichoptera: Brachycentridae) from the southern Appalachian Mountains and variation in the caddisfly B. spinae Ross ........................................... 453

ISHIKAWA, TADASHI and SHUJI OKAJIMA—A new species of the saicine assassin bug genus Carayonia Villiers (Heteroptera: Reduviidae) from Indochina .............................................. 319

KONSTANTINOY, ALEXANDER S. and BORIS A. KOROTYAEV—Sexual dimorphism and size of aedeagi in apionid weevils (Coleoptera: Apionidae) and flea beetles (Coleoptera: Chrysomelidae): Why some masculine males have small aedeagi ............................. 324

MATHIS, WAYNE N. and TADEUSZ ZATWARNICKI—A revision of the shore-fly genus Cressonomyia Amaud (Diptera: Ephydridae), with comments on species that have been excluded ................................................................. 249

NICKLE, DAVID A.—Commonly intercepted thrips (Thysanoptera) from Europe, the Mediterranean, and Africa at U.S. ports-of-entry. Part II. Frankliniella Karny and Iridothrips Priesner (Thripidae) ................................................................. 438

OCAMPO, FEDERICO C. and MIGUEL ANGEL MORÓN—Description of the third instar larva of Hemiphrileurus dispar Kolbe (Coleoptera: Searabaceidae: Dynastinae: Phileurini) ................................. 412

(Continued on back cover)
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A REVISION OF THE SHORE-FLY GENUS CRESSONOMYIA ARNAUD (DIPTERA: EPHYDRIDAE), WITH COMMENTS ON SPECIES THAT HAVE BEEN EXCLUDED

WAYNE N. MATHIS AND TADEUSZ ZATWARNICKI

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Abstract.—Five species of the shore-fly genus Cressonomyia Arnaud are revised, including C. bolivia, n. sp. (Bolivia. La Paz: Tajlihui). The genus is known only from the New World tropics and subtropics and is the sister group to Peltopsilopa Cresson. Two species groups are recognized, the aciculata group (two species) and the skinneri group (three species). Psilopa aeneonigra (Loew), which had been included in Cressonomyia, is returned to Psilopa. A neotype is designated for Psilopa aciculata Loew, the senior synonym for Plagiops nitidifrons Cresson (new synonym). All species are illustrated and distribution maps are also provided.

Key Words: review, Diptera, Ephyridae, shore flies, Cressonomyia

This revision treats species of Cressonomyia Arnaud, which are known only from the New World. The species of Cressonomyia have never been treated comprehensively, although Cresson (1942, 1946) provided a review, including keys, in his treatments of the Nearctic and Neotropical shore-fly faunas. The primary objectives of this paper are to revise the species and to present a phylogenetic context for the genus Cressonomyia within the tribe Psilopini Cresson, subfamily Discomyzinae Acloque. We recharacterize Cressonomyia and describe and illustrate several characters of the male terminalia that have not been reported or analyzed previously. These structures are described and illustrated for all known species and are included in the phylogenetic analysis.

Although the generic concept of Cressonomyia has remained relatively stable since its description, the genus-group nomenclature was confused for decades because of preoccupied names. The generic status was first recognized in 1918 as the genus Plagiops Cresson, a preoccupied genus-group name (Townsend 1911). Cresson recognized his nomenclatural lapse and proposed the replacement name of Plagiopsis Cresson, which, unfortunately, was also preoccupied (Brauer and Bergenstamm 1889). Both Plagiops and Plagiopsis were first proposed for tachinid flies, and Arnaud (1958), a specialist on Tachinidae, ultimately corrected the nomenclatural oversights by suggesting Cressonomyia as the valid replacement name. As E. T. Cresson, Jr. described most of the species included in the genus, it is appropriate that the generic name be a patronym to honor and recognize him. The type species for Plagiops is P. nitidifrons Cresson, which automatically...
became the type species for the replacement names.

Thus far eight names are available for species of *Cressonomyia* (Mathis and Zatwarnicki 1995). Loew (1862) described the first species, *Psilopa aciculata*, from specimens collected in Cuba, and the second species, *Ephydrobia metallica* Schiner (1868), was later found to be conspecific with *C. aciculata* (Cresson 1925). Loew (1878) also described the third species. *Psilopa aeneonigra*, from specimens collected in Texas, and like the first species he named, it too became a senior synonym when the fourth species, *Psilopa fulvipennis* Hine (1904) from Louisiana, was discovered to be conspecific with *C. aeneonigra* (Cresson 1942). The correct generic status of *Psilopa aeneonigra* and *P. fulvipennis* is reported in this paper. Cresson named the other four species, although none was described in *Cressonomyia*. The four species in their original generic combination are: *Plagiops hinei* (Cresson 1922); *Psilopa meridionalis* (Cresson 1918); *Plagiops nitidifrons* (Cresson 1918); and *Psilopa skinneri* (Cresson 1922). Aside from catalog entries (Wirth 1965, 1968; Mathis and Zatwarnicki 1995) and Cresson’s synopses (1942, 1946), there are no other substantive papers on *Cressonomyia*.

*Cressonomyia* has always been associated with the genus *Psilopa* and related genera, which were usually recognized as the tribe Psilopini (Cresson 1942, 1946; Wirth 1965, 1968; Mathis and Zatwarnicki 1995). We continue with that precedent, as all morphological evidence (see key and diagnosis below) substantiates that tribal placement. We also adhere to Zatwarnicki’s (1992) characterization of Psilopini, which excludes genera that are more closely related to *Discomyzidae* Meigen as a separate tribe, Discomyzinini Acloque. Both Discomyzinini and Psilopini are tribes in the subfamily Discomyzinae (Mathis and Zatwarnicki 1995).

**Methods and Materials**

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. We have followed the terminology for most structures of the male terminalia that other workers in Ephydridae have used (see references in Mathis 1986, and Mathis and Zatwarnicki 1990a, b), such as pre- and post-surstylus. Zatwarnicki (1996) has suggested that the pre- and post-surstylus correspond with the pre- and postgonostylus and that the subepandrial plate is the same as the medandrium. The terminology for structures of the male terminalia is provided directly on Figs. 2–15. The species descriptions are composite and not based solely on the holotypes. One head and two venational ratios that are used in the descriptions are defined below (all ratios are based on three specimens: the largest, smallest, and one other). Gena-to-eye ratio is the genal height measured at the maximum eye height divided by the eye height. Costal vein ratio: the straight line distance between the apices of R<sub>2+3</sub> and R<sub>4+5</sub>/distance between the apices of R<sub>1</sub> and R<sub>2+3</sub>. M vein ratio: the straight line distance along vein M between crossveins (dm-cu and r-m)/distance apicad of dm-cu.

Distribution maps were made using ESRI ArcView® GIS 3.2. Longitude and latitude coordinates were obtained for the locality where each specimen was collected and entered into a Microsoft Excel® spreadsheet. If available, the longitude and latitude were obtained directly from the specimen labels. For specimen labels that did not have longitude and latitude, gazetteers and maps were used to determine the geographical coordinates. The geographic coordinate spreadsheet was converted to a tab delimited text file and imported into ESRI ArcView. The specimen locales were plotted on a world land projection, presented within ESRI ArcView layouts and exported as encapsulated postscript (EPS) files.

The phylogenetic analysis was performed
with the assistance of Hennig86°, a computerized algorithm that produces cladograms by parsimony. Character data were polarized primarily using outgroup procedures. Although autapomorphies were not included in the cladistic analysis (they were made inactive), which would skew the consistency and retention indices, we listed them on the cladogram and included them as part of generic treatments and phylogenetic considerations to document the monophyly of the lineages, particularly at the species-group level.

Although many specimens for this study are in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM), we also borrowed and studied numerous specimens that are deposited in the following museums:

ANSP Academy of Natural Sciences of Philadelphia, Pennsylvania, USA.
AMNH American Museum of Natural History, New York, USA.
BYU Brigham Young University, Provo, Utah, USA.
CMP Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA.
INBIO Instituto Nacional de Biodiversidad, Santo Domingo, Costa Rica.
MCZ Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA.
MNBL Museo Nacional de Historia Natural, La Paz, Bolivia.
NMW Naturhistorisches Museum, Wien, Austria.
OHSU Ohio State University, Columbus, Ohio, USA.

SYSTEMATICS

TRIBE PSILOPINI CRESSON


Diagnosis.—Head: Fronto-orbital setae reclinate and procline; reclinate fronto-orbital seta usually inserted behind larger, procline fronto-orbital seta. Pedicel bearing a long, spinelike seta near anterodorsal margin. Face usually smooth, if finely striate the longest facial seta at least as long as its distance from opposite seta; medial facial area and lower facial margin without setae; facial setae inserted in more or less vertical series, parallel with parafacial; subcranial cavity small.

Thorax: Prescutellar acrostichal setae large (subequal to posterior dorsoentral seta), inserted widely apart (distance between subequal to that between either prescutellar and the posterior dorsoentral seta on the same side) and usually in front of intra-alar seta; presutural or sutural dorsoentral seta inconspicuous or absent. R stem vein lacking setulae on dorsum; vein R2+3 well separated from costal vein; crossvein dm-cu nearly straight or shallowly arched, not angulate.

Abdomen: Presurstylus well developed; posturstylus lobate, lacking a posturstylar process; subependrial plate well developed, usually narrow; pregonite moderately well developed, usually bearing 2–3 long, apical setulae; aedeagus simple, tubular; phallopodeme generally hemispherical to triangular with a well-developed, extended keel in lateral view; ejaculatory apodeme lacking; hypandrium well developed, usually pocketlike.

KEY TO NEW WORLD GENERA OF PSILOPINI CRESSON

1. Prescutellar acrostichal setae lacking
   - Prescutellar acrostichal setae well developed

2. Only inner vertical seta present. Lateral margins of abdomen sharp
   - Both inner and outer vertical setae present. Lateral margins of abdomen rounded. revolute

3. Vein R2+3 close to costa beyond end of vein R1; crossvein dm-cu with sharp angle at middle
   - Vein R2+3 well separated from costa; crossvein dm-cu mostly straight or shallowly arched, not angulate
4. Base of wing blackish, contrasted with remainder of wing; knob of halter blackish brown to black ........................................ 5
   Base of wing concolorous with rest of wing, usually hyaline or very lightly tinged; knob of halter whitish to yellowish .............. 6
5. Scutellum greatly enlarged, extended far over and above abdomen ...... *Peltopsilopa* Cresson
   Scutellum normally developed, not extended far over abdomen ...... *Cressonomyia* Arnaud
6. Face with transverse striae ........................................... *Leptopsilopa* Cresson
   Face smooth, lacking transverse striae (transverse striae in *Ceropsilopa coquillettii* Cresson, which has entirely yellow legs) ........ 7
7. Pedicel conical, broader apically, without dorsoapical lobe; dorsoapical spine weak (at most ½ as long as 1st flagellomere); 1st flagellomere from 2–4× as long as high .................................................. *Ceropsilopa* Cresson
   Pedicel short and subtriangular, with dorsoapical lobe and bearing well-developed dorsoapical spine (at least half as long as 1st flagellomere); 1st flagellomere at most twice as long as high ......................... *Psilopa* Fallén

**Genus Cressonomyia** Arnaud

*Plagiops* Cresson 1918: 53. Type species: *Plagiops nitidifrons* Cresson 1918, original designation; preoccupied, Townsend 1911.


Diagnosis.—Small to moderately small shore flies, body length 1.50–2.35 mm; microtomentum generally sparse or lacking, appearing subshiny to shiny; mostly black species.

**Head:** Head in lateral view with antenna inserted at dorsal ½; frons conspicuously wider than long; fronto-orbital setae reclinate and proclinate but sometimes weakly developed; pseudostocellar setae well developed, subequal to outer vertical seta, orientation mostly proclinate and slightly divergent; both inner and outer vertical setae well developed; vertex acutely creased; posterior ocelli situated immediately before creased vertex, ocelli forming isosceles triangle. Antenna with 1st flagellomere longer than pedicel; scape not exerted; arista with 4–8 dorsal rays. Facial vestiture variable, surface mostly flat and plain, lacking pits and transverse microrugosity or striae; 1 strong facial seta, mesoclinate; palpus black; proboscis normally developed, not elongate.

**Thorax:** Generally black to deep bluish black, microtomentum sparse to lacking; supra-alar seta absent; prescutellar acrostichal seta well developed; scutellum only slightly wider than long, disc sparsely setulose; basal scutellar seta over ½ length of apical seta; anepisternum with 2 large setae. Wing mostly hyaline to faintly yellowish except for blackish base; crossveins not darkened; vein R₂₃ extending normally to costal margin, lacking stump vein; R stem vein bare of setulae dorsally. Knob of halter black. Femora black; forebasitarsus whitish yellow to yellow, only apical 1–2 tarso-meres blackish.

**Abdomen:** Generally bare of micromomentum, shiny, blackish; tergites 3–4 long, 5th tergite very short and lacking prominent, dorsally erect setae along posterior margin. Male terminalia: epandrium in posterior view an inverted, rounded U (open ventrally), in lateral view wider subventrally; cerci lunate to rodlike, narrower dorsally, sometimes with a mediadorsal point; presurstylus much longer than wide, bearing 2–3 setae anterobasally; posturstylus longer than wide, generally as an inverted L, directed anteroventrally or ventrally, with variously developed medial lobes or processes; subepandrial plate wider than long, usually narrowed medially and with each lateral extension slightly enlarged; pregonite bearing 3 long setulae; aedeagus longer than wide, wider basally in ventral view, in lateral view with distal portion directed posterovertrally, posteroapical mar-
gin irregular, sometimes with a subapical process dorsally; phallapodeme in lateral view more or less triangular, keel sometimes irregular, asymmetrical; hypandrium U-shaped, membranous from posterior margin to center, in lateral view shallow to moderately deep, pocketlike.

Discussion.—*Cressonomyia* is similar and evidently closely related to *Peltopsilopa*. Both genera share at least two synapomorphies: 1. base of wing darkened; 2. knob of halter blackish brown to black; and 3. postsurstylus angulate, L-shaped. *Peltopsilopa* differs from *Cressonomyia* in having a greatly enlarged scutellum that extends posteriorly over most of the abdomen. Both genera are also only known from the New World, especially tropical areas. Although *Peltopsilopa* is distinctive and readily distinguished because of the enlarged scutellum and the setulose gonite (bearing setulae in addition to the three long, apical setulae), it should perhaps be recognized as a derived but included lineage within *Cressonomyia*.

Excluded from the genus, based on evidence accumulated in this study, are *Psilopa aeneonigra*, including its junior synonym *Psilopa fulvipennis*, which Wirth (1965) transferred from *Psilopa* to *Cressonomyia* without comment. We confirm the synonymy of these two names, first suggested by Cresson (1942), after determining that the two holotypes are conspecific. Wirth probably made the generic transfer on the basis of the slightly darkened wing base of *P. aeneonigra*, similar to *Cressonomyia*, but which otherwise differs from species included in the genus. The knob of the halter, for example, is white, not blackish brown to black, as in *Cressonomyia*, and structures of the male terminalia also differ, sharing similarities especially in the shape of the subependrial plate, postsurstylus, and hypandrium with those of *Psilopa*.

Phylogenetic analysis of species.—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. 1) 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" indicates the derived states. Characters 3, 8, 9, 11, 12, and
Table 1. Matrix of characters and taxa used in the cladistic analysis of Cressonomonya (numbers for characters correspond with those used in the text).

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<td>C. meridionalis</td>
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13, which are autapomorphies for various species, were made inactive () for the analysis so that they do not figure into the calculation of the consistency index. The numbers used for characters in the presentation are the same as those on the cladogram, and the sequence is the same as noted in the character matrix (Table 1). The genus Psilopa, which is the nominate genus for the tribe Psilopini, was the outgroup in our phylogenetic analysis.

**CHARACTERS USED IN THE PHYLOGENETIC ANALYSIS**

(running count in parenthesis)

**Head:**

1(1). Size of fronto-orbital setae: (0) comparatively large, well developed; (1) minute (a synapomorphy for the aciculata group).

2(2). Plane of face and frons: (0) face and frons forming an obtuse angle in lateral view; (1) face and frons nearly flat in lateral view, largely bare, shiny (a synapomorphy for the aciculata group).

3(3). Number of aristal rays: (0) arista bearing 8 dorsal rays; (1) arista bearing 4–5 dorsal rays (an autapomorphy for the meridionalis group).

4(4). Face: (0) polished or smooth; (1) bearing micromomentum as a vertical stripe or more generally microsculptured (a synapomorphy for the hinei group).

5(5). Height of face: (0) face long, height twice that of frons; (1) face shorter, height 1.5× that of frons (a synapomorphy for hinei and meridionalis groups).

**Thorax:**

1(6). Coloration of basal portion of wing: (0) wing completely unicolorous; (1) darkened portion limited, at most occupying basal ¼ of cell cu₄ (a synapomorphy for Cressonomonya and Peltopsilopa); (2) darkened base more extensive, occupying 1/2–1/2 base of cell cu₄ (a synapomorphy for the aciculata group).

2(7). Color of knob of halter: (0) whitish to yellowish; (1) brown to blackish brown (a synapomorphy for Cressonomonya and Peltopsilopa).

3(8). Size of scutellum: (0) normally developed, trapezoidal or triangular; (1) greatly enlarged, extended over much of abdomen, beetlelike (an autapomorphy for Peltopsilopa).

**Abdomen:**

1(9). Shape of the presurstylus: (0) lobate, forming subbasal notch, 3 setulae in notch along basomedial portion; (1) presurstylus elongate, narrow, almost parallel sided, shallowly curved, and lacking medial notch and setulae (an autapomorphy for the meridionalis group).

2(10). Shape of posturstylus: (0) with a shallow or very short spur; (1) with an elongate, narrow spur (a synapomorphy for the hinei group).

3(11). Shape of phallapodeme: (0) triangular, with a moderately long projection or projection lacking; (1) with an elongate anteroventral projection (an autapomorphy for the meridionalis group).

4(12). Shape of gonite: (0) nearly as wide as long, lobate; (1) gonite slender, much longer than wide (Figs. 67–68; an autapomorphy for the meridionalis group).
5(13). Shape of hypandrium: (0) usually pocketlike in lateral view; (1) hypandrium flattened (an autapomorphy for the meridionalis group).

Using the implicit enumeration (ie*) option of Hennig86, which is an exhaustive search, a single most parsimonious tree was generated from the analysis of the 13 characters. The cladogram has a length of eight steps and consistency and retention indices of 1.0.

As indicated on the cladogram (Fig. 1), the genus Cressonomyia is divided into three basal sublineages to which we have accorded species-group status. The first basal sublineage comprises the aciculata group, which includes C. aciculata and a new species, C. bolivia, and its monophyly is established by characters 1, 2, and 6. The second species group, which is sister group to the third (supported by character 5), is the hinei group and includes C. hinei and C. skinneri. The monophyly of the hinei group is established by the long, narrow spur on the poststyrus (character 10; Figs. 43, 57) and the microtomentose or microsculptured face (character 4). The last lineage, the meridionalis group, is monotypic, and its monophyly is well corroborated by five characters that we have identified (characters 3, 9, 11, 12, and 13).

Key Species of Cressonomyia Arnaud and Other Species that have been Included

1. Knob of halter white to yellowish (genus Psilopa) .................. Psilopa aeneonigra Loew
   - Knob of halter blackish brown to black (genus Cressonomyia) ............................... 2
2. Fronto-orbital setae minute; face and frons nearly flat in lateral view, largely bare, shiny; face long, height twice that of frons; darkened base of wing more extensive, occupying \( \frac{3}{5} - \frac{1}{2} \) base of cell \( \mathrm{cu}^1 \) ................. 3
   - Fronto-orbital setae well developed; face shorter, height 1.5\times that of frons; vestiture of face and frons variable; darkened base of wing less extensive, at most occupying basal \( \frac{1}{3} \) of cell \( \mathrm{cu}^1 \) ................. 4
3. Mesonotum smooth, polished, at most weakly aciculate; scutellum arched ........................ C. bolivia, new species
   - Mesonotum microsculptured, subopaque, granulose, or aciculate; scutellum flat ................ C. aciculata (Loew)

4. Face and mesonotum microsculptured ......
   - C. hinei (Cresson)
   - Face and mesonotum smooth, shiny or slightly microtomentose ................. 5
5. Face polished: arista with 4–5 dorsal rays .
   - C. meridionalis (Cresson)
   - Face with vertical, microtomentose stripe medially; arista with 8 rays ... C. skinneri (Cresson)

The Aciculata Group

Remarks.—Of the two species groups we recognize in Cressonomyia, the monophyly of the aciculata group is more evident. Synapomorphies that characterize the aciculata group and establish its monophyly are (pleisiomorphies in parenthesis): (1) fronto-orbital setae minute (elsewhere in Psilopini, the fronto-orbital setae are relatively large); (2) face and frons nearly flat in lateral view, largely bare, shiny (usually the frons and face in lateral view are on more angulate planes); (3) darkened base of wing more extensive, occupying \( \frac{3}{5} - \frac{1}{2} \) base of cell \( \mathrm{cu}^1 \). Having a darkened base is a synapomorphy, and we interpret the more extensively darkened base, as in this species group, to be the more derived state in the transformation series of this character.

Cressonomyia aciculata (Loew)
(Figs. 2–16)


Plagiopsis aciculata: Cresson 1942: 127 [generic combination]; 1946: 160–161 [review, Neotropical fauna, Colombia, Costa Rica, Cuba, Guatemala, Haiti, Ja-
maica, Mexico, Nicaragua, Panamá, Puerto Rico, Trinidad, Venezuela].


*Ephygrobia metallica* Schiner 1868: 242.—Cresson 1925: 244 [synonymy, designation of a lectotype].

*Plagiops nitidifrons* Cresson 1918: 54.—Curran 1928: 32 [fauna, St. Croix].—Hendel 1930: 141 [fauna, Paraguay].

**New synonym.**

*Plagiopsis nitidifrons*: Cresson 1938: 30 [generic combination, fauna, Brazil]; 1946: 159–160 [review, Neotropical fauna, Bolivia, Costa Rica, Guyana, Panamá].


Description.—This species is distinguished from congener by the following combination of characters: Small to moderately small shore flies, body length 1.50–2.35 mm.

**Head**: Fronto-orbital setae minute. Arista bearing 8 dorsal rays. Face and frons in lateral view only slightly arched, almost straight; face bare, shiny.

**Thorax**: Mesonotum microsculptured, subopaque, granulose, or aciculate. Wing with costal vein ratio 0.87–0.95; M vein ratio 0.56–0.60.

**Abdomen**: Male terminalia (Figs. 2–15): Epandrium broadly U-shaped in posterior view (Fig. 2), much wider ventrolaterally than dorsally; cerci almost rodlike, shallowly curved (Fig. 2); presurstylus in posterior view (Fig. 2) incised medially, forming subbasal notch, 3 setulae in notch, thereafter ventrally swollen medially to slightly more than width at base then tapered and recurved to fingerlike apex, in lateral view wider basally and slightly recurved posteriorly, very gradually tapered to blunt ventral apex; posturstylus in lateral view (Figs. 5, 15) deeply bilobed, posterior lobe longer and wider, width somewhat even throughout length, bearing numerous setulae, posterior margin sinuous, anterior lobe shorter, tapered to point; pregonite (Figs. 4–5, 10, 13) moderately long, slightly tapered, broadly rounded apically, bearing 3 well-developed setulae apically; aedegus in ventral view with slight bulge basally, thereafter parallel sided on apical half, apex broadly rounded, in lateral view with medial margin broadly incised, apex with short, curved, pointed lobe at ventral corner; phallapodeme (Figs. 6–7) with keel wide basally, extended portion irregularly triangular in lateral view; subepandrial plate in ventral view (Fig. 11) wider than long, narrowed medially, each lateral portion slightly flared, in lateral view (Fig. 14) narrowly triangular, pointed ventrally; hypan- drium in lateral view (Figs. 5, 9) more deeply pocketlike, in ventral view broadly V-shaped (Figs. 4, 8), anteriorly with very slender, pointed posterolateral projections.

**Type material.**—The neotype male of *Psilopa aciculata* Loew, here designated to preserve stability and make more universal the use of this name, is labeled “CUBA. Holquí: Santa Lucia (3 km N), 22 Feb 1992, MyvonTschirnhaus/NEOTYPE ω Psilopa aciculata Loew by Mathis & Zatwarnicki [red].” The neotype is double mounted (glued to a paper triangle), is in excellent condition, and is deposited in the USNM. We have designated a neotype for this species because no specimen from the type series is available for designation as a lectotype in either the MCZ or the Humboldt Universität (Berlin, Germany) where Loew’s collections were deposited. There is a specimen in the MCZ that is labeled “18 [handwritten]/Loew Coll./Type? [red; ‘?’ handwritten]/Cressonomyia aciculata (Lw.) WWirth ’61 [black submargin; handwritten except for ‘WWirth’].” but this specimen does not have the silver square that was used to identify Poey’s material that Osten Sacken acquired and eventually sent to Loew (Osten Sacken 1903). The lack of a
Figs. 2–5. Structures of the male terminalia of *Cressonomyia aciculata* (Cuba, Holguín; Holguín, north). 2. Epandrium, cerci, and presurstylus, posterior view. 3. Same, lateral view. 4. Aedeagus (shaded), phallapodeme, postsurstylus, pregonite, and hypandrium, ventral view. 5. Same, lateral view.
silver square or any other indication that this was a specimen of the type series is undoubtedly the reason why the red "Type?" was put on this specimen, indicating the questionable status of this specimen. For these reasons and to stabilize the use of this name, we have selected the male specimen, as noted, as the neotype.
Fig. 16. Distribution map for Cressonomyia aciculata (dots) and C. bolivia (triangles).

The lectotype female of *Ephygrobia metallica* Schiner (designated by Cresson 1925: 244) is labeled “TYPE [red]/Lindig 1864 Venezuela/metallica Alte Sammlung/Ephygrobia metallica Schin./Plagiops aciculata (Loew) det. Cresson. 1924.” The lectotype is in good condition and is deposited in the NMW.

The holotype male of *Plagiops nitidifrons* Cresson is labeled “Guacimo 6VI09 [6 Jun 1909] Costa Rica PPCalvert/d/TYPE 6127 [red: number handwritten]/TYPE Plagiops nitidifrons E T CRESSON JR [red: species name handwritten: “TYPE” written on left margin of label].” The holotype is double mounted (minuten in a thin, rectangular piece of cardboard), is in excellent condition, and is deposited in the ANSP (6127). The type locality, Guacimo, is in the province of Limón.

Other specimens examined.—Nearctic: UNITED STATES. Texas. Cameron: Boca Chica, R. H. Beamer, C. Michener, J. Rosen, W. Stephen (1 ♂: USNM); Brownsville, 8 Apr 1945, D. E. Hardy (1 ♀: USNM); Harlingen, 9 Mar 1945, D. E. Hardy (1 ♀: USNM).

Neotropical: BAHAMAS. New Providence: Nassau, 28 Jun (2 ♂, 2 ♀; MCZ).

BELIZE. Stann Creek: Placencia Lagoon, Rum Point, 4–5 Nov 1987, D. and W. N. Mathis (3 ♀; USNM).


COLOMBIA. Magdalena: Aracataca (10°35.5'N, 74°11.5'W), Feb 1912, Ujhelyi (1 ♀; ANSP).

COSTA RICA. Alajuela: Alajuela (945 m), 15 Sep 1909, P. P. Calvert (1 ♂; ANSP);
Caño Negro (10°53.6’N, 84°47.4’W; 20 m), 14–27 Apr 1994, K. F. Flores (2 ♀; 3 ♂; INBIO); Chomogó area (10°18’N, 84°47’W; 1620 m), 13 Jun 1973, T. L. Erwin, G. F. Hevel (1 ♂; 1 ♀; USNM). Cartago: Peralta (9°58’N, 83°37’W; 332 m), 7 Aug 1909, P. P. Calvert (1 ♂; ANSP). Guanacaste: Hacha, Finca el Oro (5 km S de Hacienda Alemanía; 11°01.4’N, 85°27.5’W; 400 m), 14–19 Apr 2002, D. Briceno (8 ♂; 11 ♀; INBIO); La Virgen de Sarapiquí (10°23.7’N, 84°08.5’W), 9–24 Apr 1993, M. Ortiz (1 ♀; INBIO); Santo Domingo, INBio Parque (9°58.4’N, 84°5.6’W), 18 Feb 2003, W. N. Mathis (1 ♂; 1 ♀; USNM).

Limón: Batán, 16 Jun 1951, L. L. Cartwright (1 ♂; USNM); Guácimo (10°13’N, 83°41’W; 110 m), 6 Jun 1909, P. P. Calvert (1 ♂; paratype; ANSP). Puntarenas: Estación Aguja (8°32.2’N, 83°25.5’W; 300 m), 19–24 Mar 1997, A. Azofeifa (1 ♀; INBIO); Estación Cabuya (9°35.3’N, 85°05.9’W; 50 m), 22 Mar 1997, F. Alvarado (1 ♂; INBIO); Estación Carara (9°46.5’N, 84°31.6’W; 200 m), Feb 1990, R. Zúñiga (1 ♂, 2 ♀; INBIO); Estación Quebrada Bonita (9°46’N, 84°36.5’W; 50 m), 21 Mar–21 Apr, 1989, R. Zúñiga (1 ♂; 1 ♀; INBIO); Estación Sirena, Corcovado (8°28.8’N, 83°35.5’W), 21 Mar–21 Apr 1992, Z. Fuentes (1 ♀; INBIO); Monteverde, 26 Mar 1987, W. E. Steiner (13 ♀; 21 ♂; USNM); San José: Lago Arenal (8°40.8’N, 83°34’W; 200 m), 1992, K. Flores (1 ♀; INBIO). San José: Los Cocos (8°22’N, 83°43’W), D. L. Round (1 ♀; ANSP).


DOMINICAN REPUBLIC. Distrito Nacional: Ciudad Trujillo (6 km W; = Santo Domingo), 16–20 Dec 1955, J. Maldonado Capriles (1 ♀; USNM). La Vega: El Río (9.5 km E; 19°0.9’N, 70°33.5’W; 980 m), 6 May 1995 (1 ♀; USNM); Río Camu (3.5 km NW La Vega; 19°13.7’N, 70°35.2’W; 100 m), 10 May 1995, W. N. Mathis (2 ♂, 10 ♀; USNM); Valle del Río, 28 Dec 1955, J. Maldonado Capriles (2 ♀; USNM). Pedernales: Cabo Rojo (23.5 km N; 18°06’N, 71°38’W; 540 m), 13–19 Jul 1990, L. Masner, J. Rawlins, C. Young (1 ♀; CMP).

ECUADOR. Los Ríos: Quevedo (40 km S), 11 Jul 1975, J. Cohen, Peterson, Thomdal (1 ♂; USNM).

EL SALVADOR. San Salvador, 14 Jun 1958, L. J. Bottiner (1 ♀; USNM).

GRENADE. St. Andrew: La Force Bridges (12°07.6’N, 61°39.8’W), 19 Sep 1996, W. N. Mathis (2 ♀; USNM).

GUYANA. Georgetown (6°48.6’N, 58°08.6’W), 20–29 Aug 1997, W. N. Math-
is (1 ♂; USNM); Georgetown, Atkinson Airport Road, 2 Jun 1965, S. M. Gaud, L. F. Martorell (1 ♀; USNM). Karanambo, Rupununi River (ox bow; 3°45.1’N, 59°18.6’W), 2 Apr 1994, W. N. Mathis (9 ♂, 8 ♀; USNM).

HAITI. (1 ♂, 1 ♀; USNM).

HONDURAS. Lancetilla (15°42’N, 87°28’W), Aug. Stadelmann (1 ♀; MCZ).

JAMAICA. Clarendon: Barnswell Beach (17°45.’N, 77°08.5’W), 13 May 1996, D. and W. N. Mathis, H. Williams (4 ♂, 4 ♀; USNM); Farquhar’s Beach (17°50.9’N, 77°22.8’W), 9 May 1996. D. and W. N. Mathis, H. Williams (3 ♂, 4 ♀; USNM); Jackson Bay (17°44.7’N, 77°12.6’W), 13 May 1996. D. and W. N. Mathis, H. Williams (3 ♂, 5 ♀; USNM); Portland Cottage (17°45.4’N, 77°11’W), 13 May 1996, D. and W. N. Mathis, H. Williams (1 ♂, 3 ♀; USNM); Portland Cottage (1 km S; 17°45.8’N, 77°12.6’W), 13 May 1996, D. and W. N. Mathis, H. Williams (1 ♂, 1 ♀; USNM); Salt River (4 km N; 17°52.1’N, 77°09.5’W), 13 May 1996, D. and W. N. Mathis, H. Williams (1 ♀; USNM); Toll Gate (7.7 km S; 17°58’N, 77°22.3’W), 9 May 1996. D. and W. N. Mathis, H. Williams (1 ♂, 1 ♀; USNM). Manchester: Baterssea (17°13’N, 77°29’W), Feb 1910. R. Thaxter (1 ♀; ANSP); Mandeville, Feb 1910. R. Thaxter (1 ♀; ANSP); near Mandeville (18°03.5’N, 77°31.9’W), 15 Apr–7 May 1996, 2000. D. and W. N. Mathis, H. Williams (12 ♂, 24 ♀; USNM); near Warwick (17°54.1’N, 77°25.5’W), 7 May 1996. D. and W. N. Mathis, H. Williams (1 ♀; USNM). St. Andrew: Irishtown (5 mi SW via road), 7 Dec 1975. G. F. Hevel (1 ♂); USNM); Ferry River, 13 May 1941. E. Chapin (1 ♀; USNM); Hardwar Gap, 10 Mar 1970. T. Farr, W. W. Wirth (1 ♂; USNM). St. Catherine: Fresh River at Ferry, 22 Jul 1962. T. Farr, O. S. Flint (1 ♀; USNM). St. Elizabeth: Balaclava (18°10’N, 77°39’W), R. Thaxter (1 ♀; MCZ); Black River (18°01.4’N, 77°51.1’W), 11 May 1996. D. and W. N. Mathis, H. Williams (3 ♂, 2 ♀; USNM); Elim (18°07.1’N, 77°40.5’W), 10 Apr 2000. W. N. Mathis (1 ♂, 2 ♀; USNM); Maggotty Falls (18°08.2’N, 77°45.1’W), 18 Apr 2000. W. N. Mathis (1 ♀; USNM).

MEXICO. Chiapas: Boca de Cien (17 km S Puerto Arista), 18 May 1985. A. Freidberg, W. N. Mathis (1 ♀; USNM); Cascadas de Agua Azul (62 km S Palenque), 7 May 1985. W. N. Mathis (1 ♂, 1 ♀; USNM); Finca Prusia (33 km S Jaltenango, 1000 m), 10–12 May 1985. W. N. Mathis (1 ♂; USNM); Union Juarez (9 km S), 23 Apr 1983 (1 ♂, 2 ♀; USNM). Jalisco: Puerto Vallarta, 5 Oct 1984. G. E. Borth (2 ♀; BYU). Tabasco: Teapa (8 km SW), 6 May 1985. W. N. Mathis (1 ♀; USNM). Veracruz: Ciudad Aleman, 3 May 1985. W. N. Mathis (2 ♂, 2 ♀; USNM); Fortin de las Flores, 2 May 1985. W. N. Mathis (1 ♂; USNM); Ocotal Chico (600 m), 4–5 May 1985. W. N. Mathis (1 ♂; USNM).

MONTserrat. Trinidad. 29 Jun 1905. A. Busck (1 ♀; USNM).

PANAMA. Canal Zone: Coraza, 1–6 Mar 1911. A. Busck (1 ♂, 1 ♀; ANSP); Paraíso, 3–7 Feb 1911. A. Busck (1 ♂, 2 ♀; ANSP); Plantation “Borrorcho,” 10 Jul 1918. H. F. Dietz. J. Zetek (1 ♀; USNM).

PARAGUAY. Asunción, May 1905. Veñéyi (1 ♂, 2 ♀; ANSP). Villarica, Jul 1937. F. Schade (3 ♂, 3 ♀; USNM).

PERU. Madre de Dios: Manu, Rio Manu, near Romero, 8 Sep 1988. W. N. Mathis (1 ♂, 3 ♀; USNM).


ST. VINCENT. St. Andrew: Buccament Bay (near beach: 13°11’N, 61°16’W), 8 Jun

TOBAGO. St. John: Charlotteville (beach; 11°19.5’N, 60°32.9’W), 16–18 Apr 1994, D. and W. N. Mathis (1 ♂; USNM). Charlotteville (5 km S; 11°19'N, 60°34’W), Hermitage River and beach, 22 Apr–10 Jun 1993, W. N. Mathis (2 ♂, 4 ♀; USNM); Parlatuvier (creek; 11°17.9’N, 60°35’W), 20 Apr 1994, W. N. Mathis (2 ♂, 4 ♀; USNM); Speyside (1 km NW; Doctor River; 11°18’N, 60°32’W), 12–13 Jun 1993, W. N. Mathis (3 ♂, 4 ♀; USNM). St. Paul: Argyle Falls (11°15’N, 60°35’W), 21 Apr 1994, W. N. Mathis (5 ♂, 4 ♀; USNM); Delaford, Kings Bay (11°16’N, 60°32.8’W), 13 Jun 1993, W. N. Mathis (2 ♂, 4 ♀; USNM); Roxborough (6 km NNW; 11°16’N, 60°35.4’W), 20 Apr 1994, W. N. Mathis (7 ♀; USNM).

TRINIDAD. St. Andrew: Valencia (1 km W; 10°39’N, 61°13’W), Aripo River, 20 Jun 1993, W. N. Mathis (6 ♂, 3 ♀; USNM).


Distribution (Fig. 16).—Nearctic: USA (AL?, TX). Neotropical: Bahamas, Belize, Brazil (Distrito Federal, Rio de Janeiro), Colombia (Magdalena), Costa Rica (Alajuela, Cartago, Guanacaste, Limón, Puntarenas, San José), El Salvador, Guyana, Honduras, Mexico (Chiapas, Jalisco, Tabasco, Veracruz), Panamá, Paraguay, Peru, Trinidad and Tobago, Venezuela, West Indies (Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Montserrat, Puerto Rico, St. Vincent).

Remarks.—We found considerable intraspecific variation in the degree of microsculpturing of the mesonotum and in the convexity of the scutellum of this species. Cresson (1946: 159–162) used these characters to distinguish between C. aciculata and his C. nitidifrons. Our attempts to use these characters proved futile, given the variation, and when we examined structures of the male terminalia, we quickly discovered that these two species are essentially identical. Thus, our observations reveal that there is intraspecific variation in the microsculpturing and scutellar convexity but that structures of the male terminalia are consistent. Cressonomyia aciculata and C. nitidifrons are conspecific, and their names are synonyms with the former being senior.

Although primarily occurring in the Neotropical Region, we have examined specimens of this species from southern Texas. Cresson (1942) reported a specimen from Alabama, which we have not confirmed and thus did not include on the distribution map of this species (Fig. 16).

Cressonomyia boliviana Mathis and Zatwarnicki, new species
(Figs. 17–30)

Description.—This species is distinguished from congeners, especially of the aciculata group, by the following combination of characters: Small to moderately small shore flies, body length 1.50–1.90 mm.

Head: Fronto-orbital setae minute. Arista bearing 8 dorsal rays. Face and frons in lateral view only slightly arched, almost straight: face bare, shiny.

Thorax: Mesonotum microsculptured, subopaque, granulose, or aciculate. Wing with costal vein ratio 0.97–1.05; M vein ratio 0.62–0.67.

Abdomen: Male terminalia (Figs. 17–30): Epandrium broadly U-shaped in posterior view (Fig. 17), much wider ventrolaterally than dorsally; cerci almost rodlke (Fig. 17), more rounded laterally, medial margin nearly straight: presurstylus in posterior view (Fig. 17) incised medially, forming subbasal notch, 3 setulae in notch along basomedial portion, thereafter ventrally swollen medially to slightly less than width at base then tapered and recurved to pointed
apex, in lateral view (Fig. 18) wider basally and slightly recurved posteriorly, very gradually tapered to blunt ventral apex; poststurstylus in lateral view (Figs. 20, 30) deeply bilobed, posterior lobe longer and wider than anterior lobe, bearing numerous setulae, slightly angulate, apex bluntly rounded; pregnite (Figs. 19–20, 27, 29) moderately long, slightly tapered, broadly rounded apically, bearing 3 well-developed setulae apically; aedeagus in ventral view (Fig. 19) with slight bulge on basal two-thirds, lateral margin of swollen portion irregularly wavy, thereafter apically parallel sided, apex broadly rounded, in lateral view (Figs. 20, 22) with medial margin deeply sinuous, apex irregularly truncate; phallopodeme with keel moderately wide basally, extended portion trapezoidal in lateral view; subepandrial in lateral view (Fig. 26) tapered to curved, point; hypandrium in lateral view moderately deeply pocketlike, in ventral view subquadrate anteriorly, wider than long, anterior margin nearly flat, with wide posterolateral projections posteriorly, lacking anterior projections.

Type material.—The holotype male is labeled "BOLIVIA. Depto. La Paz[,] Tajlihuí, 590 m[.] 15°40.8’S 67°41.7’W[.] 12-iii-2001 [12 Mar 2001], S.D. Gaimari/HOLOTYPE Cressonomia bolivia δ W.N. Mathis USNM & Zatwarnicki [red; species name and ‘& Zatwarnicki’ handwritten].” The holotype is double mounted (minuten in a block of plastic), is in excellent condition, and is deposited in the MNBL. Twenty-six paratypes (14 δ, 12 ♂; MNBL, USNM) bear the same locality label data as the holotype.

Other specimens examined.—Neotropical: BOLIVIA. La Paz: Guanay (15°29.8’S, 67°52.7’W; 460 m), 13 Mar 2001, W. N. Mathis (1 δ; USNM); Guanay (3 km E; 15°30.2’S, 67°52.3’W; 500 m), 14 Mar 2001, W. N. Mathis (2 ♂; USNM).

Distribution (Fig. 16).—Neotropical: Bolivia (La Paz).

Etymology.—The species epithet, bolivia, alludes to the country where the type series was collected.

Remarks.—Although this species is now only known from Bolivia, we would expect that it will be found elsewhere at mid-elevational sites.

The hinei Group

Remarks.—The hinei group, which comprises C. hinei and C. skinneri, is distinguished from the aciculata group or meridionalis groups by the following combination of characters (synapomorphies that characterize the meridionalis group and establish its monophyly are indicated by an *): (1) fronto-orbital setae well developed; (2*) face shorter, height 1.5× that of frons; vestiture of face and frons variable; (3*) face microsculptured or with vertical microtomentose stripe; (4) darkened base of wing less extensive, at most occupying basal ¼ of cell cu₄; and (5*) poststurstylus with a posterior lobe that is elongate, narrow, spur-like (Figs. 43, 57).

Cressonomia hinei (Cresson) (Figs. 31–45)

Plagiops hinei Cresson 1922: 135.
Psilopa hinei: Cresson 1942: 127 [generic combination; lapsus calami].
Cressonomia hinei: Wirth 1965: 742 [Neartic catalog; generic combination].

Description.—This species is distinguished from congeners, especially of the skinneri group, by the following combination of characters: Small to moderately small shore flies, body length, 1.75–2.35 mm.

Head: Fronto-orbital setae well developed. Arista bearing 7–8 dorsal rays. Face and frons moderately arched in lateral view; face short, height 1.5× that of frons, moderately microsculptured with some iridescent greenish blue coloration.

Thorax: Mesonotum moderately microsculptured; darkened base of wing at most occupying basal ¼ of cell cu₄. Wing with
costal vein ratio 0.96–1.10; M vein ratio 0.62–0.63.

**Abdomen:** Male terminalia (Figs. 31–44): Epandrium broadly U-shaped in posterior view (Fig. 31), rounded, moderately wider ventrolaterally than dorsally; cerci (Fig. 31) almost rodlike and parallel sided; presurstylus in posterior view (Fig. 31) incised medially, forming a large subbasal notch, 3 setulae in dorsal portion of notch, thereafter ventrally greatly swollen medially to slightly more than width at base then
Figs. 31–34. Structures of the male terminalia of *Cressonomyia hinei* (Mexico, Tabasco: Teapa (8 km SW)). 31, Epandrium, cerci, and presurstylus, posterior view. 32, Same, lateral view. 33, Aedeagus (shaded), phallapodeme, postsurstylus, pregonite, and hypandrium, ventral view. 34, Same, lateral view.
tapered and recurved to short, pronglike apex, in lateral view (Fig. 32) wider basally, thereafter almost straight, very gradually tapered to blunt ventral apex; postursstylus in lateral view (Figs. 34, 43) trilobed, medial lobe much longer and wider, spatulate on apical half, bearing numerous setulae, posterior margin of spatulate portion with 4–5 setulae from dentate bases, posterior lobe ½ length of medial lobe, slender, spurlike, bearing 1–2 setulae, anterior lobe very short, broadly triangular; pregonite (Figs. 33–34, 39, 42) moderately long, slightly narrowed medially, thereafter widened to broadly rounded to truncate apex, bearing 3 well-developed setulae apically; aedeagus in ventral view (Figs. 33, 35) with slight bulge on basal third, thereafter apically very slightly flared to mostly parallel sided, apex broadly truncate, in lateral view almost parallel sided, medial margin very shallowly and widely incised at middle third; phallapodeme (Figs. 34, 35–36) with narrowly projected, parallel sided keel; subepandrial plate in ventral view (Fig. 40) broadly inverted V-shaped, in lateral view (Fig. 44) shallowly bilobed, longer lobe slightly tapered, pointed apically; hypan- drium in lateral view (Fig. 38) more deeply pocketlike, in ventral view (Figs. 33–37) with anterior moderately wide, posteriorly curved and pointed processes, posterior processes oriented posteriorly.

Type material.—The holotype female of Plagiops hinei Cresson is labeled “Plagiops hinei Barrios. Guatemala Mch.3-14 05 [3–14 Mar 1905] / Holo-TYPE Plagiops HINEI E. T. Cresson Jr [maroon; species name handwritten].” The holotype is double mounted (glued to a narrow, paper triangle), is in excellent condition, and is deposited in OHSU.


COSTA RICA. Alajuela: Caño Negro (10°53.6′N, 84°47.4′W; 20 m), 14–27 Apr 1994, K. F. Flores (2 ♂, 3 ♀; INBIO).

EL SALVADOR. Santa Tecla (12 km NW), Feb 1954, W. B. Heed (1 ♀; USNM).

MEXICO. Tabasco: Teapa (8 km SW), 6 May 1985, W. N. Mathis (11 ♂, 20 ♀; USNM). Veracruz: Ciudad Aleman, 3 May 1985. W. N. Mathis (2 ♂, 2 ♀; USNM); Tampico, 29 Dec 1908 (1 ♀; ANSP).


Distribution (Fig. 45).—Nearctic: USA (FL, LA, MS, SC, TX). Neotropical: Be- lize, Costa Rica (Alajuela). El Salvador.
Figs. 35–44. Structures of the male terminalia of *Cressonomyia hinei* (Mexico. Tabasco: Teapa (8 km SW)).

Guatemala, Mexico (Tabasco, Veracruz), Panamá.

Remarks.—In North America, this is the most widespread species, but its distribution there is primarily confined to the southeastern United States.

The moderately microsculptured face with some iridescent greenish blue colora-
tion distinguishes this species most easily from congeners.

*Cressonomyia skinneri* (Cresson) (Figs. 46–58)

*Psilopa skinneri* Cresson 1922: 136.—Wolcott 1936: 383 [list, Puerto Rico].

*Plagiops skinneri*: Cresson 1946: 159 [generic combination].

*Plagiopsis skinneri*: Cresson 1942: 126 [generic combination]; 1946: 158–159 [review, Neotropical fauna, Brazil, Cuba, Panamá, Paraguay, Puerto Rico].


Description.—This species is distinguished from congeners, especially of the *skinneri* group, by the following combination of characters: Small to moderately small shore flies, body length 1.65–2.35 mm.

*Head*: Fronto-orbital setae well developed. Arista bearing 8 dorsal rays. Face and frons moderately arched in lateral view; face short, height 1.5× that of frons, with vertical, microtomentose stripe medially; facial setae in minute pits.

*Thorax*: Mesonotum smooth, shiny; darkened base of wing at most occupying basal ¼ of cell cu₄. Wing with costal vein ratio 0.70–0.78; M vein ratio 0.64–0.7. Tibial apices yellowish.

*Abdomen*: Male terminalia (Figs. 46–57): Epandrium broadly U-shaped in posterior view (Fig. 46), rounded, moderately wider ventrolaterally than dorsally; cerci (Fig. 46) almost rodlike, wider ventrally, lateral margins rounded, medial margin almost straight; presurstylus in posterior view (Fig. 46) incised medially, forming an angulate, moderately deep subbasal notch, 2
Figs. 46–49. Structures of the male terminalia of *Cressonomyia skinneri* (Jamaica. *Clarendon*: Grantham (18°09.3’N, 77°23.8’W; 340 m)). 46. Epandrium, cerci, and presurstylus, posterior view. 47. Same, lateral view. 48. Aedeagus (shaded), phallapodeme, postsurstylus, pregonite, and hypandrium, ventral view. 49. Same, lateral view.
setulae in dorsal portion of notch, thereafter ventrally shallowly swollen medially to slightly less than width at base then tapered and recurved to short, blunt apex, in lateral view (Fig. 47) much wider basally, thereafter almost straight, very slightly tapered to blunt apex; poststurstylus in lateral view (Figs. 49, 57) somewhat trilobed, medial lobe much longer and wider, slightly spatulate on apical half, bearing numerous setulae, posterior lobe moderately long, narrow, spurlike, bearing 2 setulae, anterior lobe broadly triangular; pregonite (Figs. 48–49, 52) moderately long, in lateral view (Fig. 55) subquadrate, apex truncate, bearing 3 well-developed setulae apically; aedeagus in ventral view (Figs. 48, 550) with basal third slightly swollen, lateral margins of swollen portion almost parallel sided, subquadrate, thereafter almost parallel sided to apex, apex broadly truncate, in lateral view (Figs. 49, 51) with medial margin widely and moderately deeply and irregularly incised, external margin more evenly arched; phallapodeme (Figs. 48–51) with keel wide basally, irregularly and asymmetrically projected, projection longest toward hypandrium; subepandrial plate in ventral view (Fig. 53) shallowly and broadly V-shaped, each arm wider than narrow medial portion, in lateral view (Fig. 56) subquadrate with apical corners slightly produced; hypandrium in lateral view (Fig. 49) more moderately deeply pocketlike, slightly angulate, in ventral view (Figs. 48, 50) with anterior margin symmetrically and shallowly sinuous, moderately wide anteriorly, thereafter posteriorly more or less parallel sided, posterior, subanteriorly with very slender, pointed posterolateral projections.

Type material.—The holotype female of *Psilopa skinneri* Cresson is labeled “Guantanamo Cuba/H. Skinner 10 11 ’14 [10 Nov 1914; “10” handwritten] /δ [sic, specimen is a female]/Holo-TYPE Psilopa skinneri E. T. Cresson Jr [red: species name handwritten].” The holotype is double mounted (minuten in a thin, rectangular piece of cardboard), is in fair condition (head missing), and is deposited in the ANSP (6346). The type locality is in the province of Guantánamo.

Other specimens examined.—Neotropical: ARGENTINA. Corrientes: Corrientes, 23 Feb 1927, R. C. Shannon (1 ♂; USNM).


CUBA. Cienfuegos: Aguada de Pasajero (22°23 ’N, 80°51’W), Feb 1915 (1 ♂, 3 ♀; USNM); Jardín Botánico (Soledad; 22°7.5 ’N, 80°19.2’W), Jan–Feb 1927, C. T. and B. B. Brues (2 ♂, 6 ♀; USNM). Granda: Cayamas. Baker (1 ♂; USNM). Guantánamo: Guantánamo, 10 Nov 1914, H. Skinner (1 ♂; paratype; ANSP). Havana: Havana. Baker (1 ♂; ANSP); Ojo de Agua (22°54.6 ’N, 82°29.1’W), 8 Dec 1994, W. N. Mathis (1 ♂; USNM). Pinar del Río: Soroa (22°47.7 ’N, 83°W), 4–6 Dec 1994, W. N. Mathis (1 ♂, 1 ♀; USNM).

DOMINICAN REPUBLIC. Independencia: Los Bolos (18°37.8 ’N, 71°39.2’W; 1370 m), 24 Mar 1999, W. N. Mathis (4 ♂, 17 ♀; USNM). La Vega: El Río (9.5 km E; 19°0.9 ’N, 70°33.5’W; 980 m), 6–24 May 1995, 1998, W. N. Mathis (11 ♂, 4 ♀; USNM); Jarabacoa (1–2 km S; 19°06.9 ’N, 70°37’W; 520 m), 8–21 May 1995, 1998, W. N. Mathis (5 ♂, 6 ♀; USNM); Rio Camu (3.5 km NW La Vega; 19°13.7 ’N, 70°35.2’W; 100 m), 10 May 1995, W. N. Mathis (1 ♀; USNM). Puerto Plata: Rio Camu (14 km E Puerto Plata; 19°11.9 ’N, 70°37.4’W), 17 May 1995, W. N. Mathis (3 ♂, 1 ♀; USNM).


Mathis (13 ♂, 11 ♀; USNM); Mavis Bank (4.3 km SE; 18°01.4′N, 76°38.1′W; 480 m). Yallahs River, 22–23 Apr 2000, W. N. Mathis (11 ♂, 8 ♀; USNM); Silver Hill Gap (18°05.1′N, 76°41.1′W; 920 m), 26 Apr 2000, W. N. Mathis (2 ♂, 1 ♀; USNM); Wag Water River, 25 Feb 1969, W. W. Wirth (1 ♀; USNM). *St. Mary: Annotto Bay* (marsh), 25 Feb 1969, W. W. Wirth (3 ♀; USNM).

MEXICO. Chiapas: Cacahoatan (7 km N), 22 Apr 1985, W. N. Mathis (1 ♂, 1 ♀; USNM); Union Juárez, 23 Apr 1983, W. N. Mathis (1 ♀; USNM). Veracruz: Tampico, 25 Feb 1972, D. Miller, F. Parker (1 ♂; USNM).
PANAMA. Canal Zone: Balboa, Oct 1946, N. L. H. Krauss (1 ♀; USNM). Taboga Island, 26 Feb 1912, A. Busck (1 ♂; USNM).


VENUEZUELA. Santa Rosa: Barinas, Feb 1943, F. Anduze (2 ♀; USNM).

Distribution (Fig. 58).—Nearctic: USA (FL). Neotropical: Argentina (Corrientes), Brazil (São Paulo), Mexico (Chiapas, Veracruz), Panama, Trinidad, Venezuela, West
Indies (Cuba, Dominican Republic, Jamaica, Puerto Rico).

Remarks.—The vertical, microtomenose, facial stripe is consistently evident but varies in its dimensions, sometimes extending dorsally to the ptinal suture and sometimes becoming gradually wider basally, toward the oral margin.

Although we have not examined any specimens of this species from the Nearctic Region, Cresson (1942) reported a specimen from Florida. This record needs confirmation and is not included on our distribution map (Fig. 58).

The Brazilian (São Paulo. Mongaguá: 24°06'S, 46°37'W) and Argentinian (Corrientes: 27°28'S, 58°50'W) localities are disjunct and appear to be outliers (Fig. 58), which prompted us to re-examine the specimens, especially the male from Brazil. We dissected this male and confirmed its identification, and here suggest that the known distribution of this species represents a sampling artifact. Thus, we predict that with better sampling, the known distribution will include sites between southeastern Brazil and northern Argentina and northern South America. The specimen from Paraguay that Cresson (1946) listed was not located, but if accurately identified, it probably reflects the same pattern just noted.

**The meridionalis Group**

Remarks.—The *meridionalis* group comprises a single species, *C. meridionalis*, which is somewhat similar externally to species of the *hinei* group. Structures of the male terminalia of this group are the most derived and divergent within *Cressonomyia* and are the primary basis for recognizing the group. The group is distinguished from the *aciculata* or the *hinei* groups by the following combination of characters (synapomorphies that characterize the *meridionalis* group and establish its monophyly are indicated by an *): (1) fronto-orbital setae well developed; (2*) arista with 4–5 dorsal rays; (3*) face shorter, height 1.5X that of frons; (4*) face polished; (5) darkened base of wing less extensive, at most occupying basal ¼ of cell cua.; (6*) presurstylus elongate, narrow, almost parallel sided, shallowly curved; (7*) phallapodeme with portion that attaches to hypandrium projected; (8*) gonite narrow; and (9*) hypandrium flattened in lateral view.

*Cressonomyia meridionalis* (Cresson)  
(Figs. 59–73)

*Psilopa meridionalis* Cresson 1918: 52.  
*Plagiopsis meridionalis*: Cresson 1946: 158  
[generic combination, review, Neotropical fauna].

*Cressonomyia meridionalis*: Wirth 1968: 11  
[generic combination, Neotropical catalog].—Mathis and Zatwarnicki 1995: 35  
[world catalog].

Description.—This species is distinguished from congeners, especially of the *skinneri* group, by the following combination of characters: Small to moderately small shore flies, body length, 1.70–2.25 mm.

**Head:** Fronto-orbital setae well developed. Arista bearing 4–5 dorsal rays. Face and frons moderately arched in lateral view; face short, height 1.5X that of frons, polished, shiny.

**Thorax:** Mesonotum smooth, shiny; darkened base of wing at most occupying basal ¼ of cell cua., Wing with costal vein ratio 0.98–1.00; M vein ratio 0.60–0.62. Tibiae mostly black.

**Abdomen:** Male terminalia (Figs. 59–72): Epandrium moderately broadly U-shaped in posterior view (Fig. 59), much wider ventrolaterally than dorsally; cerci (Fig. 59) somewhat rodlike, more rounded laterally, medial margin shallowly curved, pointed mediadorsally; presurstylus in posterior view sicklelike, gently curved, lacking medial notch and swelling, very slightly and gradually tapered to pointed apex, in lateral view as a long, narrow rod, only very slightly wider basally, apex slightly curved, almost truncate; posturstylus in lateral view (Figs. 60, 72) longer than wide, angulate, bearing numerous setulae, at corner of angle slightly wider from small, ex-
Figs. 59–62. Structures of the male terminalia of Cressonomymia meridionalis (Costa Rica, San José: Río Savegre, San Gerardo de Dota (9°39.5’N, 83°51’W; 2180 m)). 59, Epandrium, cerci, and presurstylus, posterior view. 60, Same, lateral view. 61, Aedeagus (shaded), phallapodeme, postsurstylus, pregonite, and hypandrium, ventral view. 62, Same, lateral view.
ternal lobe, apex with 2 small dentate projections at each corner; pregonite (Figs. 61–62, 67, 70) moderately long, narrow, apical half rodlike, parallel sided, narrowly rounded apically, bearing 3 well-developed setulae apically; aedeagus in ventral view (Figs. 61, 63) almost triangular, base much narrower than long, apical extension, like dorsal view of a bicycle seat, apex narrowly truncate, in lateral view (Figs. 62, 64) with

swelling on basal third, swollen portion extended medially, rounded, apical half slightly tapered, apex shallowly concave; phallopode (Figs. 62–64) comparatively large with wide, asymmetrically extended keel, longest extension toward hypandrium; subependrial plate in ventral view (Fig. 68) much wider than long, each lateral portion slightly curved posteriorly, bluntly rounded, in lateral view (Fig. 71) slightly tapered to rounded apex; hypandrium in lateral view (Fig. 62) very shallowly pocketlike, somewhat flattened, in ventral view (Fig. 61) suboval, lacking anterior and posterior projections.

Type material.—The holotype male of Psilopa meridionalis Cresson is labeled "Cartago 17V'09 [17 May 1909] Costa Rica. P.P. Calvert (1 ♂, 1 ♀; paratypes; ANSP); El Alto. Laguna de Ochomogo (9°53'N, 83°57'W; 1510 m), 7 Jul 1909, P. P. Calvert (1 ♀; ANSP); Near Tierra Blanca (Río Toyogres; 9°50'N, 83°55'W), 6 Apr 1910, P. P. Calvert (2 ♂, 2 ♀; ANSP); Trinidad (9°41.3'N, 83°54'W; 2530 m), 29 Jun 2001, A. Freidberg (1 ♂; USNM). Heredia: Santo Domingo (INBIO Parque; 9°58.4'N, 84°05.6'W), 23 Jun 2001, W. N. Mathis (2 ♂; USNM). San José: La Caja (8 km W San José), 1930, H. Schmidt (5 ♂, 1 ♀; USNM); Río Savegre. Cabinas de Quetzal (9°33.9'N, 83°48'W; 2270 m),

Fig. 73. Distribution map for Cressonomyia meridionalis.
7–8 Aug 2001, D. and W. N. Mathis (8 ♂, 2 ♀; USNM); Río Savegre, San Gerardo de Dota (9°39.5'N, 83°51'W; 2,180 m). 7–8 Aug 2001, D. and W. N. Mathis (22 ♂, 8 ♀; USNM).

MEXICO. San Luis de Potosí: Ciudad del Maíz (40–50 mi NW), 20 Nov 1948, E. S. Ross (1 ♀; USNM).

Distribution (Fig. 73). — Neotropical: Costa Rica (Cartago, Heredia, San José), Mexico (San Luis de Potosí).

Remarks.—The structures of the male terminalia, the presurstylus in particular, are quite remarkable and represent a major departure from other species in Cressonomysia. The narrow, almost parallel-sided, sickle-shaped presurstylus is quite unique, and readily identifies this species. Otherwise, however, we did not find this species to differ greatly from congeners.

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LITERATURE CITED


———. 1946. A systematic annotated arrangement of the genera and species of the Neotropical Ephydridae (Diptera) I. The subfamily Psilopinae.
KEY TO THE GENERA OF NEW WORLD ALYDIDAE
(HEMIPTERA: HETEROPTERA)

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Abstract.—There are two subfamilies in Alydidae, Alydinae and Micrelytrinae, the
latter with two tribes, Micrelytrini and Leptocorisini. The Alydinae contain two tribes,
Daclerini (Old World genus Daclera Signoret only) and Alydini (the remainder of the
subfamily). The Alydidae contain 53 genera, of which 19 occur in the New World exclu-
sively, and two others in the Holarctic; a third is pantropical. The numbers break down
as follows: Alydinae: Alydinae, 25 genera, 8 in the New World; Micrelytrinae: Micrely-
trini, 22 genera, 11 in the New World; Micrelytrinae: Leptocorisini: Leptocorisidi, 4 gen-
era, 1 in the New World; Noliphidi, 2 genera, 1 in the New World. Keys to subfamilies,
tribes, genera, and subgenera of New World Alydidae are given.

Key Words: Hemiptera, Heteroptera, Alydidae, Micrelytrinae, Leptocorisini, New World,
keys

Alydidae are a family of somewhat to
greatly elongate heteropterans included
with Stenocephalidae, Hyccephalidae, Rh-
opalidae, and Coreidae in the Coreoidea
(Schaefer 1964, Henry 1997). Although Al-
ydidae were once included as a subfamily
of Coreidae, they are now treated as a sepa-
rate family (Schaefer 1964). Three of the
family’s higher groups (based on Alydus Fab-
ricius, Micrelytra Laporte, and Leptocori-
sa Latreille) have been variously treated as
subfamilies and/or as tribes within several
subfamilies; the three groups have always
been considered distinct, but their taxonomic
affinities and levels have been ques-
tioned.

The head and thorax of Alydidae are
somewhat flattened, with no bumps or ridg-
es (except the thoracic spines of some Mi-
crelytrinae), and usually without troughs.
The family’s common sobriquet “broad-
headed bugs” is best restricted to Alydinae,
whose heads are indeed broader between
the eyes than are those of other coreoids.
The heads of Alydinae and of many Micre-
lytrini are quite antlike, as would be those
of other Micrelytrinae if their paraclypei
were shorter than their clypeoi.

A recent analysis (Schaefer 1999) con-
cludes that there are two subfamilies, Aly-
dinae and Micrelytrinae, the latter with two
tribes, Micrelytrini and Leptocorisini. Aly-
dinae contains two tribes, Daclerini (Old
World genus Daclera Signoret only) and
Alydini (the remainder of the subfamily).
Leptocorisini is divided into two subtribes,
Leptocorisidi and Noliphidi; both occur in
the New World (one genus each).

Characterizing the Alydinae is a feeding
preference for legumes (Schaefer 1980,
Schaefer and Mitchell 1983), a linear ar-
rangement of the fifth-sterneal trichobothria,
spines on the hind femora, and the nymphs’
excellent mimicry of ants, among other fea-
tures. Micrelytrinae may have spines on the
humeral angles of the pronotum as well
(sometimes) as on the scutellum’s apex; these spines are occasionally broken off, but their bases remain. The fifth-sternal trichobothria of Micrelytrinae are grouped in a triangle. More genera of Micrelytrini than of Leptocorisini have humeral and scutellar spines, and members of one group of Micrelytrini mimic ants both as adults and as nymphs. (Note: The humeral angles of some Alydinae are acuminate and may be extended as spines; this occurs for example in many *Hyalymenus* Amyot and Serville; these spines are horizontal, not vertical like those of Micrelytrinae.) Leptocorisini are quite elongate grass-feeding bugs (some are serious pests of rice in the Old World) whose more advanced members have elongated paraependyri (juga) which pass anteriorly to the clypeus (tylus) and often meet in front of it.

Micrelytrini in some ways seem to be intermediate between Alydinae and Leptocorisini (I do not mean to suggest they are intermediate phylogenetically). The adults and nymphs of one group (the New World *Trachelium* Herrich-Schaeffer and some *Cydamus* Stål; the Old World *Dulichius* Stål) mimic ants, as do immature alydines; and some members of another group are nearly as elongate as Leptocorisini and probably also (*Protenor* Stål certainly) feed on Gramineae; at least one species of the antlike *Cydamus* also feeds on grasses (Forero and Schaefer, unpublished), as does *Esperanza texana* Barber (Wheeler and Henry 1984). In some nonantlike Micrelytrini the paraependyri surpass the clypeus, as they do in most Leptocorisini. And some Leptocorisini have thoracic spines, as do some Micrelytrini. These similarities among the three family groups occur both in the New World and in the Old World Alydidae. I discuss these differences and similarities, and their systematic significance, elsewhere (Schaefer 1972, 1999; and see 2003a).

It should be noted that Bliven (1973) created a new subfamily in Alydidae. His Araphinae Bliven 1973 was necessary, Bliven argued, because “along the one-way evolutionary road, there was a successful commingling of genes between a *Tollius*-like form and a largid.” the result of which were the genera *Araphe* Herrich Schaeffer 1850, *Japetus* Distant 1883 (now *Pararaphpe* Henry [Henry 1988]), and *Pararaphpe* Bliven 1956. (Note: The last two genera were synonymized with *Araphe* by Brailovsky [1981] with brief comment. More detailed reasons for the synonymy will be given by Schaefer and Ahmad [in preparation], in a revision of the New World Largidae.) These three genera (*Araphe, Pararaphpe, and Pararaphpe*) had been included in the Largi- 

● Alydinae: Alydini—25 genera, 8 in New World.
• Micrelytrinae: Micrelytrini—22 genera, 11 in New World.
• Micrelytrinae: Leptocorisini: Leptocorisidi—4 genera, 1 in New World.
• Micrelytrinae: Leptocorisini: Noliphi-di—2 genera, 1 in New World.

The Alydinae comprise primarily Old World genera: One tribe (Daclerini, with just Daclera) occurs there only, six genera are exclusively New World, and two others (Alydus and Megalotomus Fieber) are Holartic (Schaffner 1965). The New World genera seem to be mostly Neotropical; several genera are exclusively so, and a few others, although primarily Nearctic, have ranges extending into Mexico and (in one instance, Stachyocnenmus, also into Cuba [Schaefer and Schaffner 1997]). The world genera, and some of the species, of Alydinae have been ably revised by Schaffner (1965), but the revision remains unpublished.

The Micrelytrinae: Micrelytrini badly need revision. My scant analysis comes from several published sources, but mostly from unpublished data of Imtiaz Ahmad. Of the 22 genera (two unpublished), 11 occur only in the New World; all 11 are Neotropical; of these 11, three occur also in the southwestern United States, and one (Protenor) occurs north from Central America throughout the United States and into central and eastern Canada (Braitlovsky and Flores 1979, Froeschner 1988, Maw et al. 2000).

The Old World Acestra may represent a separate micrelytrine tribe (Ahmad, unpublished; Li and Zheng 1993). Of the six genera of Leptocorisini, one (the monotypic Lynnessus Stål) is exclusively neotropical, and another (Stenocoris Burmeister) has 22 tropical species, only six of them in the New World (Ahmad 1965).

Thus, of the 53 alydid genera, only 19 occur exclusively in the New World, and only three (Alydus, Megalotomus, Stenocoris) have species in both the Old and the New Worlds (different species in most cases). A thorough revision of both the New World and the Old World Micrelytrini will probably change these numbers somewhat (I suspect several genera should be synonymized). But the fact that Alydidae—as well as its subfamilies—are basically Old World, will remain evident. The north-south division will also remain clear: most genera, including those with the most species, are tropical, in both the New and Old Worlds, and have little extension north.

In this paper I am concerned only with New World alydids, especially with providing keys to encourage more work.

Interest in and collections of the family have increased recently, especially in the New World. There are separate surveys underway of the Alydidae (and other heteropterans) of French Guiana, Colombia, Nicaragua; and doubtless there are, or will be, others. The revisions of Schaffner (1965, Alydinae), Ahmad (1965, Leptocorisini), and to a more restricted degree that of Kormilev (1953, Micrelytrini of Argentina) provide a good basis for further work, although only parts of the first have been published. Because of this interest, and with this basis, I provide the following keys to the genera and subgenera of New World Alydidae.

Some of these keys are major modifications of existing ones and others are new. Some existing keys are too vague or too inaccurate or too regional to be useful; I have not used these, and I have checked those keys I did use against specimens (with indicated exceptions). I hope these keys stimulate further work on these fascinating bugs, and I hope that work includes even better keys.

Key to Subfamilies and Tribes of New World Alydidae

I have used several keys to these groups, and that by J. C. Schaffner (1965) is the best. Because that key remains unpublished, I present it here, slightly modified, with gratitude to its author (see also Schaefer 1999). A character in some published keys is the pres-
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VOLUME

106,

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283

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ence (Leptocorisini) or absence (Micrelytrini) of a rostrum-receiving groove on the
thoracic sterna. However, at least in New
World Micrelytrinae, genera of both tribes
have the groove, although not always on all

- Hind

three sterna (Schaefer, unpublished).

-

Hind femur bearing spines (except

1

sule (Neotropical)

Hyalymemis (Hyalymemis

6.

lateral or anterior to spiracle (Fig. 1)

dominal sternum

arranged

in a triangle

pronotum with small spine (Neotropical)
Neomegalotomiis Schaffner and Schaefer
.

pos-

terior to spiracle. (Figs. 2, 3) Micrelytrinae ...

2

segment shorter than third and
fourth together; third rostral segment more than

Second

2.

-

7.

half as long as fourth; evaporative area of meta-

thoracic scent gland

smooth

Leptocorisini

segment longer than
fourth together; third rostral segment
rostral

third

lightly ridged, as in

.

stridulatory device (Fig. 4); without hu-

7

Distance between bases of ocellar tubercles
equal to or greater than distance from base of
ocellar tubercle to eye (Neotropical)

and

Biirtimis Stal

-

less than

half as long as fourth; evaporative area ridged

(may be very

With

.

meral spine

rostral

- Second

edge of corium, plectrum near base of

hind femur); posterolateral (humeral) angle of

spines: trichobothria of ab-

live

Stal)

Without stridulatory device (stridulitrum on anterior

Alydinae

- Hind femur without

Stal)

segment equal to or (more often)
shorter than head: parameres directed dorsally
and rising above capsule's ventral rim (Nearctic

First antennal

and Neotropical) .... Hyalymemis (Tivarbiis

row

in a

First antennal segment slightly longer than head:

not projecting above ventral rim of genital cap-

sternum

(= visible sternum three) airanged

6

without apical spine

piirameres of male directed towards one another,

Asian

in the

Euthelits): trichobothria of abdeiminal
five

5.

tibia straight,

Distance between ocellar bases less than distance from base to eye (Holarctic)

Calamocoris)

8.

Micrelytrini

Megalotomus Fieber

arctic)

-

Key to Genera and Subgenera of New

8

First antennal segment longer than second (Hol-

First antennal
arctic)

segment shorter than second (HolAlydus Fabricius

World Alydinae
based on those of Fracker
(1918) and Schaffner (1965), and examination of specimens of Alydus (3 species), Apidaurus (2), Burtinus (2), Hyalymemis (4-5,
This key

is

both subgenera), Megalotomus

Neome-

(2),

galotomus (2), Stachyocnemiis (1), and Tolliiis (1); and on descriptions by Van Duzee
(1906,

Bueno (1939,

1921), Torre

Brailovsky and Flores (1979), inter
1.

1941),
al.

not, peritreme absent or

reduced

2.

3.

tibial

spines

latter is

family (Rhopalidae) and ap-

onymy

4

Scheiding (1980, 1983), and discussed by
me (Schaefer 2003b). Because Darmistidus
is

now

has since been confinned by Gollner-

in the

do not include

Rhopalidae (as Xenogenus),
it

I

in this key.

Stal

Key to Genera of New World
Micrelytrinae: Micrelytrini

3

With stridulatory device (stridulitrum on
rior edge of corium [Fig. 4], plectrum near base
ante-

yond paraclypei (juga)
States into Mexico

- Without

.stridulatory device;

(Fig. 6) (Neotropical)

Hind

tibia

us Stal)

(Fig. 5) (western

United
Tolliiis Stal

clypeus extended

Apidaunis

on those of Stal
(1873), Fracker (1918), Torre-Bueno( 1941),
Kormilev (1953), and Brailovsky and Flores
(1979), as well as on descriptions and disThis key

of hind femur); clypeus (tylus) not extended be-

4.

ogenus, without remarking that the

2

tibiae with

reduced; without

not included in this key.

Uhler writes that the single included species,
D. maculatus Uhler, is "[c]losely related to
Stachyocnemus/' However, Torre Bueno
(1941) synonymized Darmistidus with Xen-

Metathoracic scent gland peritreme absent; hind

two rows of prominent spines (Nearctic into Mexico and Cuba)
Stachyocuemus
- Metathoracic scent gland opening and peritreme

is

parently without seeing specimens; this syn-

scent gland apparatus (peritreme)

well developed

the Caribbean,

in a different

Metathoracic scent gland opening reduced or

- Metathoracic

Darmistidus Uhler (Uhler 1893),
described from the island of St. Vincent in
Note.

Stal

3

based

in part

cussions in Breddin (1901, 1903), Brailov-

and Schaefer (1996). Specimens
of the following genera were studied: Bacsky

curved, with apical spine (Hyalymen-

is

(

1991

),


trodosoma (1 species), Bactropha (1), Calamocoris (2), Cydamus (5), Darmistus (3), Esperanza (1), Protenor (2), and Trachelium (2). I have not seen specimens of Eudarmistus, Bactrophyamixia, or Bactrocoris, and have relied upon the descriptions by Breddin (1903), Brailovsky (1991), and Kormilev (1953), respectively; and see discussion of Eudarmistus in Schaefer (2003a).

1. With spines on posterolateral (humeral, “shoulder”) angles of pronotum and on tip of scutellum (some species ant-mimetic) .......................... 2
   - With spines either on humeral angles or on scutellum (not both) .......................... 3
- Without spines on either humeral angles or scutellum ........................................ 4

2. Metathoracic scent gland apparatus with auricle; head not elongated before eyes (distance from antennifers to apex of clypeus less than distance between eyes); head behind eyes tapering gently (Neotropical) ............................ Cydadus Stål
- Metathoracic scent gland apparatus without auricle; head elongated before eyes (distance from antennifers to apex of clypeus equal to distance between eyes); head behind eyes tapering sharply, narrowed (Neotropical) ............................ Trachelium Herrich-Schaefier

3. Spine on scutellum only (Note: Calamocoris will key here in Froeschner's [1981] key, which errs in placing a spine on the scutellum.) (southern U.S., Mexico) ............... Esperanza Barber
- Spine on each humeral angle only (Note: Cydadus adspersipes Stål [Brazil] will key out here. However, the first antennal segment of Calamocoris is longer than the head, whereas that of Cydadus [all species] is shorter.) (northern South America) Calamocoris Breddin

4. Tip of clypeus (tylus) not sharply deflected (Fig. 7) .................................................. 5
- Tip of clypeus sharply deflected below tips of paraclypei (juga) (Fig. 8) ..................... 6

5. Small spur just medial to antennifers (Neotropical) ............................................ Bactrophya Stål
- Without small spur (Neotropical) ....................................................... Bactrophya Breddin

6. Paraclypei in side view split (bifid) (Fig. 9) (Neartic, Neotropical) ......................... Protenuor Stål
- Paraclypei not split .............................. 7

7. Longer than 16 mm; paraclypei acuminate distally (Mexico) Bactrophya brunovskyi
- Shorter than 14 mm; paraclypei rounded distally .................................................. 8

8. Body greatly elongate (width/length × 100 = 10–13) (Argentina) Bactrocorsis Kormilev
- Body not greatly elongate (width/length × 100 = 22–27) ........................................ 9

9. Length 9–12 mm (southwestern U.S. into Central America) Darmistus Stål
- Length 15 mm (Bolivia) Eunarmistus Breddin
- Paraclypei meeting anterior to clypeus; pronotum somewhat flat (Stenocoris Burmeister) .................................................. 2

2. Genital capsule of male with posterior angles pointed; posterior margin of female's seventh abdominal sternum with short medial split (southern U.S., throughout Neotropical) ..................... Stenocoris (Oryzocoris Ahmad)
- Genital capsule of male with posterior angles not sharply pointed; posterior margin of female's seventh abdominal sternum shallowly bilobed, without split (southern U.S., throughout Neotropical) ........................................ ............................ Stenocoris (Stenocoris Burmeister)

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A NEW SPECIES OF CRYPTASPASMA WALSINGHAM (LEPIDOPTERA: TORTRICIDAE: OLETHRUEUTINAE) FROM CENTRAL AMERICA, THE CARIBBEAN, AND SOUTHEASTERN UNITED STATES, WITH A CATALOG OF THE WORLD FAUNA OF MICROCORSINI

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Abstract.—Cryptaspasma bipenicilla, new species, is described and illustrated from Central America, the Caribbean, and southeastern United States. The earliest record of this species in the U.S. is a specimen collected in Pensacola, Florida, in 1962. We consider the species to now be established in the U.S. based on its widespread occurrence (on the Atlantic and Gulf coasts from North Carolina to Texas) and the duration of its presence in the region. The new species has been reared from avocado seed (Persea americana L.; Lauraceae) in Puerto Rico and from fruits of acetunillo (Belschmiedia pendula (Sw.); Lauraceae) in Cuba. Potential hosts in the U.S. include Persea borbonia (L.) (red bay) and P. palustris Sarg. (swamp bay). We also provide a taxonomic catalog of the world fauna of the tribe Microcorsini.

Key Words: new species, new U.S. record, host plant, Caribbean, Central America, catalog

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The tribe Microcorsini includes a single genus, Cryptaspasma Walsingham, and is considered to be one of the most primitive tribes of the subfamily Olethreutinae (Kuznetsov and Stekolnikov 1984, Horak and Brown 1991, Horak 1999). Diakonoff (1959) treated 26 species in the most recent revision of Cryptaspasma, dividing them among five subgenera. Subsequent authors (Kuznetsov 1970, Clarke 1976, Bradley 1982, Diakonoff 1983, Razowski 1995, Horak et al. 1996) have described new species or proposed new combinations that have resulted in a total of 33 species in the genus (see Appendix).

Four of the five subgenera of Cryptaspasma occur in different zoogeographic regions of the world. The subgenera Cryptaspasma s. str. and Anaphorodes Diakonoff in the Neotropical Region appear to be the sister group of Microcorses Walsingham in Japan and eastern Russia. Metaspasma Diakonoff in Africa and Madagascar appears to be most closely related to Allobrachyagonia Fernald in the Oriental and Australian regions (Horak and Brown 1991).

Food plants of the group are poorly known. Cryptaspasma (Microcorses) trigonana Walsingham feeds in acorns of Quercus mongolica Fisch. ex Ledeb. (Fagaceae) (Kuznetsov 1970, Kuznetsov and Stekolnikov 1984); Cryptaspasma (Microcorses) marginifasciata (Walsingham) has been reared from acorns of Quercus sp. in
Korea (Oh et al. 2001); Cryptaspasma (Allobrac hygonia) querula (Meyrick) has been reared from kernels of stone fruits in New Zealand; and an unidentified species of Cryptaspasma (Allobrac hygonia) has been reared from nuts of macadamia (Macada mia integrifolia Maiden & Betcke; Proteaceae) in Australia (Horak and Brown 1991). Hosts for the Neotropical subgenera have not been reported previously.

The purposes of this paper are to describe a new species of Cryptaspasma, present brief comments on its potential host plants, and provide a catalog of the described species of the tribe Microcorsini.

**MATERIALS AND METHODS**

Dissection methodology follows that summarized in J. Brown and Powell (1991). Genitalia were illustrated with the use of a Leica MZ 12.5 stereomicroscope and a drawing tube. Forewing measurements were made with the aid of an ocular micrometer mounted in a Wild M3Z dissecting microscope under low power (×10–16). Terminology for wing venation and genitalic structures follows Horak (1984). Terminology for forewing patterns and strigulae follows R. Brown and Powell (1991) as modified by Baixeras (2002). Abbreviations and symbols are as follows: FW = forewing; HW = hindwing; n = number of specimens examined; r.f. = reared from; x = mean; ca. = circa (approximately). In the Appendix, names are presented in their original orthography, and the following abbreviations are used: TL = type locality; HT = holotype; LT = lectotype.


**DESCRIPTION**

*Cryptaspasma (Cryptaspasma) bipenicilla*

**J. Brown & R. Brown, new species**

(Figs. 1–5)

Diagnosis.—*Cryptaspasma bipenicilla* is assigned to the subgenus *Cryptaspasma* on the basis of the following characters: costal fold absent in the male; pulvinus a huge, free flap from the median portion of the base of the valva, densely clothed in long, rhopaloid scales (sensu Diakonoff 1959); valva somewhat lanceolate-triangular, with rounded apex and several rows of truncate setae; and coremata of two dense brushes of long scales, one on each side of eighth abdominal segment in the male. *Cryptaspasma bipenicilla* is most similar to *C. lugubris* (Felder & Rogenhofer) in the absence of a pouch of androconial scales near the base of the hindwing (variably developed in all other species of the subgenus we examined), a strongly and finely reticulated, densely spicular sterigma in the female, and the overall shape of the valva, tegumen, and uncus (see Diakonoff 1959 for comparison). The female genitalia of *C. bipenicilla, C. lugubris*, and at least one undescribed species from Central America are nearly indistinguishable. *Cryptaspasma bipenicilla* can be separated easily from morphologically similar species by the configuration of the coremata of the eighth ab-
dominal segment in the male: a broad, long, dense brush on each side of the abdomen in *C. lugubris* and other species in the subgenus; a long, dense brush and a second shorter, darker brush on each side (Fig. 4) in *C. bipenicilla*. A single male specimen from Trinidad has a similar arrangement of the coremata, but has the gnathos nearly atrophied; hence it is assumed to represent a different species.

Description.—Male (Fig. 1). Head: Frons dark brown, distinct transverse ridge of scales near middle to accommodate labial palpus; vertex low, not extending greatly above eyes, mostly concolorous with frons, intermixed with variable amounts of orange and light brown; labial palpus short, blunt, all segments combined 1.1–1.2 times horizontal diameter of compound eye. dark brown on inner and outer surface; segment III short, 0.3 length of segment II, nearly concealed by distal scaling of segment II; antenna with scales restricted to less than half of segment circumference, cilia extremely short, inconspicuous; ocellus large, base black. Thorax: Foreleg with large, conspicuous brush of scales on anterior surface of femur and long scales on ventral surface of tibia. midleg with long scales on ventral surface of femur and tibia, hindleg with long scales on ventral surface of femur and dorsal and ventral surfaces of tibia. Forewing length 6.5–10 mm (\( \bar{x} = 8.0; n = 42 \)); ground color brown, with scattered orange and pale brown scales giving a superficial reticulated pattern; costal strigulae forming pale brown marks in pairs or singly, separated by dark brown, pairs of strigulae 1–4 variable in position and division, usually distinguishable as 8 separate marks between wing base and Sc, strigulae 5 and 6 unpaired with each forming single mark or with one strigula unpaired and one paired to form three marks between Sc and \( R_1 \), strigulae 7–9 paired, strigula 7 between \( R_1 \) and \( R_2 \), strigula 8 between \( R_2 \) and \( R_3 \), strigula 9 between \( R_3 \) and \( R_4 \), strigula 10 single, between \( R_4 \) and \( R_5 \) at apex, inconspicuous in most specimens; a conspicuous orange white dot between bases of \( M_1 \) and \( M_2 \); fascia dark brown intermixed with variable amounts or orange brown, subbasal fascia represented by line of scales from midwing to dorsum, often bordered by orange brown, median fascia represented by spot on costa basal to strigula 5, variable amount of dark scales basal to orange white dot, and larger, variably developed subtringular spot extending from broad base on cubitus to point at middorsum; postmedian fascia represented by elongate spot on costa between strigulae 6 and 7, some specimens with discontinuous striae extending from costal spot to midwing; preterminal fascia extending from between strigulae 8 and 9 to tornus between CuA_2 and 1A, often confluent with dark spot between strigulae 7 and 8; marginal scales between \( R_4 \) and
CuA₂ often orange brown between veins; fringe dark gray brown; underside mostly dark gray brown with faint trace of some pattern elements, especially costal strigulae. Hindwing pale gray brown to cream gray; underside nearly uniform gray brown with darker mottling in costal region.  

**Abdomen:** Cream, with two paired patches of coremata at posterior edge of segment 8; one pair composed of a dense brush of long brown scales, second pair a shorter, more compact brush of darker brown scales. Genitalia (Fig. 3) with uncus relatively long, broad, parallel-sided basally, tapered from midlength to rounded apex, dorsally with long setae on distal half, setae extending beyond apex for twice length of uncus; socii represented by pair of setose, dorsally arched lobes immediately basolateral of uncus; gnathos a narrow band, angulate near middle, with triangular subscaphium; tegumen narrowed near middle, with ventromedial triangular projection; valva broadest at base, attenuate distally, somewhat lanceolate-triangular, with rounded apex; pulvinus forming large, free, semicircular flap in basomedial area of valva, densely covered with long, rhopaloid scales; sacculus with several rows of blunt spinelike setae ca. 0.15–0.85 distance from base to apex of valva; outer wall of valva weakly sclerotized medially, with patch of moderately long, deciduous, flattened setae arising from rounded lobe at base of weakly sclerotized area. Aedeagus moderately large, broad, basally straight, curved and attenuate distoventrally; phallobase rounded with ductus ejaculactoris entering dorsally; cornuti absent.

Female (Fig. 2). Head, thorax, and abdomen similar to male, except fore- and midlegs smooth and short scaled, hindleg with long scales on dorsal and ventral sides of tibia only. Forewing length 7.1–11.5 (x = 8.7, n = 52); FW with ground color more uniform, dark brown markings less conspicuous, median fascia spot more reduced, often subquadrate, and reaching dorsum as narrow line. Genitalia (Fig. 5) with tergite VIII setose on posterior border, scales absent; papillae anales broad. several lateral setae with papilllose bases; apophyses anteriores and posteriores relatively long, slender, anteriores ca 1.2 times as long as posteriores; sterigma composed of a pair of ventrolateral, slightly convex, triangular processes separated posteriorly by ventromedial gap, each process strongly and finely reticulated with cellular spaces bordered by walls with spicules detectable at high magnifications, postero medial corners of processes setose; antrum short, conical, sclerotized dorsally, membranous ventrally, with 3–4 setae on inside of posterior dorsal lip; colliculum not detectable as separate sclerite; ductus bursae long, widened asymmetrically at middle, sclerotization restricted to ventral side of ductus from antrum to middle, forming ring encircling ductus at middle posterior to inception of ductus.
Fig. 5. Cryptaspasma bipenicilla. female genitalia with enlargement of stergmina to show sculpturing; scale bar = 1 mm.

...seminalis on left side; corpus bursae relatively large, pear-shaped, with finely dimpled wall; a pair of huge, hollow, paddle-shaped signa, nearly equal in size, with base of right signum arising more posteriad than that of left.


Additional specimens examined.—COSTA RICA: Sixola River. Sep (1 ♀) (W. Sehau, USNM). J. Bolling Sullivan has examined additional specimens from the preceding and additional localities in North Carolina and Carteret Co. (Walker Mill Pond; Roosevelt Natural Area, Bogue Bank; Fort Macon State Park), Jones Co. (Croatan Natl. Forest, Haywood Landing), and New Hanover Co. (UNC Wilmington campus, Conservation Trail).

Distribution.—Cryptaspsma bipenicilla has been recorded from the Caribbean (Cuba, Dominica, Dominican Republic, Jamaica, and Puerto Rico), Central America (Costa Rica), and southeastern United States (Florida, Louisiana, Mississippi, North Carolina, and Texas). It is most likely a Caribbean species that has expanded its range northward into the U.S. during the past 50 years. The earliest record of C. bipenicilla in the U.S. is a specimen collected in Pensacola, Florida, by Ms. Shirley Hills in 1962. We consider this species to be resident in the U.S. based on its occurrence on the Atlantic and Gulf coasts from North Carolina to Texas and the number of specimens examined by us (56 ♀). 57 ♂) and others from the U.S.

Etymology.—The specific epithet, bipenicilla, refers to the presence of a hairpencil of two distinct lengths at the posterior end of the abdomen in the male.

Hosts.—Two specimens of C. bipenicilla from Puerto Rico (USNM) were reared from avocado seed (Persea americana Mill.: Lauraceae). Two additional specimens are labeled “S. Cristobal, P.R.. XII-22-36, A. J. Fors. col.; reared from aceitunillo; E.E.A. [probably Estación Experimental Agronómica de Santiago de las Vegas (John Rawlins, personal communication), Cuba Ent. No. 10891]; [genitalia slide] “AB 27 March 1937.” Both sexes are on the same slide that bears a J. F. G. Clarke determination label of “Cryptaspsma lugubris” on top of Busck’s original label, which reads faintly as “(Olethreutes) near anaphorana Wlsm: from fruit of ‘aceitunillo’ Hupelandia pendula.” These two specimens are undoubtedly the same as those recorded as feeding on fruits of Belschmiedia pendula (Sw.) (Lauraceae) in Cuba and reported as being collected by “A. Fors” in November 1936 and subsequently identified by Busck in 1937 as Olethreutes sp. n. “afin a aeropharana Walsingham” (Bruner et al. 1975).

If this species was first introduced into
Florida, it may have fed initially on avocado, which is naturalized in the southern part of the state. The present distribution of Cryptaspasma bipenicilla from North Carolina to Texas excludes avocado as a host. Potential hosts of this species in the U.S. include Persea borbonia (L.) (red bay) and P. palustris Sarg. (swamp bay). Both species of bay occur from North Carolina to Texas; their fruits are small, ranging 0.7–1.2 cm in diameter, and only slightly fleshy (Elías 1987). Red bay is common at the sites where Cryptaspasma bipenicilla has been collected in North Carolina (J. B. Sullivan, personal communication).

During field work in Michoacán, Mexico in November 2002, we observed larvae of a closely related species of Cryptaspasma (probably C. lugubris Felder & Rogenhofer) feeding internally in the hard seeds of cultivated avocado (Persea americana). This feeding habitat is typical of the avocado moth, Stenoma catenifer Walsingham (Elachistidae: Stenomatinae), with which the larvae were initially confused. However, the larvae of Cryptaspasma species were typical of Olethreutinae (e.g., chaetaxy), with last instars 23–25 mm in length, pinkish, with small, pale pinacula (darker in early instars) and no anal fork. The most unusual feature of the larvae was the position of SD1 on A8, which was situated considerably further anterad than in other tortricids. Larvae were found only in bare seeds (i.e., fleshy part absent) that were on the ground. A brief survey of fruit still on trees revealed no signs of larval feeding. A few larvae were taken into the laboratory and placed in a small box with vermiculite, where they pupated in tough silken cocoons incorporating the substrate. The cocoons were oval, somewhat inflated bean-shaped, about 1.0–1.5 cm in length, and about 0.75 in width. Adults emerged about 20–25 days following pupation.

These observations are consistent with previous reports of avocado and other Lauraceae hosts for Cryptaspasma bipenicilla. Coupled with previous host records for other species of Cryptaspasma worldwide, we suspect that all species of Cryptaspasma may be specialists on the hard seeds of fallen fruit.

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APPENDIX

Catalog of the World Fauna of Microcorssini

Tribe Microcorssini

Genus Cryptaspasma Walsingham
Subgenus Anaphorodes Diakonoff


Subgenus Cryptaspasma Walsingham


lugubris (Felder & Rogenhofer 1875) (Penthina’?), Reise Freg. Novara, Lepid. 5: pl. 138, fig. 32. TL: Brazil (Amazonas). HT (♂): BMNH.
Acharneodes microloga

Subgenus Allobrachygonia Fernald

Allobrachygonia Fernald 1908, Torricidae

Genera & Type: 62 [replacement name for Brachygonia].

Bakia Koçak 1981, Priamus: 117 [replacement name for Idiomorpha].

achlyoptera Clarke 1976 (Cryptaspasma), Insects of Micronesia 9 (1): 58. TL: Micronesia (Guam, Ritidian). HT (?): USNM.


querula (Meyrick 1912) (Eucosma), Trans.


**zophocosma** (Meyrick 1931) (*Hysterosia*), Exotic Microlepid. 4: 159. TL: Formosa (Ranrun). HT (♂): BMNH.

Subgenus **MICROCORIES** Walsingham


**mirabilis** (Kuznetsov 1964) (*Microcorses*), Entomol. Obozr. 43: 875. TL: Russia (Primorsk, Okeanskaya). HT (♂): ZIRA. [probably a synonym of *marginifasciatus* according to Razowski (1995); treated as a synonym of *angulicostana* by Byun et al. (1998)].

NEW RECORDS OF PALEARCTIC HEMIPTERA
(STERNORRHYNCHA, CICADOMORPHA, HETEROPTERA)
IN THE CANADIAN MARITIME PROVINCES

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Abstract.—New records of twelve unintentionally introduced Old World hemipterans are given for the Canadian Maritime Provinces. The Nova Scotian records for Grypotes puncticollis are the first for Canada, the record from Nova Scotia for Anaptus major (Costa) (Nabidae) is the first for eastern Canada, and records from Nova Scotia for Cacopsylla peregrina (Foerster) (Psyllidae) are the first for eastern North America. New to the fauna of the Maritime Provinces are Psyllophis fraxini (L.) (Psyllidae), Aphrophora alni (Fallén) (Cercopidae), Empoasca ludia Davidson and DeLong (Cicadellidae), Dictyla echii (Schrank) (Tingidae), and Pseudoloxops coccineus (Meyer-Dür) and Sthenarus rotundus (Scholtz) (Miriidae), Euptychus atropunctata (Goeze) (Cicadellidae), previously reported in the Maritimes from New Brunswick, is recorded from Nova Scotia, and Trioza chenopodii Reuter (Triozidae), known previously from Prince Edward Island, is reported from Nova Scotia and New Brunswick. The mirid Phytocoris ulmi (L.), a Palearctic species known previously in the Nearctic Region only from a single specimen collected in Nova Scotia (Yarmouth) in 1914, is reported from additional Nova Scotian localities (Cape Breton Island). A summary of the North American distributions and habits of all twelve Palearctic hemipterans is provided.

Key Words: Hemiptera, insect detection, new records, adventive species

More Old World insects have been found in Atlantic Canada than in any other region of North America. The insect fauna of Newfoundland and the Halifax, Nova Scotia, area is notable for its large proportion of unintentionally introduced Palearctic species (e.g., Brown 1940, 1950, 1967; Lindroth 1957; Hamilton 1983; Wheeler and Hoebeke 1994; Hoebeke and Wheeler 1996).

Herein, we give the first records from Nova Scotia, New Brunswick, or Prince Edward Island for eleven species of Hemiptera (including “Homoptera”), and the first North American records since 1914 of Phytocoris ulmi (L.), a mirid known previously in North America only from a specimen from Nova Scotia and whose establishment in the Nearctic Region has remained in doubt (Wheeler and Henry 1992). Families (but not suborders) are arranged according to the Checklist of the Hemiptera of Canada and Alaska (Maw et al. 2000), which provides the most current distribution of species by province. All collections were made by the authors. The number of specimens examined is given in parentheses after each locality record. Vouch-
er specimens have been placed in the Cornell University Insect Collection, Ithaca, N.Y., and the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Suborder Sternorrhyncha

Family Psyllidae

*Cacopsylla peregrina* (Foerster).—The first record of *C. peregrina* in the Nearctic Region was "British Columbia" (Maw et al. 2000); locality (Victoria) and other collection data were provided by Wheeler and Stoops (2001). In the United States, this psyllid is known from California, Oregon, and Washington (Wheeler and Stoops 2001). *Cacopsylla peregrina* is univoltine, overwinters as eggs, and specializes on hawthorns (*Crataegus* spp.; Rosaceae) (Missonnier 1956; Sutton 1983, 1984; Novak 1994; Novak and Achtziger 1995; Wheeler and Stoops 2001).


*Psyllopsis fraxini* (L.).—The first North American record for *P. fraxini* is based on specimens collected at Buffalo, New York, dating from July 1886 (Tuthill 1943). The only additional Nearctic records are "Ontario" and "British Columbia," Canada (Maw et al. 2000). Widespread in the western Palearctic Region, *P. fraxini* is a specialist on ash (*Fraxinus* spp.; Oleaceae) (Ossiannilsson 1992). In Europe, eggs are deposited on the terminal buds of *Fraxinus* in the summer and then overwinter; by the following May or June, nymphs produce a "roll leaf gall with reddish thickened veins" (Ossiannilsson 1992).


Family Triozidae

*Trioza chenopodii* Reuter.—Burckhardt’s (1994) mention, in passing, of the presence of *T. chenopodii* in Virginia represents the first North American record of this psyllloid. Wheeler and Hoebke (1997) gave Charlottetown, Prince Edward Island, Canada, as the first specific record from North America. This bivoltine or multivoltine species develops mainly on species of *Atriplex* and *Chenopodium* (Chenopodiaceae). Early instars are gall formers, whereas late instars are free feeders on vegetative and reproductive parts of their hosts (e.g., Hodkinson and White 1979, Lauterer 1982, Burckhardt 1986, Ossiannilsson 1992, Wheeler and Hoebke 1997).

Additional North American records for *T. chenopodii* are New Brunswick: Westmorland Co., Shediac, 27 July 1997, ex *Atriplex* sp. (15); Nova Scotia: Cape Breton Co., Glace Bay, 1 Aug. 2003, ex *Atriplex* sp. (8); Colchester Co., Truro, nr. railroad tracks, 3 Aug. 2001, ex *Atriplex* sp. (23); Digby Co., Digby and Saulnierville, St. Mary’s Bay, 6 Aug. 2001, ex *Atriplex* sp. (not collected); Digby, Annapolis Basin, 6 Aug. 2001, ex *Atriplex* sp. (6); Halifax Co., Halifax, Point Pleasant Park, 2 Aug. 2001, ex *Chenopodium* sp. (3); St. Mary’s University, 4 Aug. 2001, ex *Atriplex* sp. (not
collected), and Mt. Saint-Vincent University, 4 Aug. 2001, ex Atriplex sp. (8); Lunenburg Co., Lunenburg, Fisherman’s Wharf, 8 Aug. 2001, ex Atriplex sp. (15).

Suborder Cicadomorpha

Family Cercopidae

Aphrophora alni (Fallén).—Records from Ontario (Moore 1956) were the first for A. alni in North America. Hamilton (1982) noted that this spittlebug is found mainly within a 260-km radius of Toronto. Previous North American records also include Michigan, New York, and Quebec (Hanna and Moore 1966, Hamilton 1982, Maw et al. 2000). Nymphs develop at the base of various herbaceous plants and on adventitious shoots of willows (Salix spp.; Salicaceae), whereas adults feed on alders (Alnus spp.; Betulaceae), willows, other trees and shrubs, and herbs (Ossiannilsson 1950, Hamilton 1982).


Family Cicadellidae

Empoasca (Kybos) luda Davidson and DeLong.—Empoasca luda, although originally described from the United States (Davidson and DeLong 1938), is considered a West Palearctic leafhopper (the European E. betula Wagner is a synonym [Hamilton 1983]). The previously recorded U.S. distribution includes Connecticut, Illinois, Maryland, Minnesota, New York, Ohio, Pennsylvania, and Virginia (Wheeler 1997). In Canada, E. luda is known from British Columbia, Newfoundland, and Ontario (Hamilton 1983, Maw et al. 2000). Empoasca luda is thought to have been accidently introduced into North America with shipments of its most common host plant, European white birch (Betula pendula Roth) (Hamilton 1983). This bivoltine species causes foliar chlorosis on European white birch in landscape plantings (Wheeler 1997).


Eupteryx atropunctata (Goeze).—Moore’s (1950) record of E. atropunctata from Quebec was the first for North America; the earliest North American collection was from Ottawa, Ontario, in 1942 (Hamilton 1983). Hoebeke and Wheeler (1983) referred to a previous record from Connecticut and gave Michigan, New York, and Pennsylvania as new records. This leafhopper now is known from New Brunswick (Maw et al. 2000). In New York and Pennsylvania, this mesophyll-feeding typhloecyst is multivoltine, the nymphs developing on various herbs, especially species of Lamiaceae in flower and medicinal gardens. Nymphal feeding causes chlorosis on the
upper leaf surfaces of host plants (Hoebeke and Wheeler 1983).


**Grypotes punceticollis** (Herrick-Scheaffer).—First collected in the New World in southwestern New York and northwestern Pennsylvania in 1988. *G. punceticollis* since has been reported from one locality in Michigan and one in Ohio. The principal North American host is the Palearctic Scotch pine (*Pinus sylvestris* L.): nymphs also develop on Swiss mountain pine (*P. mugo* Turra). In Michigan, adults were found on jack pine (*P. banksiana* Lamb.), a native North American conifer (Wheeler 1989, 1992).


**Suborder Heteroptera**

**Family Miridae**

*Phytocoris ulmi* (L.).—Reported from Nova Scotia by Knight (1923), *P. ulmi* has remained known in North America only from a female collected in August 1914 at Yarmouth. Wheeler and Henry (1992) noted that its establishment in North America requires confirmation. In Europe, this univoltine plant bug of the subfamily Mirinae preys on small arthropods, such as mites and aphids, found on elms (*Ulmus* spp.; Ulmaceae), hawthorns (*Crataegus* spp.), and other trees and shrubs (e.g., Kullenberg 1944, Southwood and Leston 1959).

Additional Nova Scotian records for *P. ulmi* are Cape Breton Co., Glace Bay, Renwick Park, 1 Aug. 2003, ex *Cydonia japonica* (5) and Sydney, 24 July 1995, ex *Solanum dulcamara* and other weeds at base of trees (7) & 31 July 2003, ex *Lonicera* sp. (1).

*Pseudoloxops coccineus* (Meyer-Dür).—Previous North American records of *P. coccineus* are limited to those of Kelton (1983) from Ontario. This orthotyline plant bug is a univoltine omnivore on ash (*Fraxinus* spp.; Oleaceae) where it preys on aphids and apparently feeds on the fruits (samaras) of host trees (Southwood and Leston 1959, Putskhov 1961, Strawiński 1964, Ehanno 1987).


*Sthenarius rotemundi* (Scholz).—First reported in the Nearctic Region from Pennsylvania and Ontario (Henry and Wheeler 1979). *S. rotemundi* since has been collected in New York, Vermont (Wheeler and Henry 1992), and Quebec (Barnes et al.
In North America, this phyline plant bug has been found not only on the Old World white poplar (Populus alba L.; Salicaceae) but also on native bigtooth aspen (P. grandidentata Michx.) and quaking aspen (P. tremuloides Michx.) (Wheeler and Henry 1992). White poplar and gray poplar (P. canescens (Ait.) Sm.) serve as host plants in Europe (e.g., Southwood and Leston 1959).


Family Tingidae

Dictyla echii (Schrank).—Hambleton (1968) referred to the earliest North American collections of D. echii—late 1950s in Pennsylvania—and provided the first records for Maryland, Virginia, and West Virginia. Previous New World records also include New York, Ohio, Ontario (Wheeler and Hoebeke 1985), and Quebec (Barnes et al. 2000). This common Old World lace bug specializes on boraginaceous plants (Vayssieres 1983) and in North America is found almost exclusively on viper’s bugloss or blueweed (Echium vulgare L.). Populations on E. vulgare in southcentral Pennsylvania are bivoltine (Wheeler and Hoebeke 1985).


Discussion

Our collections of Grypotes puncticollis represent the first Canadian records of this leafhopper. Records from Nova Scotia of the psyllid Cacopsylla peregrina are the first for eastern North America, and the Nova Scotian record of the nabis Anaptus major is the first for eastern Canada. Previous Canadian records of A. major and C. peregrina have been limited to British Columbia. Their collection near the principal ports of Halifax, Nova Scotia, and Vancouver, British Columbia, suggests separate introductions to eastern and western Canada, either with commerce originating in Europe or via established U.S. populations of these insects.

The Nova Scotian records of the cercopid Aphrophora alni, the cicadellid Empoasca (Kybos) luda, the mirids Pseudoloxops coccineus and Stenaria rotermundi, the tingid Dictyla echii, and the psyllid Psyllopsis fraxini are the first for these Palearctic species in the Maritime Provinces. The psyllid Triozia chenopodii, known previously in North America only from Prince Edward Island and Virginia, and the cicadellid Eupteryx atropunctata, known previously in the Maritime Provinces from New Brunswick, are reported new to Nova Scotia. The collection of seven of the twelve species—C. peregrina, P. fraxini, T. chenopodii, A. alni, E. luda, G. puncticollis, and P. coccineus—at Halifax further increases the impressive number of Old World insects recorded from this Nova Scotian port city. At the Public Gardens in Halifax, we found P. fraxini on European ash with two other Old World congeners, P. discrepans (Flor) and P. fraxinicola (Foerster), both of which have been reported previously from Nova Scotia (Maw et al. 2000).

Additional Nova Scotian records for the mirid Phytocoris ulmi, the first in North America in almost 90 years, indicate the establishment of this Palearctic plant bug in the Nearctic Region. Despite field work in Nova Scotia by the miridologist L. A. Kelton and others, this species, until 1995, had not been collected in North America since 1914.

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LITERATURE CITED


A NEW NEOTROPICAL SPECIES OF CLINODIPLOSIS
(DIPTERA: CECIDOMYIIDAE) INJURIOUS TO ALLIGATORWEED,
ALTERNANTHERA PHILOXEROIDES (AMARANTHACEAE)

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Abstract.—A new species of cecidomyiid, Clinodiplosis alternantherae Gagné, is reported from alligatorweed, Alternanthera philoxeroides (Mart.) Griseb. (Amaranthaceae) in Argentina. The gall midge forms galls on branch tips and is a likely candidate to aid in the control of the invasive, alien alligatorweed in North America and Australia. The male, female, pupa and larva are described, illustrated, and compared to other Clinodiplosis species.

Key Words: gall midges. Neotropical, biocontrol of alligatorweed

Alligatorweed, Alternanthera philoxeroides (Mart.) Griseb., an aquatic and semi-aquatic perennial plant indigenous to southern South America, has become introduced into California and southeastern United States and elsewhere, including Australia, where it outcompetes native plants and obstructs waterways. Galls of a cecidomyiid new to science are commonly found on new branch tips at sites in Argentina, Paraguay, Uruguay, and Brazil. The galls also appear on Alternanthera aquatic Chod.

Eggs are laid on the growing branch tips. Newly hatched larvae begin feeding on the developing leaves and cause the leaf tissue to swell and envelop the larvae (Figs. 1–4). The leaves remain green while the white, gregarious larvae inside are feeding. When mature, the larvae mine a single, cylindrical partial exit tunnel through the thickened gall tissue up to but not including the outer cell layer of the epidermis. Pupation then occurs and, when the adult stage is fully developed, the pupa breaks through the outer layer of epidermis and crawls halfway out. The adult then emerges through the thorax of the pupa. Affected branch tips then die and turn black. The gall midge is multivoltine and galls can be found throughout the year. At some sites almost every plant may be infested. Besides killing terminal buds, infestation usually causes a severe foreshortening of the inflorescence peduncle. The cecidomyiid could be an important control of alligatorweed outside its native range because of its apparent abundance and its many generations per year if host-testing shows that this species is as narrowly oligotrophic as it appears to be.

The new species of gall midge will readily run to Clinodiplosis in the last couplet of the key to genera in Gagné (1994). Clinodiplosis is a worldwide genus of 93 known species. 17 of them from the Neo-
tropical Region. 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. The new species and most of the other Neotropical species, however, are known to be from galls in which they are primary plant feeders (Gagné 1994), as is the new species described below.

**METHODS**

Galls with pupae or full-grown larvae collected in the field 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). The field work, rearing of adults, and securing of other stages were done by H. Cordo and A. Sosa, as well as others (see acknowledgments). The taxonomic investigation was the responsibility of R.J. Gagné.

**Clinodiplosis alternantherae** Gagné, new species
(Figs. 5–11, 14–20)

**Adult.**—Head: Eyes connate, 11–12 facets long at vertex; facets hexagonoid, all closely adjacent. Occiput with dorsal protuberance with 2 large apical setae and 1–2 smaller, subapical setae. Frons with 6–8 setae. Labella ellipsoid and pointed apically, each with several lateral setae. Palpus 4-
segmented. Male antennal flagellomeres (Fig. 5) binodal; one circumfilum on basal node, two on distal. Loops of each circum-
filum subequal to one another in length, loops of first and third circumfilia not reaching next distal node. Female flagellomeres (Fig. 6) cylindrical with long, bare necks, surrounded by two appressed circumfilia connected by two longitudinal bands.

Thorax: Wing unmarked, 1.6–1.9 mm long in males (n = 5), 2.0–2.2 mm long in females (n = 5), R₃ curved toward apex, joining C posterior to wing apex. Anepi-
sternum with scattered scales on dorsal half, anepimeron with 6–8 setae. Tarsal claws (Fig. 7) untoothed, strongly curved nearly at right angle beyond midlength, slightly widened just beyond bend; empodia attaining bend in claws; pulvilli about 1/2 length of empodia.

Male abdomen (Figs. 8–11): First through sixth tergites entire, rectangular, with single posterior row of setae, several lateral setae, scattered scales, and 2 anterior trichoid sensilla; seventh tergite weakly sclerotized mesoposteriorly and bearing only 2–3 posterior setae per side, several adjacent lateral setae, 0–few scales laterally, and anterior pair of trichoid sensilla; eighth tergite undifferentiated from surrounding tissue except by presence of anterior pair of trichoid sensilla. First through eighth sternites rectangular, covered with setae and a few scales, except for bare area immediately anterior to 2 rows of posterior setae, and with 2 anterior trichoid sensilla; eighth sternite similar to preceding except weakly sclerotized between midlength and pair of trichoid sensilla. Genitalia (Figs. 8–
10): cercus rectangular, the lateral edges curved ventrally, with several posterior setae; hypoproct much longer than cercus, widest before midlength, narrowing beyond midlength and parallel-sided beyond, deeply divided into two narrow lobes on distal third, each lobe with a short subapical seta and a shorter distal seta; dorsal surface setulose except for smooth lateral flanges on basal third (Fig. 10), entire ventral surface smooth, setulose; aedeagus elongate, narrower and longer than hypoproct, with 2 longitudinal rows of 3 sensory pits; gonoco-
oxite elongate-cylindrical with mesoposterior surface forming nearly right angle at about half of gonocoxite length; gonostylus elongate-cylindrical, setulose near base, covered beyond with minute carinae and widely scattered short setae.

Female abdomen (Figs. 14–15): First through sixth tergites entire, rectangular, with single row of posterior setae, several lateral setae, scattered scales, and 2 anterior trichoid sensilla. Seventh tergite similar to preceding except for 2 uneven rows of posterior setae. Eighth tergite unsclerotized, differentiated by several posterior setae and anterior pair of trichoid sensilla. Second through seventh sternites quadrately, covered with setae and scales, except for bare area immediately anterior to 2 rows of posterior setae, and with anterior pair of trichoid sensilla. Ovipositor slightly protrusible; dor-
sum of ninth and tenth segments without vestiture; venter of eighth, ninth and tenth segments with setae; cercus large, ovoid, with pair of apical sensory setae and scattered setae elsewhere; hypoproct short, nar-
row, with 2 posterior setae.

Pupa (Fig. 16).—Antennal base barely projecting apically or ventrally, with apical horizontal sclerotized ridge; cervical sclerite with two elongate setae, each situated on conspicuous lobe; face without ventral pro-
jections, with two groups of facial papillae per side, mesal group with two papillae, one with seta, lateral group with 3 papillae, one with seta. Prothoracic spiracle elongate, narrow, pointed apically. Abdominal ter-
gites (Figs. 17–18) dorsally with 2–3 hor-
zontal rows of conspicuous spines on basal third, a field of small spicules near midlength, a glabrous, crinkled area on apical third, and 6 closely-set pairs of papillae be-
tween middle and posterior thirds of scler-
tites, only one of each pair with seta.

Third larval instar.—Length, 2.1–2.3 mm (n = 10). White. Integument mostly cov-
ered with spicules, especially prominent in
more mature specimens. Antenna about twice as long as wide. spatula (Fig. 19) with 2 triangular anterior lobes. 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 (Fig. 20) with 8 papillae as follows: 1 pair as long as dorsal setae of previous segment; 1 pair with setae less than ½ as long as previous pair; the two posterior pairs with short, corniform setae, those of medial pair slightly smaller than lateral pair.

Holotype.—♂, reared from Alternanthera philoxeroides, Argentina, Buenos Aires Prov., Rt. 63, 4 km from Dolores, 12-XII-2001, A.J. Sosa & H. Cordo, deposited in the Museo de La Plata, Paseo del Bosque, 1900 La Plata, Argentina.

Other material examined.—All reared from tip galls of Alternanthera philoxeroides unless otherwise noted (deposited in the National Museum of Natural History, Washington, DC, USA, and Museo de La Plata):


PARAGUAY: Asunción, 24-III-1960, G. Vogt, 2 pupae (♂ genitalia visible in one).


Etymology.—The specific name, alternantherae, means “of Alternanthera.”

Remarks.—Clinodiplosis alternantherae is one of five Neotropical species of the genus known to have tarsal claws that are curved beyond midlength (Figs. 7, 13) instead of at the basal third. The other four are C. americana (Felt), C. castilevae (Mollard), C. coffeae (Felt), and C. eupatori (Felt). Of these five species only the new species and C. americana, a species reared from a dead wild fig branch found in Panama (Felt 1911), show a general similarity in the male genitalia. They both have a deeply lobed hypoproct, with long and narrow lobes, and a long, narrow aedeagus, but in C. alternantherae (Figs. 8–9) the cerci are wider and each bears several setae instead of only two, the hypoproct is not so deeply lobed, and the gonocoxite not so narrow as in C. americana (Fig. 12, illustrated for the first time). Unlike in the new species, the circumfilar loops of C. americana are very irregular, with some loops of the first and third circumfila nearly surpassing the next distal flagellomere node in length. In addition, the claws of C. americana are bent at nearly right angles (Fig. 13) and are much more flared beyond the bend than in C. alternantherae (Fig. 7).

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LITERATURE CITED


A NEW SPECIES OF *BRACHYCERCUS CURTIS* (EPHEMEROPTERA: CAENIDAE) FROM CHINA

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Abstract.—*Brachycercus capnicus*, new species, is described from larvae and reared male adults recently collected from the southern provinces of China. The new species represents the first true record of the genus *Brachycercus* Curtis and subfamily Brachycercinae from China, and the eighth such from the Eastern Hemisphere. *Brachycercus capnicus* is morphologically similar to *B. gillesi* Soldán and Landa from southern Asia and *B. japonicus* Gose from eastern Asia; however, the larvae of *B. capnicus* are distinguished by color pattern, antennal setae, and shape of the ocellar tubercles. The adults of *B. capnicus* are distinguished from other known Asian congeners by body size, pedicel length compared to that of the scape, color pattern, and development of vestigial abdominal processes. Larval habitat of the new species is typical of the genus.

Key Words: mayflies, China, *Brachycercus*, new species

The genus *Brachycercus* Curtis of the subfamily Brachycercinae (McCafferty and Wang 2000) of the cosmopolitan mayfly family Caenidae is distributed in the Holarctic and Oriental regions. Larvae of the genus are typified by their possession of ocellar tubercles and two-segmented labial palpi. Seven species have been known previously from the Eastern Hemisphere (Tshernova 1952, Soldán 1986, Kluge 1991, Soldán and Landa 1991, Tojo 2001), but only one *Brachycercus* species has been recorded from China. It was taken from the northeastern region of that country and informally referred to as B. YUa by Quan et al. (2002). In the vicinity of China, *B. harriella* Curtis has been recorded from Mongolia and the Amur River Basin, and *B. tubulatus* Tshernova has been recorded from Korea and the Amur River Basin (Tshernova 1952, Soldan 1986, Kluge 1991, Hwang and Bae 1999). These records suggest that the two latter species eventually will be found in China. The Chinese species originally described as *Brachycercus parviforcipis* Zhou, Gui, and Su (2000) is actually a member of the genus *Caenis* Stephens (subfamily Caeninae) and was recombined as such by Zhou and Zheng (in press). The description of a new Chinese species of *Brachycercus* is presented below.

*Brachycercus capnicus* Zhou, Sun, and McCafferty, new species

(Figs. 1–18)

Mature larva.—Body (Fig. 1) length 3.4–5.0 mm. Caudal filaments length 1.8–2.3 mm. General coloration pale yellow brown. Head: Coloration pale yellow; occiput and frons stained with brown centrally, without dark brown patches or black stripes posterior to lateral ocellar tubercles. Head capsule with anterolateral transverse row of long setae on either side between base of
antenna and base of mandible. Lateral ocellar tubercles triangulate in lateral view (Fig. 2), with length slightly greater than width at base, and subequal to width of eye, with anterior margin slightly concave and with apex round and lacking long setae. Middle ocellar tubercle triangulate in dorsal view (Fig. 1) and straight in lateral view, with length ca. two-thirds that of lateral ocellar tubercles and ca. 1.5X basal width; apex round to bluntly pointed. Eyes not elevated above level of vertex (Fig. 2). Antenna (Fig. 3) pale, with pedicel 2.0X scape length; scape and pedicel without maculae; pedicel with ca. 10 setae subequal to, or longer than, one-half length of pedicel. Clypeus with transverse row of relatively long setae anteriorly. Labrum (Fig. 4) nearly trapezoidal, with lateral margins slightly protruding, with medioapical margin slightly concave, and with relatively dense, stout setae along anterior margin. Lingua of hypopharynx (Fig. 5) with distal margin straight; superfinguae with lateral margins moderately and roundly produced. Maxilla (Fig. 6) with galealacinia length 2.9X basal width; palp segment 2 length 1.8X that of segment 1; segment 1 width 1.6X that of segment 2; palp segment 2 with few long, stout setae at apex extending somewhat basally along inner margin, and with only sparse, fine setae near base. Labial palp
(Fig. 7) with dense, long setae in lateral aspect of segment 2. **Thorax:** Notal coloration yellow brown, without distinct black maculae; sternal coloration pale yellow with diffuse black stain. Pronotum (Fig. 8) trapizoidal, darker medially, with lateral margin slightly produced. Prothoracic pleura and lateral mesonotum with sparse marginal setae. Prosternum with median transverse ridge roundly curving, but not produced ventrally. Mesosternum with anterior margin straight, without long, fine setae. Mesosternum and metasternum without protrusions. Legs pale throughout. Ratios of length of body: foreleg : midleg : hindleg, 3.1:1.0:1.5:1.5. Ratios of length of forefemur : tibia : tarsus : claw, 3.3:1.6:1.7:1.0. Ratios of length of hindfemur : tibia : tarsus : claw, 3.9:2.5:2.7:1.0. Ratio of hindfemur length to width, 4.3:1.0. Forefemur (Fig. 9) with row of very short setae in addition to relatively long setae along dorsal margin, and with row of stout setae in addition to some short setae along ventral margin; foretibia with row of four or five short setae along ventral margin; foretarsus with row of ca. 10 short setae along ventral margin; foretibia and tarsus also with scattered, sparse, short, fine setae on both anterior and posterior surfaces. Hindfemur (Fig. 10) with row of short setae interspersed with long setae along dorsal margin and short setae along ventral margin; hindtibia and tarsus with row of sparse, long setae along dorsal margins and row of short, stout setae along ventral margin; hindclaw (Fig. 10) adenticulate and moderately curved, with length 4.0× basal width. **Abdomen:** Terga pale yellow, without distinct maculae; terga 1, 2, 7–9 with medial area somewhat darker; tergum 10 darkened anteriomedially. Tergum 1 with fine setae along posterior margin; tergum 7 with row of relatively dense, long setae along posterior margin; tergum 8 with much fewer setae along posterior margin. Segment 2 without short fingerlike process near base of operculate gill. Lateral processes on segments 2–8 (Fig. 11): process 2 triangulate and blunt; processes 3–6 strongly curved dorsally, with apices bluntly pointed; processes 5 and 6 subequal in length; processes 7 and 8 short; process 9 small, triangulate, with apex acutely pointed. Tergum 9 with posterior margin straight. Sterna flat, pale yellow, with pale diffuse black stain in some individuals, without noticable setae; sternum 9 (Fig. 12) with posterior margin convex. Operculate gill (Fig. 13) subquadrate, with length 1.3× width, without protruding edge at outer-posterior corner; dorsal surface yellow brown except pale along outer and posterior margins, with few long setae in outer region; Y-ridge somewhat darker than adjacent areas, with outer branch stained with black, branching in anterior third of gill, and with few long setae; ventral surface lacking dense, short setae; inner margin with row of relatively sparse, short setae; inner-posterior corner with row of relatively dense, long setae; outer-posterior corner with row of long setae (shorter than those of inner-posterior corner), intermixed with several very short setae; outer margin with row of long setae shorter than those of posterior margin. Caudal filaments pale yellow, with segments in apical third with long setae.

Male adult (in alcohol).—Body (Fig. 14) length 3.5–3.7 mm. Caudal filaments length 11.0–12.0 mm. Wing length 3.5 mm. **Head:** Occiput pale yellow, stained with diffuse pale brown. Stem of epicranial suture bordered with diffuse pale brown stain. Frons diffuse brown centrally above middle ocellus. Scape diffuse pale brown; pedicel pale brown, 2.3× length of scape; flagellum pale. **Thorax:** Pronotum pale yellow, with extensive black shading. Mesonotum and metanotum yellow brown. Metanotum with posteromedial protrusion broadly triangulate, with apex bluntly pointed. Thoracic sterna yellow, with diffuse black stain. Prosternum with blackened median transverse ridge straight, not prominent ventrally; mesosternum with sternocostal suture not blackened; mesosternum and metasternum without vestige of central protrusions.
Legs with coxae and trochanters brown; femora without a black dorsodistal macula; foreleg (Fig. 15) with femur pale brown, with brown stripes, and with tibia and tarsus pale; midleg and hindleg pale. Ratios of length of body : foreleg : midleg : hindleg, 2.5:2.3:1.0:1.1. Ratios of length of forefemur : tibia : tarsus, 1.0:2.9:1.9. Ratios of length of foretarsus segment I:II:III:IV:V, 1.0:12.7:5.3:3.0:2.0. Forewing (Fig. 16) with ratio of length to width at widest portion 1.9, with Sc. R1 and adjacent area pale brown; other veins pale. Abdomen: Coloration generally pale, without maculae, with terga 3–6 somewhat palest. Segments 3–6 with distinct vestiges of larval lateral processes. Genitalia (Fig. 17) with penes lobes moderately convex laterally, and with forceps slightly bowed, with apex pointed. Caudal filaments pale.

Female adult (in alcohol).—Body length 4.0 mm. Caudal filaments length 1.2 mm. Forewing length 4.5 mm, with ratio of length to width at widest portion 2.0. Ratio
of length of body: foreleg: midleg: hindleg, 2.2:1.0:1.3:1.4. Coloration similar to male.

Egg (dissected from mature larva).—
Length approximately 160 m. Shape (Fig. 18) narrow ovate, with single polar cap ca. one-third length of entire egg. Chorion (Fig. 18) with 10–15 broad costae in lateral view.

Material examined.—Holotype: ♂ adult. Wei-Yuan River (23.30 N, 100.41 E), Feng-Shan Village, Jing-Gu County, Yunnan Province, China, IV-8-2001, Chang-Fa Zhou (deposited in Nanjing Normal University, Nanjing, China). Paratypes: 17 ♂ adults, one ♀ adult, 15 ♂ subimagos, 3 ♀ subimagos (reared from larvae), 18 larvae, data and deposition same as holotype; 3 ♂ adults: two larvae, data same as holotype (deposited in the Purdue Entomological Re-

Etymology.—The specific epithet is an adjective of masculine gender latinized from the Greek word “kapnikos,” which means smoky. It is an allusion to the diffuse black stain on the thoracic sterna in the larvae and adults of the new species.

Discussion.—Among Asian species, larvae of Brachycercus capnicus and those of B. tubulatus, B. corniger Kluge, B. japonicus Gose, and B. gilliesi Soldán and Landa are relatively similar. Larvae of these species share the absence of thoracic sternal protrusions and a posterolateral protruding edge on the operculate gill (Fig. 13), and as such are distinguished from B. harrisella. Also, they all do not have dense, long setae along the anterior margin of mesosternum, which is a distinctive characteristic of B. petersorum Soldán and B. minutus Tshernova. Additional diagnostic features in larval B. capnicus are as follows. The lateral margin of abdominal segment 2 (Figs. 1, 11) is slightly produced and does not form a process subequal to that of segment 3, as is the case in B. corniger. The lateral ocellar tubercle (Figs. 1–2) is triangular in lateral view, slightly shorter than the combination of scape and pedicel; the middle ocellar tubercle length is ca. 1.5× its basal width, and less than that of the lateral ones by ca. one-third; whereas in B. japonicus the lateral ocellar tubercle is fingerlike in lateral view and longer than the combination of scape and pedicel; the middle ocellar tubercle length is ca. 2.5× its basal width, and subequal to that of the lateral ones; and in B. tubulatus the middle ocellar tubercle is distinctively longer than the lateral ones. The pedicel (Fig. 3) has ca. 10 setae subequal to, or longer than one-half the length of the pedicel, and the abdominal terga (Fig. 1) lack maculae; whereas in B. gilliesi the pedicel has over 20 long setae, and the abdominal terga 1, 2, and 7–9 have a pair of brownish bands (Soldán and Landa 1991).

Four species of Asian Brachycercus had previously been known in the adult stage (Soldán 1986, Kluge 1991, Tojo 2001). The adults of Brachycercus capnicus can be distinguished from them as follows. Male and female B. capnicus are no more than 4.0 mm in length; whereas the male of B. harrisella is more than 4.5 mm, and the female is more than 5.0 mm. The ratio of pedicel to scape length is greater than 2.0 in B. capnicus (Fig. 14); whereas this ratio is ca. 1.5 in B. minutus. Abdominal segment 2 lacks vestiges of larval lateral processes in B. capnicus (Fig. 14); whereas these vestiges are distinct in B. corniger. Thoracic sterna of B. capnicus are extensively stained with pale black; whereas B. japonicus lacks such shading.

Brachycercus capnicus larvae were collected from a relatively clean-water river during the dry season when the river was 5–10 m in width. The larvae were found in association with a substrate composed of sand and silt, strewn with driftwood and leaf packs; a water depth of ca. 40 cm; and a current velocity less than 0.5 m/s. Other genera of mayflies collected in the same habitat included Ephemera Limnaeus, Potamanthellus Lestage, and Caenis.

Subimagos and adults of B. capnicus were attracted to a collecting light in predawn hours. The subimagos molted to adults while perched on stones near the attracting light. Many subimagos and adults of Caenis and Clypeocaelis Soldán were also collected at the same time by the same method. Similar observations for collecting alate stages of caenid mayflies were made by WPM in South Africa.

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copy was conducted at the Life Science Microscopy Facility, Purdue University.

LITERATURE CITED


Abstract.—*Carayonia orientalis*, n. sp., is described based on recently collected specimens from Vietnam, Laos, and Thailand. This new species inhabits wetlands with monocots.

**Key Words:** Insecta, Heteroptera, Reduviidae, Saicinae, *Carayonia*, Indochina

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*Carayonia* Villiers is a comparatively small assassin bug genus of the subfamily Saicinae, comprising nine species described from the Old World tropics and subtropics (Maldonado 1990, Malipatil 1990). The Asian fauna of the genus has been represented only by two species, *C. nitens* (Miller) from the Philippines and *C. culiciformis* Usinger from Sri Lanka, while the others occur in Australia (one species) and Africa (six species).

From recent fieldwork by us and our colleagues in Indochina, we discovered an interesting species belonging to *Carayonia*. Upon examination, we concluded that it is undescribed. In this paper, we describe the species as new and provide habitus photographs and illustrations, including the male genitalia. The diagnostic characters for the genus also are given.

All the type material is housed in the Laboratory of Insect Resources, Faculty of Agriculture, Tokyo University of Agriculture, Atsugi, Japan.

*Carayonia* Villiers


Diagnosis.—Distinguished from other saicine genera by a combination of the following characters: Body shining; head pyriform, lacking dorsal transverse sulcus between eyes, with conical anteculus; pronotum without spines at humeri; scutellar spine long; forecoxae elongate; forefemora and foretibiae with series of long, sparse, spiniform setae; foretibia apically with large, flattened, distally acute projection; tarsal segment II long; and abdomen elliptic. Detailed generic diagnoses and descriptions were provided by Villiers (1951, 1969), Miller (1952, as *Visayanocoris*) and Malipatil (1990, as *Visayanocorinae*).

Remarks.—Taxonomic placement of *Carayonia* has been controversial. It has been put either in Saicinae (Villiers 1951, 1958, 1969; Maldonado 1990) or Visayanocorinae (Miller 1952, China and Miller 1959, Malipatil 1990, Cassis and Gross 1995). Wygodzinsky (1966) and Putshkova and Putshkov (1996) treated *Visayanocorini*.

Carayonia orientalis Ishikawa and Okajima, new species
(Figs. 1–12)

Description.—Measurements (in mm): ♂/♀ (holotype in parentheses): Body length 3.30–3.50/3.65–3.90 (3.33). Head length including neck 0.72–0.74/0.73–0.80 (0.74); width across eyes 0.42–0.44/0.42–0.43 (0.44); interocular space 0.19–0.22/0.23 (0.21). Antenna length 2.93–3.55/3.00 (3.55); lengths of segments I, II, III and IV 1.03–1.13/1.06 (1.13), 0.37–0.41/0.37 (0.40), 0.62–0.73/0.57 (0.73) and 0.80–1.29/1.00 (1.29), respectively. Rostrum length 1.03–1.10/1.05–1.09 (1.10); lengths of segments I, II and III 0.49–0.51/0.52 (0.51), 0.23–0.26/0.23–0.24 (0.26) and 0.29–0.33/0.30–0.33 (0.33), respectively. Pronotum length 0.54–0.59/0.55–0.58 (0.54); width

nae as a tribe in Saicinæ and placed this genus in Visayanocorini. We herein follow the Villiers and Maldonado’s opinions in the placement for convenience.

The pyriform head without the dorsal transverse sulcus is a distinct feature separating this genus from the other saicine genera, and it is considered to be an autapomorphy for Carayonia. The genus Wardamanocoris Malipatil is most similar to it in sharing such characters as the forefemur with long, sparse, spiniform setae, the foretibia apically with a large, flattened, distally acute projection, and tarsal segment II much longer than the remaining segments combined (Malipatil 1990). However, the reliable sister genera are currently not determined, and a comprehensive revision is required to ascertain the accurate systematic position.
across humeri 0.69–0.70/0.71–0.73 (0.70). Hemelytron length 2.14–2.47/2.26–2.38 (2.39). Lengths of femur, tibia and tarsus of forelegs 1.14–1.22/1.21–1.23 (1.22), 1.16–
1.25/1.21–1.24 (1.25) and 0.60–0.65/0.62 (0.65); of midlegs 1.29–1.39/1.38–1.41 (1.39), 1.32–1.43/1.40–1.42 (1.43) and
0.54–0.66/0.68 (0.66); of hindlegs 1.64–
1.88/1.90–1.95 (1.88), 2.05–2.32/2.22–2.34 (2.30) and 0.63–0.71/0.66 (0.71), respectively.
Abdomen length 1.70–1.84/1.96–1.98 (1.76).

Coloration (Figs. 1–2): Body generally
dark brown to fuscous. Head and thorax
shining. Anterior part of head, rostrum and
areas above metacoxal cavities yellowish
brown. Antennal segments I and II brown,
except for apex of II whitish; segment III
brown, with many narrow, whitish annula-
tions; segment IV brownish yellow, with
many brown annihilations on basal half. Legs
brown; tibiae gradually pale toward apices;
tarsi brownish yellow; mid- and hindcoxae
eyellowish brown. Hemelytron including
veins brown to dark brown, except for pale
subbasal parts. Abdomen dark brown,
tinged with yellow posteriorly; laterotergites brownish yellow.

Structure: Head (Fig. 3) elliptical. 1.7
times as long as width across eyes, ventro-
laterally armed with 4 pairs of long
spinion setae, and with several, long, spini-
form setae in ventral disc; anteculus 0.7
times as long as postoculus, covered with
short, decumbent setae; postoculus with
long, sparsely distributed, suberect setae.
Compound eye half as wide as interocular
space in dorsal view. Antenna densely cov-
ered with short reclining and suberect setae;
proportion of segments I to IV 14: 5: 9: 16.
Rostrum (Fig. 3) bearing short, suberect
setae; segment I with 2 pairs of long spini-
form setae and a few slender setae; segment
II with 3 pairs of long spiniform setae; seg-
ment III with 2 pairs of long spiniform setae;

Pronotum about 0.7 times as long as
head, slightly more than 0.7 times as long
as humeral width, with long, sparsely dis-
tributed, erect setae; posterior margin weak-
ly arched; anterior lobe a little more than
0.75 times as long as posterior lobe. Scut-
ellar spine (Fig. 3) about 1.3 times as long
as scutellum, weakly curved upward, blunt-
tipped. Foreleg (Fig. 4) densely covered
with short, reclining and suberect setae;
forefemur with 8 to 9 interolateral and 4
ventral, long spiniform setae (in Fig. 4, api-
cal parts of former 3 setae visible); foretibia
with 4 interolateral and 2 ventral, long spi-
iform setae; foretarsus half as long as tibia.
Mid- and hindlegs densely covered with
short, decumbent and suberect setae. Hem-
eytron slightly exceeding posterior apex of
abdomen; veins on membrane ambiguous;
venation shown as in Fig. 5.

Abdomen wider than hemelytra, covered
with short, decumbent setae except for an-
terior part, apically rounded in male, sub-
acute in female.

Male genitalia: Pygophore (Figs. 9, 10)
somewhat flattened dorsoventrally, with
posterior process; posterior process taper-
ing, slightly sinuate and apically obtuse in
lateral view (Fig. 9), spatula-shaped and
apically rounded in dorsal view (Fig. 10).
Parameres (Figs. 11, 12) curved inward,
weakly constricted dorsoventrally near mid-
dle, rounded apically, covered with erect
and suberect setae variable in length. Phal-
lus (Fig. 6) elliptical, somewhat flattened
dorsoventrally; phallotheca sclerotized on
dorsum; endosoma long, membranous, with
2 rows of minutely spinulate areas.

Female genitalia: Tergite VIII with
rounded posterior margin (Fig. 8). Tergite
IX declivous (Fig. 7). Valvifer I with round-
ed margin (Figs. 7, 8); valvula I (Figs. 7,
8) large, nearly triangular, subacute at apex.
Styloids (valvula III) oblong, well visible
between tergite IX and valvula I (Fig. 8).

Holotype.—♂. Vietnam: Dambri, Bao
Loc. Lam Dong Prov., 28.xii.2001. T. Ish-
ikawa.

Paratypes.—Vietnam: 1♂. same data as
for holotype; 1♂. 1♀. Loc. Thang Ward,
Bao Lam. Lam Dong Prov., 27.xii.2001. T.
Figs. 3–12. Carayonia orientalis (only long, spiniform setae shown on Figs. 3–10). 3, Head, prothorax and scutellum, lateral view. 4, Left foreleg. 5, Right hemelytron. 6, Phallus, dorsal view. 7–8, Apical part of female abdomen, lateral and posterior views. 9, Pygophore, lateral view. 10, Apical part of pygophore, dorsal view. 11–12, Left paramere, lateral and dorsal views.


Distribution.—Vietnam, Laos, Thailand; this is the first record for the genus Carayonia from continental Asia.

Etymology.—From the Latin, orientalis, referring to the type locality; an adjective.

Remarks.—This new species is distinguished from other members of Carayonia by a combination of such features as the body 3.3–3.9 mm long, the head about 1.7 times as long as width across eyes, antennal segment IV much longer than segment III, rostral segment I twice as long as segment II, the venter of the forefemur with four long spiniform setae, the venter of the foretibia with two long spiniform setae, the scutellar spine 1.3 times as long as the scutellum, and the evenly curved parameres.
This species inhabits marshes grown with monocots in Vietnam and Thailand, and was found on low parts of shrubs. A single individual was attracted to light. No other information is available on its biology.

**KEY TO ASIAN SPECIES OF CARAYONIA**

1. Pronotum 1.3 times as long as scutellum and scutellar spine combined
   
   - Pronotum as long as scutellum and scutellar spine combined
     
     1.3 times as long as scutellum and scutellar spine combined................. C. caliciformis Usinger
     
     2. Scutellar spine twice as long as scutellum; venter of foretibia with 4 long spiniiform setae; parameres bent at middle.... C. nitens (Miller)
     
     - Scutellar spine 1.3 times as long as scutellum (Fig. 3); venter of foretibia with 2 long spiniiform setae (Fig. 4); parameres evenly curved inward (Fig. 12).............. C. orientalis, n. sp.

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**LITERATURE CITED**


SEXUAL DIMORPHISM AND SIZE OF ADEAGI IN APIONID WEEVILS
(COLEOPTERA: APIONIDAE) AND FLEA BEETLES (COLEOPTERA: CHrysomELIDAE): WHY SOME MASCULINE MALES HAVE SMALL ADEAGI

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Abstract.—A correlation between strongly developed sexually dimorphic external structures and the size and mechanical properties of male genitalia are described and illustrated in Trichoconapion Korotyaev (Coleoptera: Apionidae) and Normaltica Konstantinov (Coleoptera: Chrysomelidae). Sexually dimorphic structures include legs and antennae in Trichoconapion and head and mouth parts in Normaltica. These sexually dimorphic characters in our examples are likely to function as clasping (restraining) or copulatory courtship devices rather than male/male combat or precopulatory courtship devices.

Key Words: Apionidae, Chrysomelidae, sexual dimorphism, male genitalia, copulatory courtship

A monotypic Oriental apionid genus Trichoconapion Korotyaev with an unusually sharp sexual dimorphism in external characters was described without any reference to the male genitalia (Korotyaev 1985). In the type series, only a few males were present, and the content of their abdomens was partly decayed. Examination of additional material has revealed a small, membranous aedeagus with a weakly sclerotized median lobe, which was rather unexpected in a species with strongly developed external dimorphic characters manifested in various structures. The obvious disagreement between the external characters and the desclerotized genital structures invited a search for similar trends in other beetles. The recently described West Indian flea beetle genus Normaltica Konstantinov (2002b) (Chrysomelidae) presented such an opportunity. The male of one of the only two known species of this genus differs dramatically in having greatly enlarged head with all the mouthparts being extraordinarily long. Males and females of the other species are indistinguishable by their heads. Comparison of male genitalia of the Normaltica species revealed the same tendency as in the Oriental apionids. In the species without sexual dimorphism, the aedeagus was significantly larger and more complex in shape than in the one with sexual dimorphism. The difference in size was even greater when aedeagi were compared to body size.

Unfortunately, the sexual behavior of Trichoconapion and Normaltica remains undocumented, so how their sexually dimorphic structures function is unknown. However, the fact that the structures under
consideration are very species specific, suggests that they are under strong pressure of sexual selection (Eberhard 1985).

Although we did not use a statistical analyses, standardly used to establish correlation in comparative data, it is quite clear that smaller and mechanically weaker male genitalia occur in males with strongly developed external, sexually dimorphic structures in such distant groups as Curculionoida and Chrysomeloida. An objectivity of this result is insured by comparing the genitalia of males with sexual dimorphism to those of males from closely related species (or genus) without sexual dimorphism. The structure and size of internal sac is not known for the species under consideration, so it is assumed that it correlates in size with the sclerotized portion of male genitalia.

Below we will describe external, sexually dimorphic structures in Trichoconapion and Normalitica; propose an explanation for the observed correlation between sexual dimorphism and size of male genitalia; and propose hypotheses on the possible function of these structures.

Dissecting techniques and terminology for internal and external structures of these beetles follow Konstantinov (1998, 2002a) and Korotyaev et al. (2000). Illustrations were made with an AMRAY 1810 scanning electron microscope and ZEISS Stemi SV 11 stereo microscope with camera lucida attachment.

**Sexual Dimorphism in Apionids and Flea Beetles**

Sexual dimorphism is widespread among apionids. In addition to the characters obviously associated with oviposition (length and width of rostrum, which are sexually dimorphic in the great majority, if not in all Apionidae), males in many groups have more or less distinct legs. Males of many species in various regions of the world differ from females in brighter coloration of the rostrum and dense white pubescence on the rostrum, underside of the head, sides of the thorax and procoxae. Tibiae, especially protibiae, are often also more brightly colored in males. Femora in males are usually at least slightly thicker than in females; in species of the Palearctic genus Squamapion Bokor, the metafemur is often strongly swollen. Tibiae (usually protibiae) in males are often longer than in females and more or less inwardly (less frequently outwardly) curved apically, and meso- and metatibiae often have a variously shaped tooth (mucro) on the inner or, rarely, outer apical edge. Procoxae in some Protapion Schilsky are armed with spines. The apical part of the protibiae in Ceratapion penetrans Germar and C. basicorne Illiger are flattened, somewhat twisted, and shallowly concave. Tarsi, especially in fore legs, are usually conspicuously wider in males, except for the xeromorphous species which lack or have reduced sole hair brushes. In some groups lacking a tibial mucro, e.g., in several genera of the Palearctic tribe Ceratapini, the first pro- or mesotarsomere is often armed with a sharp denticle on the ventral surface. The presence of mucro on male meso- and metatibiae also is very common in many Curculionidae, and in some cases of its reduction on metatibia, for example, in saltatory Ceutorhynchinae, the first metatarsomere also may develop an acute dent on the ventral surface. Thus, both tibial mucro and tarsal denticles probably are used by males to hold themselves on the convex female body. Apionidae have an additional structure probably for the same purpose, a denticle on the midline of the male metasternum (Eutrichapion Reitter) or first ventrite (Hemitrichapion Voss); in several Asian species of Piezothrachelus Schoenherr the basal process of the first ventrite bears a pair of small denticles laterally (Korotyaev 1987).

In many species of Apionidae, the male antennae are more or less conspicuously modified and usually more brightly colored, these changes being accompanied by alteration of the head proportions and structure. Antennae may become more or less strong-
Figs. 1–6. Comparison of body and aedeagus size in Apionids. 1–3, Trichoconapion hirticorne. 1. Habitus. 2. Aedeagus in proportion to body size. 3. Aedeagus in details. 4–6, Vietapion paradoxum. 4. Habitus. 5. Aedeagus in proportion to body size. 6. Aedeagus in detail.
ly elongated and covered with longer hairs (Protapion), the entire funicle may be thickened and pilose (many Ceratapion Schilsky) or the first antennomere (scape) is more or less strongly, sometimes pear-shaped swollen [Tatyanaapion laticeps (Desbrochers)]. The head capsule and basal part of the rostrum in species with strongly modified antennae become wider, the rostrum often forming rather strong and more or less angular expansion at antennal insertion (Loborhynchapion Györffy, Tatyana-
Aspidapion Legalov, *Ceratapion* Schilsky); this expansion may be dentiform (*Exapion* Bedel, many *Ceratapion*) in species with moderately or weakly elongate antennae but with sharp difference between sexes in rostrum length. The antennal club may be more or less strongly elongate (often in *Ceratapion*), sometimes similarly to what is common in the Dermestidae, apparently revealing a parallelism to the Cyladinae (Brentidae).

Some really monstrous forms are known in the Mediterranean fauna of the genus *Prota*pin, with strongly shortened and dilated antennae, strongly flattened tarsi with angular or dentiform expanded tarsomeres, and inner margin of protibia produced into a long acute projection. In a recently found undescribed apionine from northeastern Turkey, usual modifications of the antennae and rostrum (resembling those in *Loborhynchapion*) and apically outcurved protibae are supplemented with an unusual position of the sharp tubercle (present in some *Entrichapion*) at the anterior margin of the mesosternum and a unique modification of the middle legs which have dense and long erect pilosity on both femora and tibiae. In no examined species with sharply dimorphic external male characters, including the most peculiar ones, has any conspicuous modification of the genitalic structures been found. The most bizarre male appearance is known for taxa from the temperate, predominantly Mediterranean fauna. No particular example of sexual dimorphism has been reported from the Australo-Pacific apionids (Wanat 2001). That manifested by *Trichoconapion* hirticorne Korotyaev may be the most pronounced one among the known Oriental species of the family.

In addition to those of *Trichoconapion* hirticorne, the only disproportion of the genitalic structures reported in the Apionidae is the small, weakly sclerotized aedeagus in *Aspidapion grisescens* Korotyaev, from India and Vietnam, which is only half as long as the normally sclerotized aedeagus with strengthened apex (Korotyaev 1985: figs. 5, 6, 7) in *Aspidapion vietnamense* Korotyaev, a species co-occurring with *A. grisescens* in Vietnam and of exactly the same body size as in *A. grisescens*. In contrast to *Trichoconapion* hirticorne, the mechanically weak aedeagus in *A. grisescens* is not accompanied by considerable development of the external secondary dimorphic structures. The fifth to seventh funicular antenomeres in *A. grisescens* each bear one erect hair longer than the usual pubescence; the protibia is slightly incurved apically and armed with a small mucro; the metasternum has a sharp, rather high median keel at the base, which is not found in any other Oriental *Aspidapion* Schilsky, but the meso- and metatibiae lack the mucro, which is well developed in *A. vietnamense*. Although not so conspicuous as in *T. hirticorne*, these external distinctions of *A. grisescens* may also be correlated with the small, poorly sclerotized aedeagus and provide additional evidence in support of the hypothesized existence of the interrelation between the genitalic and external secondary dimorphic male structures.

Sexually dimorphic structures of *Trichoconapion* include the antennae and front and hind legs. The male of *Trichoconapion* hirticorne (Figs. 1–14) can be easily separated from the female (Figs. 15–23) by the thickened and pilose antennae with enlarged and angular antennomere 1 (Figs. 13, 14, 20–23). The ventral side of male antennomeres 3 to 7 (which constitute most of the funicle) is covered with long setae, some of which are as long as two funicle antennomeres together (Fig. 14). Female antennae lack such setae (Fig. 23). The profemur of *Trichoconapion* is only slightly longer in males than in females, but in males its ventral surface bears two rows of stiff, closely placed, semierect setae (Figs. 9–11). In the female this surface of the profemur has two rows of thin, sparse, less erect setae (Figs. 18, 19). The latter character is unique among the Oriental Apionidae. The protibae in the male are much
longer than in the female, they are also strongly incurved near the apex (Figs. 12, 15, 17). The protarsi are only slightly different in the male with setae slightly longer than in the female. The male metatibia has a unique dent on the inner-dorsal (instead of the usual inner-ventral) angle of the apex.

*Trichoconapion* is a monotypic genus so we chose *Vietapion paradoxum* Korotyaev, which is not very closely related to *Trichoconapion*, but similar in size and with only moderately expressed sexual dimorphism to compare their aedeagi. The median lobe of the aedeagus of *Vietapion paradoxum* is solid, strongly sclerotized, strongly curved near the apex with a wide abrupt hook at the apex (Fig. 5, 6). The paired apodemes, a part of the median lobe which is much weaker mechanically than the solid part of the median lobe, are not longer than \( \frac{1}{3} \) of the total length of the median lobe. The median lobe of *Trichoconapion* (Figs. 2, 3) is mostly membranous, clearly consisting of two weakly connected parts: a ventral, flattened, short cylinder and a dorsal, flat at
apex, continuation of the apodemes. The apodemes are nearly as long as half of the total length of the median lobe. The aedeagus of *Trichoconapion* is noticeably smaller than the aedeagus of *Vieptapion* Korotyaev, and the difference in size is even more significant if the solid, sclerotized parts of the aedeagi are measured in relation to the body size (Figs. 1, 2, 4, 5).

Moderately developed sexual dimorphism is also common in flea beetles. In the great majority of taxa males can be separated from females by their wide first pro- and mesotarsomeres. In some *Aphthona* Chevrolat and *Phyllotreta* Chevrolat species, males have strongly and variably modified antennomeres (Konstantinov 1998). Males of some species of *Chalœnus* Westwood have greatly enlarged heads with the facial part longer and wider, but their mouthparts do not seem longer than those of females. The male of *Normaltica obrieni* Konstantinov has a similar kind of sexual dimorphism with enlarged heads, but its mouthparts are much longer. The head of the female of *Normaltica obrieni* has lateral parts converging below the eyes, but in the male the sides continue to be parallel to each other (Figs. 28–30). The clypeus and labrum together are as long as the facial part of the head to the dorsal margins of the eyes (Fig. 30); in the female, the clypeus and labrum reach to the middle of the eye (Fig. 29). In lateral view, male mandibles are particularly long (as long as the head capsule). The ventral view of the male head is even more bizarre (Fig. 31). The pre-mentum is long, wide at the base and in the

middle (nearly as wide as ⅔ of the head width), narrowing at the apex, and deeply concave. The mentum is the apex and long, as long as the prementum.

We compare *Normaltica obriseni* with *N. iviei* Konstantinov which lacks sexual dimorphism and is the only other species in the genus. *Normaltica iviei* is slightly smaller than *N. obriseni*, however its median lobe is actually larger than that of *N. obriseni* (Figs. 25–27). It is also more complicated in shape (Figs. 24, 26). The difference is even more impressive if the genitalia are compared in relation to the body size.

Both examples of apionid and flea beetle clearly show aedeagi to be significantly smaller and generally mechanically weaker in males with strongly developed sexual dimorphism.

**Discussion**

A negative correlation between sexually dimorphic characters and the size of male genitalia is spread across a wide array of structures in a variety of taxa at least among phytophagous beetles, since secondary sex characters occur in flea beetle heads and mouthparts and apionid legs and antennae. However, a search of available literature failed to find a described example of this tendency in other animals.

Correlation of sexual behavior and genital characters has been noted before. For example, Eberhard (1985: 82) suggested that elaborate premating courtship “imperfectly” correlates with “relatively simple and uniform genitalia.” Rapid diversification of male genitalia and nongenitalic structures specialized to function in sexual contexts is also well known (Eberhard 1996). “Those nongenitalic portions of the male which consistently contact the female and become specialized for such contact should tend to evolve like genitalia and diverge rapidly; they should also often function as courtship devices to influence female choice” (Eberhard 1996: 354). It is therefore pretty obvious that dimorphic structures of *Trichoconapion* and *Normaltica* function in a sexual context and an explanation of negative correlation between secondary sex characters and the size of male genitalia can be found in the fact that male secondary sex characters and genitalia function similarly, at least to a degree. Our argument is based on the assumption that it is not evolutionary advantageous to invest energy into morphological structures which function redundantly. Further, we would argue that sexually dimorphic characters in our examples are likely to function as clamping (restraining) or copulatory courtship devices rather than male/male combat devices.

All feasible explanations of functional significance of male sexually dimorphic structures are limited to four general possibilities: male/male combat devices; precopulatory courtship devices; copulatory courtship; and/or clamping (restraining) devices.

Most commonly, development of sexual dimorphism is explained as a result of male/male competition (Medvedev and Pavlov 1987, Windsor 1987, Eberhard and Gutierrez 1991, Zeh et al. 1992). In groups where reproductive success depends on domination (e.g., elephant seals), large male body size is strongly favored by sexual contests competition (Andersson 1995). In leaf beetles, most known sexually dimorphic structures are used in male combat (Beaman 1980, Eberhard 1981, Windsor 1987, Konstantinov 2002c). Leaf beetles without sexual dimorphism fight much less commonly (Konstantinov, in press). Sexually dimorphic structures used in fights include cephalic and thoracic horns, enlarged mandibles, fore and hind legs, appendages on the pronotum, etc. In our examples, the large legs and mandibles of *Trichoconapion* and *Normaltica* potentially can be used in male fights. However, that would not explain the smaller size of the genitalia in sexually dimorphic males since genitalia have no role in male/male combat. A male which won the precopulatory battle still faces obstacles provided by “cryptic female choice” (Eberhard 1996) during and after copula-

tion, and still competes with other males if the female copulates with multiple males. In that competition larger male genitalia may be an advantage in providing copulatory stimuli which ensure successful insemination.

Another possible explanation would be use of sexually dimorphic structures in pre-
Copulatory courtship for recognition or/and as visual or tactile stimuli indicating “good viability genes.” Andersson (1995) suggested that large head size in certain flies may help to impress rivals. In Normaltica a large head may be used for this reason, but it can be a base of large, widely separated mandibles. Long antennal setae and stiff setae on the profemora of Trichoconapion can function as precopulatory tactile stimuli. However, genitalia play no role in precopulatory courtship, so no function of them can be substituted by the aforementioned structures. In addition, cryptic female choice and competition with other males during and after copulation would still be an obstacle to overcome.

Copulatory courtship is described in many insects, including leaf beetles (Eberhard 1994). Also well documented is that male courtship influences the male’s chances for fertilization success (Eberhard and Kariko 1996). For example, in Macrohalatica jamaicensis (F.) movements of antennae and legs of males during copulation are synchronized with aedeagal movements inside the female, both stimulating the female. Clearly, long antennal setae and setal
rows on the profemora of *Trichoconapion* can function as courtship devices during copulation, but the other sexually dimorphic characters of *Trichoconapion* and *Normaltica* do not look like obvious stimulators. Nevertheless, it is not too difficult to imagine that the stimulating function of male genitalia can be diminished by the stimulating ability of their external sexually dimorphic structures, which may result in smaller size and more simple shape of the genitalia.

An ability of males to remain mounted on females during (and sometimes after) copulation is very important for reproductive success. It prevents other males from copulating with the female and assures sperm transfer to the spermatheca or insemination site. Copulating pairs are often attacked by single males in donaciine and chrysomeline leaf beetles (Konstantinov 2002c, Shimizu and Fujiyama 1986). That would probably constitute "direct male-male competition via mechanical properties of their genitalia" (Eberhard 1985: 92). A male structure which would help to maintain control over the female is important to assure reproductive success in male-female conflict of interests (Eberhard 1996). Documented episodes of this conflict include the female countering male mating attempts (Eberhard 1996), or forcefully terminating copulation (known in some cicindelids, Eberhard 1996).
Sexual selection would favor development of characters functioning as clasp- ing devices. Such devices are described in the waterstrider *Gerris odontogaster* (Zetterstedt), for which it was shown that larger devices in the male is actually favored by sexual selection (Arnqvist 1989). Male genitalia are also reported to be used for clasp- ing (Eberhard 1996). The male of *Chrysolina aurichalcea* (Mannerheim) uses its ac- deagl to anchor on a female while being attacked by another male (Shimizu and Fujiyama 1986). Thornhill and Alcock (1983) suggested that several characteristics of male genitalia are particularly important for clasp- ing: length, presence of spines and interlock features. The long and bent protib- iae, strongly setose profemora and antennae of *Trichoconapi* on and the giant mouthparts of *Normaltica* can be used to remain mounted on top of the female and/or main- tain control over her during and after copu- lation. This would lessen the clasp- ing role of male genitalia, and as a result the geni- talia could evolve to become smaller and mechanically weaker.

In the last two examples, sexually di- morphic, external characters and male geni- talia work together to provide stimuli and/or maintain control over the female during copulation, so the genitalia are partly re- lieved from this function. However, that the smaller genitalia are less effective as stim- ulators is not really clear. They are undoubt- edly less effective as clasp- ing devices. A single structure can be used for more than one function, but if we are to make a choice, we would conclude that the sexually dimorphic external characters in *Trichoconapi* on and *Normaltica* are more likely used during copulation as restraining and/or clasp- ing devices. Further studies of sexual dimorphism can put this hypothesis to the test. Therefore, based on that reasoning, we would hypothesize that if dimorphic struc- tures are used in male combat, or precopu- latory courtship, they will not correlate with the size of the male genitalia.

Most of the above discussion, at least to a degree, is based on an idea that larger male genitalia are more effective for assur- ing reproductive success, so if the genitalia in a related species are significantly smaller, something else is contributing to this suc- cess. Eberhard (1996) described three ex- perimental tests of the hypothesis that larger genitalia are associated with greater fertil- ization success. Test of the spider *Nephila clavipes* (Linnaeus) showed no relation be- tween size of the male genitalia and copu- latory success. The latter was measured by the amount of sperm that reached the sper- matheca and the frequency of rejections of males with shortened genitalia. In the cassi- dine leaf beetle *Chelymorpha alternans* Boheman, males with a longer aedeagal flagel- lum had greater paternity. Apparently the flagellum threads up the spermathecal duct of the female delivering sperms as close to the spermathecal receptacle as possible (Eberhard 1996). The last example of rats, *Rattus norvegicus* (Berkenhout), in an analysis of Eberhard (1996) also suggested that the size of male genitalic structures is important in determining fertilization suc- cess.

Conversely some studies of the allometry of male genitalia and their relation to the size of other male structures show contra- dictory results and produced debate (Eber- hard et al. 1998, Eberhard et al. 1999, Green 1999). Eberhard et al. (1998) found overall low allometric values of male geni- talia, even in *Chelymorpha alternans* men- tioned above, for which previously it was suggested that selection would favor larger genitalia. Based on that, they supported the earlier idea (Eberhard 1985: 79) that “male genitalia may not be consistently good indi- cators of male size” (Eberhard 1996: 76, 200). They have also concluded that selec- tion would favor an intermediate size of male genitalia which would fit the typical size of the opposite sex, and suggested that the hypothesis of forceful male/female con- flict cannot explain genitalic evolution. Green (1999) reanalyzed the data of Eber- hard et al. (1998) using different statistical
analyses and concluded that their results are dependent on the techniques used and therefore inconclusive. In a reply to Green (1999), Eberhard et al. (1999) insisted on the validity of their results.

Unable to comment on the statistical techniques used by Eberhard et al. (1998 and 1999) and Green (1999), we strongly suggest against generalization in this issue. Based on the examples provided by *Trichocconapion* and *Normaltica*, we would suggest that the results of the analyses are species specific. In groups in which clasping is important for assuring reproductive success, with strongly developed sexually dimorphic structures which work as restraining/clasping devices, the genitalia are less important for clasping becoming smaller and mechanically weaker, possibly having low allometric value (*Trichocconapion* and *Normaltica obrieni*). In comparison, in groups with vital clasping, but with the male genitalia as
the only claspers, the larger genitalia may be selectively advantageous with high allometric values (Vietapion paradoxum and Normaltica iviei).

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A NEW GENUS OF PRIMITIVE CRANE FLIES (DIPTERA: TANYDERIDAE) 
IN CRETACEOUS BURMESE AMBER, WITH A SUMMARY OF 
FOSSIL TANYDERIDS

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Abstract.—A new genus and species of primitive crane flies, Dacochile microsoma 
Poinar and Brown (Tanyderidae) is described from Cretaceous Burmese amber. It differs 
from extant and extinct members of the family by the following combination of characters: 
small size (wing length, 2.8 mm), reduced anal lobe, hyaline wing membrane, crossvein 
cua-a, forming cell cua, very short vein R_{2+3}, very long terminal maxillary palps, and 
mandibles. The well-developed mandibles indicate that the species obtained food by piercing 
and sucking. A list of fossil tanyderids is presented.

Key Words: Dacochile n. gen., Dacochile microsoma n. sp., Tanyderidae, Burmese am-
ber, Cretaceous

The Tanyderidae, or primitive crane flies, possess many plesiomorphic characters, es-
pecially regarding the wing venation. The family consists of 12 extant genera, most in 
the Southern Hemisphere. The adults occur in moist terrestrial habitats while the larvae 
are found in shallow water or along the margins of lakes, rivers and streams, usual-
ly in sediment or rotting vegetation (Alexander 1981). Origin of the family and its 
relationship with other Nematocera has been of interest, and fossils from the Eo-
cene and Jurassic have been reported (Table 1).

A female tanyderid discovered in Creta-
ceous Burmese amber, described below in 
a new genus, provides insight into the mor-
phology of early members of this interesting 
group. Amber from Burma occurs in 
lignite seams in sandstone-limestone de-
posits in the Hukawng Valley (Poinar 1992, 
Zherikhin and Ross 2000). Nuclear mag-
netic resonance (NMR) spectra of amber 
samples taken from the same locality as the 
fossil indicated an araucarian (possibly 
Agathis) source of the amber (Lambert and 
Wu, unpublished research 2002). Palyno-
morphs obtained from the amber beds 
where the fossil originated have been as-
signed to the Upper Albian (~100–110 
mya) of the Lower Cretaceous (Crui-
ckshank and Ko 2002).

Materials and Methods

The amber was recut and polished in or-
der to view the specimen better. The amber 
piece containing the fossil is rectangular in 
outline, measuring 7 mm in greatest length, 
5 mm in greatest width and 1 mm in great-
est depth. The specimen is well preserved 
and nearly complete, with only the tips of 
the tibiae and ovipositor missing. Obser-
vations, drawings and photographs were 
made with a Nikon SMZ-10 stereoscopic 
microscope and Nikon Optiphot optical mi-
croscope (with magnifications up to 650×).
In the following description, terminology is

The presence of a radius with 5 branches all ending at the wing margin, the subcosta bifurcate at its extremity, with the basal branch appearing as a crossvein in $R_1$, a single anal vein reaching the margin, the costa continuing around the wing margin, setae between the ommatidia and cell br (first basal cell) longer than cell bm (second basal cell) place the fossil in the family Tanyderidae Osten-Sacken 1879.

**Dacochile Poinar and Brown, new genus**

*Type species:* Dacochile microsoma Poinar and Brown.

Description.—Body (length, 2.6 mm) and wing (length, 2.8 mm) small, anal lobe greatly reduced, anal margin slightly concave; wing membrane hyaline, crossvein cu a-a$_1$ forming cell cu a, vein $R_{2+3}$ short, mandibles well developed.

Etymology.—Daco is from the Greek “dakno” for bite; chile is from the Greek “chilo” for lip; the gender is neuter.

Diagnosis.—In Williams’ (1933) key to the extant and fossil Tanyderidae, *D. microsoma* would align with the Baltic amber fossil *Macrochile* Loew in the couplet “wings immaculate.” Whether the wings of *Macrochile* are completely hyaline is questionable since Alexander (1931) noted vague indications of dusky spots at the end of vein Sc, on r-m and at the fork of M3 and CuA1 on *M. spectrum* Loew, and Podenas (1997) noted dark areas on the wings of *M. baltica* Podenas. The two described species of *Macrochile* are large (body length from 8.2 mm to 12 mm and wing length from 4.5 mm to 8.5 mm) and have distinct anal lobes. The Rs varies from shorter to approximately the same length as $R_{2+3}$ in *Macrochile* while it is 3 times as long as $R_{2+3}$ in *Dacochile*. The extant and extinct Jurassic species of *Protopanyderus* Handlirsch differ from *Dacochile* in having pictured wings with an anal lobe and in lacking the cu a-a$_1$ crossvein. The presence of a distinct cu a-a$_1$ crossvein, forming a cu a cell is rare in tanyderids. However, it occurs in the Patagonian species *Neoderus patagonicus* Alexander (Williams 1933).

The extinct genus *Praemacrochile* Kalugina differs from *Dacochile* in having Sc end opposite the middle of $R_{4+5}$, $R_2$ short, almost 1/2 of Sc and 1/2 of $R_{3+4}$ and having $R_{4-5}$ as long as or slightly longer than $R_2$. *Dacochile* shares some characters with *Nannotanyderus* Ansorge 1994, namely the small size and reduced anal lobe, but the latter genus is characterized by a short Rs vein, only half as long as $R_{2+3}$, a large cell bm and a rounded anal lobe (Ansorge 1994, Ansorge and Krzeminski 2002).

**Dacochile microsoma Poinar and Brown, new species**

(Figs. 1–8)

Description.—Holotype female: with characters listed under the generic diagnosis. General coloration brown; body length 2.6 mm. Head: Length: 315 μm (not including rostrum), eyes dichoptic, with short hairs arising between facets of ommatidia; antenna 17-segmented, 2.37 mm long. segment 1: 63 μm, 2: 113 μm, 3: 63 μm, 4: 283 μm, 5: 214 μm, 6: 189 μm, 7: 189 μm, 8: 145 μm, 9: 170 μm, 10: 95 μm, 11: 107 μm, 12: 107 μm, 13: 101 μm, 14: 107 μm, 15: 107 μm, 16: 107 μm, 17: 107 μm. Antennal segments with numerous uniform setae: conspicuous verticils equal or exceed corresponding segments in length. apical segment as long as preceding segment. postpedicel short, equal in length to pedicel: maxillary palp 5-segmented. 850 μm long, with 5th segment 2.6 times as long as 4th. segment 1: 50 μm, 2: 132 μm, 3: 145 μm, 4: 145 μm, 5: 378 μm; head bearing distinct, short rostrum. 265 μm long, with strong, pointed mandibles lacking noticeable teeth on inner surface (details shown in Figs. 2. 7). Thorax: Brown, 790 μm long: legs yellowish brown, coxa 1: 334 μm, 2: 410 μm, 3: 422 μm, trochanter 1: 113 μm, 2: 126 μm, 3: 113 μm, femur 1: 1.28 mm, 2: 1.43 mm, 3: 1.42 mm; all tarsi and tips
Figs. 4–5. *Dacochile microsoma.* 4. Flagellomere showing verticils at the base of each segment and dense setae uniformly covering each segment. Bar = 89 μm. 5. Extremely long terminal segment of maxillary palp. Bar = 48 μm.

... of tibiae missing; wing hyaline, all veins bearing setae, long setae on costa in anal area, wing membrane covered with microtrichia, Sc relatively short, less than half wing length, ending before origin of R₂₃; cell br over twice as long as cell bm; cross-vein m-cu absent; Cu P vein faint, arising from A₁ and curving toward wing margin; base of Cu A₁ appears as crossvein; tip of veins R₁, R₂ and R₃ bent anteriorly at wing margin; anal lobe greatly reduced or possibly absent, replaced with long setae; halter brownish yellow, 258 μm long, covered with short setae; further details of venation...
shown in Fig. 6 and of thorax in Fig. 8. Abdomen: Brown, extended, 1.64 mm long, twisted unnaturally about 90° at approximately 2/3 of its length, tip of ovipositor missing.

Male.—Unknown.

Material examined.—Holotype female in Burmese amber, deposited in the Poinar amber collection (accession # B-D-12) maintained at Oregon State University.

Etymology.—Micro is from the Greek “mikros” for small and somus is from the Greek “soma” for body.

Diagnosis.—Dacochile microsoma is one of the smallest known members of the family. Other distinguishing characters are the short antennal postpedicel, the very short R2+3 and the extremely short bm cell. While members of the genus Radinoderus also have a relatively short R2+3, they lack a cu-a cell, possess an anal lobe and have pictured wings. Most tanyderids have the terminal flagellomere shorter than the penultimate, and the terminal maxillary palp not more than twice the penultimate one (Williams 1933, Alexander 1981). However the terminal and penultimate flagellomeres are equal in D. microsoma and the terminal maxillary palp is 2.6 times longer than the penultimate. Unfortunately, head structures are not noted for the other Mesozoic fossil tanyderids (Table 1).

### DISCUSSION

The presence of well-developed mandibles in *D. microsoma* is interesting because these structures have only been reported in the Australian genus *Radinoderus* Handler and the North American *Protoplaga* Osten-Sacken (Downs and Colless 1967). In *Dacochile*, the size of the mandibles suggests that a piercing-sucking habit provided the major means of obtaining nourishment. The blood-sucking habit is well established in the Diptera, with each group evolving their own specialized type of mouthpart modification in order to obtain the food source (Downs 1970, Kalugina 1991).

It is interesting that the mouth structures closely resemble those of the Psychodidae (Quate and Vockeroth 1981). The similarity between the wing structure of Mesozoic Tanyderidae and Psychodidae has been noted, and the similarity of the mouth structure reported here supports the contention that the two families are closely related and may have originated from a common stem (Crampton 1926, Krzeminski and Evenhuis 2000).

A list of described fossil tanyderids is presented in Table 1. Twelve fossil species in 5 genera (one extant and 4 extinct) have been described, all from Old World deposits. The oldest members are from the Lower Jurassic and the youngest from the Eocene.

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**Table 1.** Fossil species of Tanyderidae.

<table>
<thead>
<tr>
<th>Species</th>
<th>Locality</th>
<th>Age</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dacochile microsoma, n. sp.</td>
<td>Burma</td>
<td>Cretaceous</td>
<td>present work</td>
</tr>
<tr>
<td>Macrochile baltica Podenas</td>
<td>Baltic amber</td>
<td>Eocene</td>
<td>Podenas 1997</td>
</tr>
<tr>
<td>Macrochile spectrum Loew</td>
<td>Baltic amber</td>
<td>Eocene</td>
<td>Loew 1850</td>
</tr>
<tr>
<td>Namotanyderus grimmernensis A. &amp; K.</td>
<td>Germany</td>
<td>Lower Jurassic</td>
<td>Ansorge &amp; Krzeminski 2002</td>
</tr>
<tr>
<td>Namotanyderus krzemiński Anisorge</td>
<td>Germany</td>
<td>Lower Jurassic</td>
<td>Ansorge 1994</td>
</tr>
<tr>
<td>Praemacrochile chinensis K. &amp; R.</td>
<td>China</td>
<td>Middle Jurassic</td>
<td>Krzeminski &amp; Ren 2001</td>
</tr>
<tr>
<td>Praemacrochile decipiens (Bode)</td>
<td>Germany</td>
<td>Lower Jurassic</td>
<td>Ansorge &amp; Krzeminski 2002</td>
</tr>
<tr>
<td>Praemacrochile dobberthensis A. &amp; K.</td>
<td>Germany</td>
<td>Lower Jurassic</td>
<td>Ansorge &amp; Krzeminski 2002</td>
</tr>
<tr>
<td>Praemacrochile stackelbergi Kalugina</td>
<td>Siberia</td>
<td>Upper Jurassic</td>
<td>Kalugina &amp; Kovalev 1985</td>
</tr>
<tr>
<td>Protanyderus mesozoicus Kalugina</td>
<td>Mongolia</td>
<td>Upper Jurassic</td>
<td>Kalugina 1988</td>
</tr>
<tr>
<td>Protanyderus senilis Kalugina</td>
<td>Mongolia</td>
<td>Upper Jurassic</td>
<td>Kalugina 1992</td>
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<tr>
<td>Protanyderus vetus Kalugina</td>
<td>Mongolia</td>
<td>Upper Jurassic</td>
<td>Kalugina 1992</td>
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</table>
Only three species have been described from amber deposits. It is interesting that some of the Upper Jurassic forms have been placed in the extant genus *Protanystyron* Handlirsch. Since the Jurassic fossils were identified only on the basis of wing characters, we feel that their placement in an extant genus is premature and should be made only after an examination of body characters. If confirmed, these would represent the oldest terrestrial generic lineages, thus far limited to four insect genera found in Cretaceous Lebanese amber (Poinar and Milki 2001).

**ACKNOWLEDGMENTS**

We thank Neal Evenhuis, Jörg Ansorge, and Wieslaw Krzeminski for supplying pertinent literature on fossil tanyiderids and Roberta Poinar for comments on an early draft of the manuscript.

**LITERATURE CITED**

**ALLOEORHYNCHUS TRIMACULA** (STEIN) (HETEROPTERA: NABIDAE: PROSTEMMATINAE), A PREDATOR OF RHYPAROCHROMIDAE (LYGAEOIDEA) ASSOCIATED WITH FIGS IN MEXICO

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**Abstract.**—The nabid *Alloeorhynchus trimacula* (Stein) was found preying on adults and nymphs of several species of Rhyparochromidae, including members of the tribes Antillocorini, Myodochini, and Ozophorini. All records correspond to rhyparochromids that are associated with several native species of figs in Mexico. Descriptions of the adult and immature stages and information on the biology of *A. trimacula* are included.

**Resumen.**—El návido *Alloeorhynchus trimacula* (Stein) fue encontrado depredando adultos y ninfas de varias especies de Rhyparochromidae, incluyendo miembros de las tribus Antillocorini, Myodochini y Ozophorini. Todos los registros corresponden a rhyparochromidos que están asociados a especies nativas de higuera en México. Se incluyen descripciones del adulto, estados inmaduros e información sobre la biología de *A. trimacula*.

**Key Words:** Nabidae, *Alloeorhynchus*, Rhyparochromidae, Moraceae, *Ficus*

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Harris (1928) gave descriptions of all species of Nabidae known from North and Central America and the West Indies. He included notes about the biology of many species and their economic importance. Within this family, members of Nabinae seem to be general predators on small arthropods. Species of the Prostematinae were reported to prey exclusively on other Heteroptera (Pe ricart 1987, Lattin 1989). Carayon (1970) reported other species of *Alloeorhynchus* Fieber known to prey on lygaeids in Africa, but little work on this group of nabids with its prey has ever been documented. Information about the biology and descriptions of all instars of *Alloeorhynchus trimacula* (Stein) are given in this study. A list of the species of rhyparochromid bugs and their host plants of the associated bugs, and geographical records from several states in Mexico are presented.

**Materials and Methods**

Monthly collecting trips during 2001 and 2002 were made to several localities in the Mexican states of Campeche, Puebla, Tamaulipas, and Veracruz. The objective was to collect rhyparochromids associated with figging trees. While collecting lygaeids, other insects associated with the bugs or preying on them were collected. Around 30 fig species were sampled from localities at sea level to an altitude of 1,000 m. Several types of vegetation were included: low tropical dry forest, medium tropical forest, high tropical rain forest, and cloud forest.

Nabids were collected alive and put into plastic containers (9 × 8 cm) covered with muslin to avoid condensation. A dry fig leaf and a small humid cotton ball were put in each container; living rhyparochromids of several species were offered as food. Con-
tainers were checked daily for the presence of eggs, and more prey added when necessary. Individuals were kept under laboratory conditions at about 20° C and 70% RH. Individuals were placed in 70% alcohol and used for illustrations and descriptions. Measurements are given in mm, ±SD. Material collected during 2001 and 2002 is deposited in the Insect Collection of Instituto de Ecología, A.C. (IEXA). Additional material in the Insect Collection of Instituto de Biología, U.N.A.M. (CNIN) was studied.

**Alloerhynchus trimacula** (Stein)  
(Fig. 1)

Descriptions.—*Egg* (Fig. 1A) (*n* = 3): Elongate, 0.8 ± 0 mm long, 0.23 ± 0.03 mm wide, anterior pole slightly bent toward one side, anterior pole with grayish chori-onic ring, posterior pole round. White when laid, turning yellowish in two to three days; red eye spots appear after day seven.

*First instar* (Fig. 1B): Body elongated, with maximum width across abdominal segment III. Head, thorax, and a heart-shaped macula over dorsal abdominal segments IV to IX pale brown. Eyes reddish brown; antennal segments pale gray, with joints white. Rostrum and legs grayish yellow. Thoracic pleuræ reddish. Abdomen pinkish gray, except for pale brown macula on last abdominal segments. All dehiscent lines pale yellow. Head slightly declivent, with two long setae on tylus; rostrum reaching posterior part of procoxae. Postero-lateral angles of pro-, meso-, and metanotum with a long seta. Front and middle femora with thick black mid spine on ventral surface. Scent gland openings barely apparent on segments III–IV, IV–V, and V–VI, the first two as a pair of openings, the third as a single opening. *Measurements* (*n* = 3). Body length 1.45 ± 0.14; head length 0.19 ± 0.04; width across eyes 0.31 ± 0.04; interocular distance 0.16 ± 0.02; postocular distance 0.02 ± 0.0; antennal segments: I 0.1 ± 0, II 0.02 ± 0, III 0.17 ± 0.03, IV 0.2 ± 0, V 0.39 ± 0.01; rostral segments: I 0.12 ± 0.006, II 0.16 ± 0.01, III 0.08 ± 0.006; pronotum: length 0.25 ± 0.02, width across humeral angles 0.32 ± 0.05, width across anterior margin 0.26 ± 0.04; fore leg: femur length 0.31 ± 0.01, tibia length 0.27 ± 0.005, tarsi length 0.15 ± 0.005.

*Second instar* (Fig. 1C): Similar to first instar. Head and pronotum slightly darker and macula on abdomen not always apparent. Antennal segments turn grayish yellow and first antennal segment with a reddish band on external margin; first rostral segment reddish brown. Spine of fore and middle femora more apparent and two or three more spines present near longer one. Tri-chobotria evident on dorsum of segments II to VIII. Scent gland opening on segments V–VI not always visible. *Measurements* (*n* = 4). Body length 1.8 ± 0.11; head length 0.25 ± 0.04; width across eyes 0.37 ± 0.01; interocular distance 0.18 ± 0.01; postocular distance 0.02 ± 0.02; antennal segments: I 0.18 ± 0.03, II 0.02 ± 0, III 0.25 ± 0.01, IV 0.26 ± 0.02, V 0.51 ± 0.01; rostral segments: I 0.12 ± 0.01, II 0.21 ± 0.02, III 0.12 ± 0.005; pronotum: length 0.33 ± 0.02, width across humeral angles 0.46 ± 0.02, width across anterior margin 0.31 ± 0.03; fore leg: femur length 0.46 ± 0.01, tibia length 0.42 ± 0.005, tarsi length 0.19 ± 0.01.

*Third instar* (Fig. 1D): Similar to second instar. Head and thorax with irregular red markings, region anterior to eyes brown; eyes also darker, almost black. Spines of fore and middle femora longer and more numerous. Meso- and metathoracic wing pads start developing. Otherwise as in second instar. *Measurements* (*n* = 10). Body length 2.28 ± 0.13; head length 0.26 ± 0.03; width across eyes 0.45 ± 0.02; interocular distance 0.24 ± 0.02; postocular distance 0.03 ± 0.03; antennal segments: I 0.23 ± 0.03, II 0.02 ± 0, III 0.33 ± 0.02, IV 0.38 ± 0.02, V 0.6 ± 0.04; rostral segments: I 0.13 ± 0.02, II 0.34 ± 0.01, III 0.14 ± 0.008; pronotum: length 0.41 ± 0.02, width across humeral angles 0.58 ± 0.03, width across anterior margin 0.37 ±
0.02; fore leg: femur length 0.55 ± 0.05, tibia length 0.46 ± 0.01, tarsi length 0.24 ± 0.01.

Fourth instar (Fig. 1E): Pyriforme. Head and pronotum brown, posterior areas reddish. Antennal segments gray, although joints still white. Abdomen yellolish, especially near lateral margins; two scleritized rectangular areas appear on segments I and II; heart-shaped macula on last abdominal segments turn darker and divisions between segments become clearer; scent gland opening on segments V–VI obscure. Spines of front and middle femora double-ranked; internal margin of front and middle tibiae with a longitudinal line of flat black teeth extending half way onto abdomen. Meso- and metathoracic wing pads covering half of following segment. Measurements (n = 10). Body length 3.2 ± 0.26; head length 0.32 ± 0.04; width across eyes 0.54 ± 0.03; interocular distance 0.25 ± 0.006; postocular distance 0.02 ± 0.02; antennal segments: I 0.3 ± 0.02, II 0.03 ± 0.008, III 0.49 ± 0.06, IV 0.53 ± 0.02. V 0.71 ± 0.06; rostral segments: I 0.16 ± 0.02, II 0.27 ± 0.02, III 0.22 ± 0.02, IV 0.16 ± 0.01; pronotum: length 0.58 ± 0.06, width across humeral angles 0.76 ± 0.06, width across anterior margin 0.44 ± 0.05; scutellum: length 0.32 ± 0.04, width 0.53 ± 0.04; fore leg: femur length 0.77 ± 0.06, tibia length 0.7 ± 0.07, tarsi length 0.31 ± 0.02.

Fifth instar (Fig. 1F): Similar to fourth instar. Head dark brown; eyes black, slightly reddish near their base. Pronotum, lateral areas of meso- and metanotum and thoracic pleurae brown. Pinkish coloration of abdomen completely disappeared, changed to creamy yellow; heart-shaped macula visible, four small black maculae appear on connexivum of segments II to V. Ventral abdominal segments creamy yellow. Mesothoracic wing pads covering metanotum and reaching middle of abdominal segment II. Measurements (n = 10). Body length 4.32 ± 0.29; head length 0.45 ± 0.09; width across eyes 0.69 ± 0.04; interocular distance 0.29 ± 0.03; interocellar distance 0.06 ± 0.06; postocular distance 0.04 ± 0.04; antennal segments: I 0.37 ± 0.02, II 0.05 ± 0.004, III 0.69 ± 0.05, IV 0.7 ± 0.02, V 0.86 ± 0.04; rostral segments: I 0.2 ± 0.02, II 0.33 ± 0.04, III 0.26 ± 0.02, IV 0.19 ± 0.02; pronotum: length 0.85 ± 0.06, width across humeral angles 1.08 ± 0.05, width across anterior margin 0.54 ± 0.03; scutellum: length 0.52 ± 0.02, width 0.81 ± 0.04; fore leg: femur length 0.97 ± 0.08, tibia length 0.85 ± 0.06, tarsi length 0.39 ± 0.02.

Adult (Fig. 1G): Elongate, body densely covered with semi-erect black and pale yellow hairs. Head brownish black and shiny; antennal segment I grayish-yellow, antennal segments II to IV dark brown to gray, slightly paler distally; rostrum grayish brown. Pronotum reddish with one black spot on each humeral angle, another black, triangular spot on midline of posterior margin; scutellum and hemelytron dull brown, costal margin varying from pale yellow to reddish. Most individuals with tarsi, tibiae, and apical one third to one half of all femora blackish brown, basal half of femora pale yellow; a few individuals had lighter tibiae and tarsi. Propleura reddish, mesopleura dark shiny brown, and metapleura dark dull brown. Abdominal venter creamy yellow with broad submarginal dark brown stripe on each side. Head broader than long, distinctly broader than collar; eyes prominent; antennal segment IV sometimes twisted; rostrum reaching mesosternum. Pronotum clearly divided into anterior and posterior lobe; scutellum with three small depressions, two on disc and one near apex, apex distinctly bifid. Fore and mid femora with double row of spines, fore femora robust. Female measurements (n = 10). Body length 5.69 ± 0.61; head length 0.64 ± 0.1; width across eyes 0.8 ± 0.05; interocular distance 0.29 ± 0.02; interocellar distance 0.09 ± 0.09; postocular distance 0.09 ± 0.04; antennal segments: I 0.46 ± 0.03, II 0.05 ± 0.005, III 0.96 ± 0.09, IV 0.88 ± 0.06, V 1.03 ± 0.12; rostral segments: I
0.22 ± 0.02, II 0.55 ± 0.05, III 0.37 ± 0.03, IV 0.21 ± 0.02; pronotum: length 1.22 ± 0.13, width across humeral angles 1.7 ± 0.12, width across anterior margin 0.6 ± 0.03; scutellum: length 0.83 ± 0.11, width 0.98 ± 0.08; fore leg: femur length 1.32 ± 0.13, tibia length 1.13 ± 0.08, tarsi length 0.51 ± 0.04. Male measurements (n = 10). Body length 4.93 ± 0.31; head length 0.56 ± 0.08; width across eyes 0.73 ± 0.04; interocular distance 0.27 ± 0.02; interocular distance 0.09 ± 0.09; postocular distance 0.11 ± 0.03; antennal segments: I 0.41 ± 0.04, II 0.05 ± 0.006, III 0.83 ± 0.03, IV 0.76 ± 0.04, V 0.88 ± 0.04; rostral segments: I 0.22 ± 0.02, II 0.5 ± 0.02, III 0.32 ± 0.03, IV 0.18 ± 0.02; pronotum: length 1.06 ± 0.05, width across humeral angles 1.54 ± 0.06, width across anterior margin 0.51 ± 0.02; scutellum: length 0.75 ± 0.06, width 0.83 ± 0.03; fore leg: femur length 1.13 ± 0.06, tibia length 0.98 ± 0.06, tarsi length 0.44 ± 0.03.

Biology.—Alloeorhynchus trimacula preyed on adults and nymphs of several species of Rhyparochromidae in the tribes Antillocorini, Mydochini, and Ozphorini. Species of lygaeids that A. trimacula captured varied according to fig species and locality. In Antillocorini it preyed on several unidentified species of Botocudo Kirkaldy, Cligenes distinctus Distant, and on a new genus; in Mydochini, it preyed on Mydocha mispinosa Stål and Neopamera bilobata (Say); and in Ozphorini, on Ozphora atropictoides Slater & Baranowski, O. baranowski Slater & O’Donnell, O. concava Distant, O. consanguinea Distant, and O. maculata Slater & O’Donnell.

Adults of Alloeorhynchus trimacula arrived soon after the fig tree started to drop its fruits, also corresponding to the time when the first adult lygaeoids were first found around the trees. Counts of rhyparochromid and nabids two weeks after the first fruit had dropped reached 106.94 ± 18.64 and 10.28 ± 2.03 individuals, respectively per square meter (Cervantes, unpublished data). Adults and nymphs of the two groups of bugs were abundant. Alloeorhynchus trimacula was observed preying on adults and nymphs of all the species mentioned above. They appeared to catch more nymphs of the species of lygaeoids that are good flyers, but they also preyed on the less mobile adults of Antillocorini. Nabids run rather quickly among the litter looking for lygaeoids. Under laboratory conditions, nymphs and adults of A. trimacula captured the rhyparochromids offered as soon as they were put in the containers, catching at least one rhyparochromid every two days. Cannibalistic behavior was not observed, although it is possible that it could occur if not enough rhyparochromids were available. Female A. trimacula laid isolated eggs on leaf litter at the same time when several species of rhyparochromids were doing the same. The life cycle for both groups was completed between 50 to 60 days. It is possible that nabids and rhyparochromids move to different fruiting trees as the food resources for the bugs decrease. Due to the asynchronous fruiting of the fig species, nymphs and adults of rhyparochromids and A. trimacula were present all year around. Alloeorhynchus trimacula adults sometimes were attracted to light.

From the 30 native species of figs sampled, A. trimacula was recorded on Ficus calyculata Miller, F. cotinifolia (Kunth), F. insipida (Willd.), F. lapathifolia (Liebm.) Miq., F. obtusifolia (Kunth), F. pertusa L.f., F. tecolutensis (Liebm.) Miq., and F. trigonata L. A few species are widely distributed within Mexico, such as F. cotinifolia and F. insipida; although F. calyculata and F. lapathifolia have more restricted distributions. Ficus cotinifolia can be found at sea level, while F. calyculata can reach 1,500 m. This wide range of distribution will show that A. trimacula will have a broader host list if a higher number of samples for each individual fig species are taken.

Distribution.—In the literature, A. trimacula has been reported from México, Guatemala, Panama, and Brazil (Champion
351


New records: MEXICO: Campeche: Calakmul, Balamku; Calakmul, El Hormiguero; Calakmul, Km 25 to Calakmul Ruins; Calakmul, Calakmul Ruins, 172 m. Nayarit: Los Sabinos, Oaxaca: Km 55 Tuxpec-Oaxaca; Km 11 Teotitlan-Huautla, 1.850 m; Km 14 Mitla-Albarradas. Puebla: Km 4 San Jose Acateno-Poza Rica, 288 m. Queretaro: Puente Escandilla. Tamaulipas: Gómez Farias, Ejido el Azteca, 350 m; Gómez Farias, 276 m; Gómez Farias, Km 7 to Ciudad Mante, 320 m; Gómez Farias, Km 5 to Altacima, 600 m. Veracruz: Ozuluama, Km 40 Matatampico-Ozuluama, 3 m; Naranjos, Km 10 Naranjos-Chontla, 118 m; Naranjos, Km 30 San Sebastian-Naranjos, 262 m; Misantla, Km 14 Misantla-Martinez de la Torre, 80 m; Huatusco, Km 21 Jalcomulco-Huatusco, 546 m; Actopan, La Mancha, sea level; Actopan, Quiahuiztlan; Cuitlahuac, Km 44 Cuitlahuac-Tierra Blanca, 204 m; San Andres Tuxtla, Los Tuxtla, 150 m; Catemaco, Km 10 to Tebancan; Isla, Km 13 Benito Juarez-Villa Juanita, 137 m; Isla, Km 45 Isla-Playa Vicente, 49 m; Jesus Carranza, Km 54 Boca del Monte-Poblado Doce, 102 m; Orizaba, Buena Vista, 1,200 m; Atoyac; Montepio, Quetzalan, 1.160 m. (IEXA) (CNIN).

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**Literature Cited**


A REVIEW OF THE GENUS DOIRANIA WATERSTON (HYMENOPTERA: TRICHOGRAMMATIDAE), WITH A DESCRIPTION OF A NEW SPECIES FROM NORTH AMERICA

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Abstract.—The trichogrammatid genus Doirania is reviewed. The genus, previously known only from species in Japan and New Guinea, has a considerably more widespread distribution which includes North America and other areas of the Palaearctic. Three species are assigned. The North American species (D. elegans, n. sp.) is described and compared to congeners. The limits of Doirania and its relationship to other members of the tribe Oligositini are discussed.

Key Words: Hymenoptera, Trichogrammatidae, Doirania, taxonomy

As is the case with most trichogrammatid genera, Doirania is uncommonly collected and poorly known. It was described by Waterston (1928) for a single species, D. leefmansi, a parasite in eggs of Tettigoniidae (Orthoptera), from Ambon, Indonesia. A second species, D. longiclavata Yashiro, from Japan, was added in 1980. Recent collections show the genus to be considerably more widespread. This paper presents a brief review of the genus and the description of an additional species, D. elegans, which is widespread in eastern North America.

Doirania is assigned to the tribe Oligositini (Viggiani 1971). It has been considered close to Oligosita (Doultt and Viggiani 1968, Yashiro 1980), and possibly deserving only subgeneric status (Viggiani 1971). The primary feature separating the two genera historically is antennal club segmentation (one in Doirania, two or three in Oligosita). Although additional traits separating these taxa are proposed here, generic limits remain questionable, and certain species currently assignable to Oligosita appear to be closer to Doirania. The current definition of Doirania is retained pending a complete evaluation of oligositine relationships.

Terminology employed for most morphological traits follows Doutt and Viggiani (1968) and Gibson (1989, 1997). Terms for antennal sensilla follow Olson and Andow (1993), and Pinto (1999).

Doirania Waterston


Diagnosis.—Ranging from 0.4–0.8 mm in length; color light to dark brown. Head: Foramen magnum near top of head, at or above level of dorsal margin of eyes (Fig. 1). Antennal formula (Fig. 4): 2 anelli (2nd anellus discoid, inconspicuous). funicle 1-segmented, club 1-segmented; funicle well separated from club, transverse; club with 6 placoid sensilla (2 at middle and 4 api-
cally), with at most 1 or 2 unsocketed setae, these at extreme base when present: length of scape and pedicle combined greater than that of flagellum. Mesosoma: Finely etched longitudinal line present medially on scutum and scutellum (correlated with a white line visible in dried specimens). Mesopleuron without a pleural suture. Venter of metasothorax with distinct transeptisternal sulci (see Gibson 1989). Forewing (Fig. 15) 2.5–3× as long as wide: longest fringe setae length ca. ½–⅔ greatest wing width. Metasoma: At least the anterior 3 terga longitudinally striate posteriorly (Figs. 13, 14). Two or more metasomal sterna completely divided longitudinally and ovipositor short, not extending beyond apex of metasoma or only slightly so (Figs. 8, 9). Male with a relatively broad, apically truncate ventromedial projection on antepentultimate sternum (Fig. 10). Male genitalia simple, as in several other oligositine genera, reduced to a single tube with two short apodemes at base (Figs. 10, 16, 17).

Remarks.—The Oligositini are recognized by features of the male genitalia (Viggiani 1971) as well as by the black rather than red compound eyes and the presence of one instead of two pair of setae each on the scutum and scutellum (Fig. 7). Genera assigned to the tribe in addition to Doirania include Oligosita, Megaphragma, Prestwichia, Epoligosita, Prosoligosita, Chaetostrichella, Hayatia, Eteroligosita, and Probrachista. De Santis (1997) also assigned his new genus Brachistographa to this tribe but, known only from females, its placement requires confirmation.

Doirania is separated from all other oligositine genera by the following combination of characters: Foramen magnum placed near top of head (Fig. 1); antenna (Fig. 4) with a single club segment and a transverse funicle; three or more metasomal terga with a longitudinally striate posterior section (Figs. 13, 14); ovipositor relatively short, not extending beyond apex of metasoma; male genitalia simple (Figs. 16, 17), tubular, without complex apodemes basally. Certain species of Epoligosita also have a one-segmented club (Doutt and Viggiani 1968) but in that genus, as in other oligositines, the foramen is placed near the middle of the head (Fig. 2), much closer to the mouthparts, and the metasomal terga are uniform, lacking a striate posterior section. Chaetostrichella, also with a one-segmented club (Doutt and Viggiani 1968, as Brachista), has a more ventrally placed foramen magnum, an elongate funicle, more complex genitalia, and an ovipositor which extends considerably beyond the apex of the metasoma.

Doirania can be separated unambiguously from other described oligositine genera. Yet it is probable that certain undescribed species, currently assignable to Oligosita based on antennal segmentation, are actually closer to Doirania. Unfortunately, these taxa are known only from females which makes their placement difficult at present. Oligosita is the largest genus of Trichogrammatidae and it is likely that it is composed of two or more unrelated lineages which simply lack certain derived features of other oligositine genera. A detailed analysis of the entire tribe is required before generic limits are satisfactorily clarified.

**KEY TO SPECIES OF DOIRANIA**

(Traits pertain to females unless indicated)

1. Ovipositor elongate, ⅓–½ longer than hind tibia, extending slightly beyond cerci (Fig. 9).
   - Male genitalia elongate, ca. ⅓ longer than hind tibia, with apodemes curving laterally at base (Fig. 17). Forewings with a small but distinct fumate cloud near apex of stigma. Known from Papua New Guinea and Ambon, Indonesia . . . .
   - Ovipositor shorter, its length ranging from distinctly less than to subequal to hind tibial length, not quite attaining level of cerci (Fig. 8).
     - Male genitalia shorter, length only 0.5–0.6 that of hind tibia, with apodemes straight, not curving laterally at base (Fig. 16). Forewing (Fig. 15) at most slightly darkened at apex of stigma, without a distinct fumate cloud . . . .

2. Metasomal terga with longitudinally striate posterior section distinct, at least second and third visible terga with striate section ca. twice the length of uniformly sclerotized anterior
**Doirania elegans Pinto, new species**

(Figs. 1, 3–5, 7, 8, 11–13, 15, 16)

Two forms (A & B) of this species are recognized (see Variation). The description is based on North American specimens of Form A. Unless indicated, quantitative data are based on five specimens from different locales; data represent means unless reported as a range.

**Description.—**Female: Body length 0.44–0.75 mm. Medium to dark brown in color except face, legs and antenna lighter brown; forewing only slightly fumate beneath venation. Head: Antenna (Fig. 4) with toruli at level of ventral margin of eyes; scape and pedicel together 1.2× combined length of funicle and club; club 1-segmented; mean length/width of antennal segments as follows: scape, 2.76; pedicel, 1.95; funicle, 0.67; club, 2.24; relative length of antennal segments in same order: 47/37/14/56; club 1.2× as long as scape, with terminal sensillum (= UPP trichodea D of Olson and Andow 1993) setiform (see Variation), 0.45 segment length (Fig. 11), placed on a small apical truncate pedestal; longest flagelliform setae (= MPP trichodea

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**Doirania elegans**

(Figs. 1–6) 1. *Doirania elegans*, posterior view of head. 2. *Epoligosita* sp. (same). 3, *Doirania elegans*, right maxillary palp (ventral). 4, *D. elegans*, antenna (lateral). 5, *D. elegans*, sensilla on dorsum of forewing disk anterior to retinaculum (see arrow in Fig. 15 for location). 6, *leefnansi* (same).

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**Section (Fig. 13).** Male club distinctly longer than scape. New World *D. elegans*, new species

Metasomal terga with longitudinally striate posterior section relatively indistinct, sclerotized striae poorly distinguished from adjacent membrane, terga with striate section, at most, subequal in length to uniformly sclerotized anterior section (Fig. 14). Male club shorter than scape. Palaearctic ............. *D. longiclavata*
A) 0.65 club length. Maxillary palp narrowing asymmetrically to apex, with apical sensillum longer than half the length of adjacent seta (Fig. 3). *Mesosoma*: Propodeum transverse (Fig. 7), slightly arcuate at middle and slightly longer (<2X) than metasternum. Hind femur ca. 0.3 as wide as long; tarsi relatively short, pro-, meso- and metatarsi ca. 0.80, 0.75 and 0.75 the length of their respective tibia; segment I slightly shorter than II and III on fore- and middle legs, all tarsomeres subequal on hind legs. Forewing (Fig. 15) 2.5–3.0X as wide as long, longest fringe setae 0.4–0.5 maximum wing width; sensilla anterior to retinaculum on dorsal surface of disk relatively large, digitiform, usually clavate (Fig. 5). Hind wing with 2 complete tracks of setae on disk, a partial third track present at apex in some specimens. *Metasoma*: Terga anterior to VII clearly differentiated into an anterior, uniformly sclerotized section and a posterior longitudinally striate section; striate section elongate, twice as long as anterior section on most terga (Fig. 13). Venter (Fig. 8) with all visible sterna except hypogynium narrowly divided longitudinally; hypogynium broadly emarginate; first visible sternum with a distinct posterior longitudinally striate section, others obsolescently striate posteriorly. Ovipositor 0.76 (0.67–0.89, n = 10) as long as hind tibia (see Variation).

Male: As in female except antennal club with only 3 placoid sensilla (1 basal, 2 near apex), and fewer flagelliform setae; club longer than scape (1.1–1.4 as long); only anterior 3 metasomal terga with an obvious posterior striate section. Venter with a medial, posteriorly projecting lobe on antepenultimate sternum (as in Fig. 10, see Remarks); lobe only slightly longer than wide. Genitalia (Fig. 16) gradually but distinctly widened to apex, length 0.5–0.6 that of hind tibia, with basal apodemes straight, not curved laterally.

Variation.—There appears to be two sympatric forms (A & B) of this species. The description and types refer to Form A. In Form A the terminal club sensillum in females is setiform (Fig. 11) and is similar in dimensions to the numerous flagelliform setae on the same segment; also the ovipositor is relatively short (see above). In Form B, the terminal sensillum is broader and, although tapering, it remains slightly truncate at the apex rather than acuminate (Fig. 12). Also the ovipositor is longer in Form B [0.98 (0.87–1.14, n = 12) as long as hind tibia] and the discal forewing setae are usually shorter. I am unable to distinguish the males of these variants. Although the two forms are not geographically disjunct there is a degree of character overlap.

A small series from Ecuador (Limoncocha, Napo Province) consisting only of females is questionably conspecific to *D. elegans*. In these specimens the propodeum is more distinctly produced at the middle, and the pedicel is subequal in length to the scape. Ovipositor length and the form of the terminal club sensillum are as in Form A.

Types.—Holotype ♀. UNITED STATES. Oklahoma: Red Oak (Latimer Co.); ix-1993; flight intercept trap (FIT); K. Stephen. Paratypes. 2 ♂, 1 ♀ with same data. Holotype and one male paratype deposited in Canadian National Collection, Ottawa (CNC); the two additional paratypes deposited in the Entomology Department, University of California, Riverside. Types are mounted in Canadian balsam on glass slides. Seven carded females from the same series are not designated as types. The slide-mounted types belong to Form A.

Diagnosis.—*Doirania elegans* is closest to the Palaeartic species, *D. longiclavata*. It is separated by the more distinct and longer striate section of the metasomal terga (see key to spp.). Also, in the male of *D. elegans* the club is distinctly longer than the scape, not shorter as in *D. longiclavata*. Sensilla anterior to the retinaculum on the dorsal surface of the forewing apparently provide an additional difference. In the new
species they are rather elongate, digitiform and often clavate (Fig. 5); in *D. longiclavata*, as in *D. leefmansi* as well, they are shorter and typically acuminate apically (Fig. 6). Ovipositor length and shape of the apical antennal sensilla in females of *D. longiclavata* resemble Form A of *D. elegans*.

Although very similar phenetically, it is not yet clear if *D. elegans* and *D. longiclavata* are sister species. The only similarity which may be derived is the asymmetrically
narrowed maxillary palp (Fig. 3). It occurs in both species but not in *D. leefmansi*.

**Geographic distribution.**—Eastern United States, Arizona, southeastern Canada, with a single record of questionable conspecifics from Ecuador.

**Remarks.**—Hosts are unknown. Several of the records (see below) suggest that *D. elegans* occurs in relatively mesic habitats.

Males of *Doirania* and of related genera are characterized by at least one medial prolongation on the sternal region of the metastoma (Pinto and Viggiani, in preparation). The few males available of *D. elegans* and *D. longiclavata* are mounted on slides and do not allow adequate description of this structure. However, it appears to be similar to that occurring in *D. leefmansi* (Fig. 10).

**Material examined.**—136 ♀, 8 ♂. Identification of ‘form’ (A or B) is possible for slide-mounted females only. Consequently an indication of ‘A’ or ‘B’ does not follow those records based only on males or carded females. In cases where both slide-mounted and carded females are available, the number of individuals that identification of ‘form’ is based on is indicated (e.g., A/2; signifies that two of the females in the series were slide-mounted and identifiable to form).

**CANADA. Ontario:** Ottawa (Innes Point); viii-20/27-1985; 1 ♀; L. Dumochel/J. Denis (B). Powell’s Lake (105 km NE Lake Superior); viii-16-1980; 1 ♀; M. Kaulbars. Shirley’s Bay; viii-27/ix-10-1985; 1 ♀; M. Sanborne/H. Goulet. UNITED STATES. Arizona: Brawley Wash (Pima Co.); viii-3-1982; 1 ♀; G. Gibson (A). Nogales (N edge of town); ix-27-1985; sweeping; 1 ♀; J. Pinto (A). Florida: Archbold Biological Research Station; x-27/xi-30-1988; Malaise trap; 2 ♀; D. Wahl (A/1). Bradenton; x-19/26-1985; sweep; 1 ♀; C. Yoshimoto. Everglades National Park (Long Pine Key); vi-6/vii-26. & viii/xi-986; Malaise/flight intercept trap; 6 ♀; S. & J. Peck (A). Gainesville; iv-17/23-1988; 1 (sex undetermined); D. Wahl. Gainesville; iv-8/14-1987, xii-1/7-1986; 2 ♀; W. Mason. Highlands Hammock (Highlands Co.); ix-18-1987; sweep; 2 ♀; L. Masner (A/1). Georgia: Athens (Whitehall Forest); ix-14/28-1987; flight intercept trap, hardwood forest (beaver swamp); 1 ♀; CNC Hym. Team (A). Sapelo Island; vii-18/ix-11-1987, ix-9/21-1987, x-15/xi6-1987; Malaise trap; live oak forest; 14 ♀, 1 ♂; CNC Hym. Team (A/4). Tifton, 13 km NW; ix-25/x-17-1985; pan trap; 2 ♀; M. Keller (A/1). Illinois: Centralia (along roadside: Hwy 51 & Bethel Rd.); yellow pan trap “among weeds nr. soybeans”; ix-12/17-1995; 2 ♀; S. Triapitsyn (A). Centralia, 3 mi N; ix-12/17-1995; yellow pan trap “in grass nr. pond”; 1 ♀; S. Triapitsyn. Centralia, 2 mi S (of downtown); ix-13/17-1995; yellow pan trap “on edge of forest”; 1 ♀; S. Triapitsyn. Centralia, 8 mi E; ix-7-1993; sweeping “open field”; 2 ♀; J. Pinto. Litchfield; x-3-1983; sweep; 1 ♀, 1 ♂; J/D, Huber (A). Marion Co. (Myers Rd. nr. hwys. 57 & 161); ix-12/17-1995; yellow pan trap “in grass in swampy area”; 1 ♀, 1 ♂; S. Triapitsyn. Kansas: Manhattan, 2 mi S; ix-6-1983; 1 (sex undetermined); J/D. Huber. Wauconda Lake (2 mi W Glen Elder, Mitchell Co.); viii-28-1985; sweep; 1 ♀; J. Pinto. Maryland: Port Republic; viii-ix-1986; flight intercept trap; 9 ♀, 1 ♂; M. Sharkey/Munroe (B/1). Prince Frederick. 7 km S; v-7/vii-7-1987; 1 ♀; CNC Hym. Team. Missouri: Columbia (Hinkston Creek); ix-8-1987; sweep; 1 ♀; J. Pinto. Williamsville (Wayne Co.); vii-16/viii-8-1988, viii-1987, viii-8/31-1988, ix-1/20-1988, ix-10/26-1987, ix-20/20-1988, x-21/xi-11-1987; Malaise trap; 38 ♀, 2 ♂; J. Becker (A/3. B/5). Nebraska: Odessa. 6.8 mi E; viii-29-1983; 2 ♀; J. Pinto (A). Oklahoma: Red Oak (Latimer Co.); 9 ♀, 2 ♂; (see Types). North Carolina: Whiteside Mtn. (Jackson Co.); ix-13-1987; sweep; 3 ♀; L. Masner (B/1). South Carolina: Francis Beidler Forest (nr. Harleyville); ix-22-1987; sweep; 1 ♀; L. Masner (A). Francis Beidler Forest (10 km NE Harleyville); v-26/vi-11-1987; flight intercept trap; “bald cypress swamp”; 1 ♀. Pendleton (Tangle-
wood Springs; 34°38.7'S, 82°47.1'W; 225 m; vii-30/viii-20-1987, ix-1/9-1987, ix-15/30-1987, x-16/xi-3-1987; Malaise trap; 6 ♀: J. Morse (A/1). Pendleton (225 m); vii-15/22-1987, vii-29/viii-5-1987; Malaise trap; 2 ♂; CNC Hym. Team (A/1). South Dakota: Pickstown (Charles Mix Co.); viii-26-1985; “sweeping riparian”: 4 ♀; J. Pin-to (A/1, B/1). Texas: Ben Bolt, 8 mi NW (La Copita Res. Stn.); ix-28/30-1990; Malaise trap; 1 ♂; R. Wharton/J. Woolley. Clymer Meadow (Hunt Co.); vii-9/1991; sweep; 1 ♀; J. Woolley (A). College Station; viii-26-1987; 1 ♀; J. Woolley/G. Zol-nerowich (B). College Station (Lick Creek Park); vii-30-1987; sweep; 1 ♀; J. Woolley. College Station (Lick Creek Park); x-16/xi-17-1987; sweep; 1 ♀; J. Woolley/J. Heraty. Hallsville. 2 mi W; iv-27-1984; sweep “roadside forbs”: 1 ♀; W. Ewart (B). Hear-ne, 8 mi E.; x-22/27/1990; Malaise trap; 1 ♀, 1 ♂; J. Woolley, et al. Park Hill Prairie (Collin Co.); vii-9-1991; 2 ♀; J. Woolley (B/1). Virginia: Blacksburg, 8 km NW (1000 m); vi-9/19-1987, vi-19/30-1987, vii-13/19-1987; Malaise trap; 6 ♀; CNC Hym. Team (A/2).

**Doirania longiclavata** Yashiro (Fig. 14)


**Diagnosis.**—Similar to *D. elegans* except for the more poorly defined striate section of the metasomal terga (cf. Figs. 13, 14), the smaller club/scape ratio in males, and the differently shaped sensilla at the base of the forewing (cf. Figs. 5, 6).

**Types.**—Holotype ♀, from JAPAN, “Hataadera. Matsuyama City. Ehime Pref., Shikoku”; x-19-1977: N. Yashiro; “on turfs”: presumably in the Entomological Laboratory, University of Osaka Prefecture (inquiries regarding the holotype were unanswered).

**Geographic distribution.**—Previously recorded only from Japan, but probably widespread in Palaeartic. Currently known from Japan, eastern Russia, and France.

**Material examined.**—FRANCE. Dept. Girondes: St. Colombe (nr. Castillon-la-Bataille), 44°54’N, 00°02’W; viii-17-2000; suction trap; 1 ♂; M. van Helden. JAPAN. *Kyushu*: Fukuoka (Mt. Tachibana); vii-26/31-1979; yellow pan traps. “primarily evergreen forest”: 4 ♀; K. Yamagishi. *Hon-syu*: Iwate (Mt. Hayachine); 400 m; viii-2/8-1989; Malaise trap; M. Sharkey. [Several additional Japanese records cited by Yashiro 1980]. RUSSIA. Primorskiy Krai: Tai-jvaza (30 mi NE Vladivostok); flight intercept trap “coastal forest”: viii-5-1992; 5 ♀, 1 ♂; B. Gill. Krasnodsarskiy Krai: Krasnodar, nr. (All Russian Research Institute of Biological Plant Protection); viii-30/31-2001; yellow pan trap; 1 ♂; V. Kustjukov.

**Remarks.**—Hosts are unknown. As with *D. elegans, D. longiclavata* apparently frequents mesic habitats. Yashiro (1980) states that the species has been collected in “paddy fields and grassplots.”

**Doirania leefmansii** Waterston (Figs. 6, 9, 10, 17)


**Diagnosis.**—Female. Body light brown in color. Antenna with scape subequal in length to club. Maxillary palp regular at apex, not narrowing asymmetrically. Forewing with a small fumate cloud directly behind stigma; sensilla anterior to retinaculum on dorsal surface of disk small, accumulate (Fig. 6). Ovipositor elongate, distinctly longer than hind tibia, extending beyond cerci (Fig. 9). Male. Antenna with scape also subequal to club. Genitalia elongate, ca. ½ longer than hind tibia, with basal apodemes directly laterally (Fig. 17).

**Types.**—Holotype ♀, “Ambon (D.E.I.)” (currently Indonesia) from “eggs of Saxava coriacea.” iv-30-1925, S. Leefmans coll.; stated to be in The Natural History Museum, London (Waterston 1928) but not lo-
cated (4 ♀ paratypes with same data as holotype examined).

Geographic distribution.—Known from Indonesia (Ambon) and Papua New Guinea.


Remarks.—Doirania leefnansi is known to attack eggs of species of Tettigoniidae (Segestes spp.), pests of oil palm, in Papua New Guinea. Although their role in affecting pest populations is questionable, these wasps continue to be cultured and released into oil palm growing areas (Caudwell 2000).

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NEW SPECIES OF CENTRAL AMERICAN CULICOIDES LATREILLE (DIPTERA: CERATOPOGONIDAE) WITH A SYNOPSIS OF SPECIES FROM COSTA RICA

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Abstract.—Ten new species of Central American Culicoides are described, illustrated and placed to subgenus or species group. Their position in previously published keys is indicated and their features discussed in light of the most recent revisions. Eight of the new species are known only from Costa Rica, one is known from Costa Rica and Panama and one is recorded from Honduras and El Salvador. The new species are named Culicoides annetiae, C. chaverrii, C. cummingi, C. hermani, C. hondurensis, C. monicae, C. picadoae, C. ronderosae, C. trifidus, and C. zumbadoi. A list of 148 Culicoides species known or suspected of being in Costa Rica is given in a table. Of these, 42, including the new species, are recorded from Costa Rica for the first time. Most of the new species are recorded from mid to high elevations.

Resumen.—Se describen, ilustran y ubican en su respectivo subgénero o grupo de especies, a diez especies nuevas de Culicoides de América Central. Se indica su posición en las claves publicadas previamente, y sus caracteres distintivos se discuten a la luz de las revisiones más recientes. Ocho de las especies nuevas se conocen sólo para Costa Rica, una para Costa Rica y Panamá y la restante para Honduras y El Salvador. Las especies nuevas son nominadas Culicoides annetiae, C. chaverrii, C. cummingi, C. hermani, C. hondurensis, C. monicae, C. picadoae, C. ronderosae, C. trifidus y C. zumbadoi. Se ofrece en una tabla, una lista de 148 especies de Culicoides conocidos o sospechados de ser hallados en Costa Rica, 42 de los cuales, incluyendo a las especies nuevas, son registrados por primera vez para Costa Rica. Muchas de las especies nuevas se registran para altitudes medias a elevadas.

Key Words: Ceratopogonidae, Culicoides. Costa Rica, Honduras, El Salvador, Central America, South America

Species in the genus Culicoides Latreille are by far the most notorious members of the 103 currently recognized genera of Ceratopogonidae. Not only is Culicoides the most diverse genus in the family, with 1,255 named extant species, but members occur virtually throughout the terrestrial world, from the tropics to far southern and northern areas, from coastal areas to very high altitudes (up to 4,200 m). Many of these are miserable pests of humans and domestic animals and serve as vectors of a variety of diseases (Borkent, in press).

In spite of their economic, medical and
veterinary importance, it is surprising that the species of *Culicoides* of many areas remain poorly understood. The genus is so diverse that even in regions which have been studied for many years (e.g., United States), there are still quite a number of species represented in museums which remain to be described (and undoubtedly many more yet to be discovered!). Furthermore, there remains a great need to provide keys to species in some broader areas; there is still no key available to the species of either the United States or Canada!

In this paper we describe 10 additional species of *Culicoides* from Central America. We have been fortunate to have at hand the excellent treatment of the *Culicoides* of Panama by Wirth and Blanton (1959) and the wing atlas of Neotropical species by Wirth et al. (1988). We have indicated where each new species terminates in their key, with additional comments when more recent revisions are available. Borkent and Spinelli (2000) recently catalogued all species of Ceratopogonidae south of the United States and provided references to the most recent revisions and keys.

Although we have placed the new species in subgenera or species groups, readers should be aware that the current classification of *Culicoides* is in dire need of careful cladistic analysis. Some subgenera are “garbage can” groupings of species which cannot be placed elsewhere and every major region of the globe has species of *Culicoides* which cannot be placed even in those subgenera but are relegated to species groups or listed as “miscellaneous.”

**Materials and Methods**

All specimens were mounted on microscope slides using the technique described by Borkent and Bissett (1990). Terms for structures follow those used in the *Manual of Nearctic Diptera* (McAlpine et al. 1981). Terms for wing veins follow the system of the *Manual of Nearctic Diptera*, with modifications proposed by Szadziewski (1996) (Table 1). Names of veins are in upper case and those of cells in lower case. Pale areas in cell r1 posterior to or immediately distal to the 2nd radial cell are called poststigmatic pale spots. More specific larval and pupal terms follow Lawson (1951). Ratios used are those explained in Spinelli et al. (1993).

Adults were collected by sweeping with an aerial net, with malaise traps or with light traps (a fluorescent bulb on a white sheet). Larvae and pupae were extracted through manual examination of substrates placed in shallow dishes or pans. Dates of collections of reared specimens refer to the date upon which the immatures were collected. Most of the specimens reported here have a “CD” number which refers to further collecting and habitat details in the junior author’s personal collecting notes. Specimens are deposited in the following collections:

| Table 1. Terms for wing veins and cells as used here and by Wirth (and his coauthors) in his publications. |
|-------------------------------------------------|-------------------------------------------------|
| **Veins**                                       | **Wirth and Coauthors**                          |
| R1                                             | R1                                             |
| R2                                             | radial crossvein                                |
| R3                                             | Rs or R4-5                                     |
| R1-5                                           | intercalary of *Leptoconops*                    |
| M                                              | M1-2                                           |
| M1                                             | M1                                             |
| M2                                             | M2                                             |
| CuA1                                           | M3-4                                           |
| CuA2                                           | Cu1                                            |
| CuP                                            | Cu2                                            |
| A                                              | A                                              |
| 1st radial cell                                | 1st radial cell (or 1st anterior radial cell)   |
| 2nd radial cell                                | 2nd radial cell (or 2nd anterior radial cell)   |
| r1                                             | R2                                             |
| m1                                             | M1                                             |
| m2                                             | M2                                             |
| cuA1                                           | M4                                             |
| anal                                           | anal                                           |
CNCI—Canadian National Collection of Insects, Ottawa, Ontario, Canada.
MLPA—Museo de la Plata, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Argentina.
INBC—Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica.
USNM—Smithsonian Institution, National Museum of Natural History, Washington, D.C., U.S.A.

Wing photomicrographs were taken with a Canon PowerShot, S40, digital camera through a Leica, DMLB, compound research microscope. Wings were photographed in either two or three sections at either 10X or 20X and the separate images assembled in Photoshop®, version 6.

RESULTS

Culicoides (Avaritia) hermani Spinelli and Borkent, new species
(Figs. 1A, 2A–E, 10A)

Diagnosis.—Small adults in the andicola species group, very similar to C. orjuelai Wirth and Lee, from which it may be distinguished by the shorter distal flagellomeres, smaller number of mandibular teeth, tibiae with subbasal pale rings, the pale area centered on crossvein r-m broadly abutting costal wing margin, and the presence of a very faint, indistinct pale area in cell cu1A.

Description.—Male. Similar to female with usual sexual differences. Wing length 1.15 mm; width 0.52 mm; CR 0.61. Genitalia (Fig. 2E): Tergite 9 subquadangular, lacking apicolateral processes; sternite 9 short, with broad, deep postero medial excavation. Gonocoxite with slender, pointed dorsal, ventral roots, the latter contacting at midline; gonostylus shorter than gonocoxite, moderately curved, tip pointed. Parameres (Fig. 2D) separate, each with short, stout anterolateral process, midportion slender, nearly straight, tapering to slender, filamentous, recurved tip. Aedeagus triangular; basal arch very low, extending 0.20 of total length; lateral arms well sclerotized, tapering to short, posteromedial projection, tip blunt; with dorsal, subapical, sclerotized process present.

Female. Head: Dark brown. Eyes with numerous interommatidial spicules, contiguous by distance equal to diameter of 1.5 ommatidia. Flagellum (Fig. 2A) uniformly brown: flagellomeres 1–8 short, vasiform, 9–13 subcylindrical, stout to apices; AR 1.08 (1.00–1.16, n = 5); sensilla coeloconica on flagellomeres 1, 9–13. Palpus (Fig. 2B) brown; third segment with conspicuous irregular pit; PR 3.05 (2.90–3.40, n = 5); P/H ratio 1.03 (1.00–1.09, n = 5). Mandible with 15 (n = 5) teeth. Thorax: Dark brown, scutum with sublateral, faint paler bands. Legs brown, fore and midfemora pale apically, tibiae with narrow, subbasal rings; hind tibial comb with five spines, one nearest spur longest. Wing (Fig. 1A), length 1.25 (1.16–1.36, n = 5) mm; width 0.64 (0.60–0.68, n = 5) mm; CR 0.61 (0.59–0.63, n = 5); with pale areas much reduced; faint pale area near basal arculus continuous with basal pale area in anal cell; conspicuous pale spot centered on crossvein r-m, broadly abutting costal wing margin; poststigmatic pale spot in cell r1 transverse, including distal half of second radial cell: very faint, indistinct pale area in cell cu1A; anal cell with distal rounded pale area. Macrotrichia very sparse, scattered on distal half of wing. Halter pale. Abdomen: Dark brown. Two ovoid, unequal spermatothecae, tapering to moderately long necks (Fig. 2C), measuring 47 (44–53, n = 5) by 39 (36–44, n = 5) μm, and 38 (36–46, n = 5) by 34 (30–40, n = 5) μm; rudimentary third, ring present.

Distribution.—Culicoides hermani is known only from high elevations in southern Costa Rica and northern Panama (Fig. 10A), from 1,600–2,750 meters. The adults from 15 km N San Isidro de el General were taken at Reserva Avalon, a few kilometers SW of División.

Bionomic information.—The holotype of C. hermani was swept from a flowering...
Fig. 1. Wings of female Culicoides. (A) C. hermani; (B) C. annettae; (C) C. hondurensis; (D) C. monicae; (E) C. chaverri; (F) C. ronderosae; (G) C. cummingi; (H) C. picadoae; (I) C. zumbadoi; (J) C. trifidus. Scales = 0.2 mm.
bush on the trail leading up to Volcán Barú in northern Panama. The allotype female and two of the paratypes were taken while biting humans and one paratype female was collected from a light. Adults were present in high elevation cloudforest habitat and have been collected in March, September and October.

The female adult habit of biting humans and the presence of this species in higher altitudes is shared with the other Neotropical species of the *alticola* group, all four of which are restricted to elevations above 3,000 meters in Colombia (Rodriguez and Wirth 1986).

Taxonomic discussion.—*Culicoides hermani* is a member of the *andicola* species group of the subgenus *Avaritia*. This new species keys out in Wirth and Blanton (1959) to couplet 13 where it may be distinguished by the presence of a pale apical band on the fore and midfemora but with the hind femora entirely dark. As a member of the *andicola* species group, *C. hermani* will key in Rodriguez and Wirth (1986) to *C. puracensis* Wirth and Lee, a Colombian paramo species. Females of *C. hermani* can be distinguished from that species by the sensillar pattern (1.11–13 in *C. puracensis*) and the flagellomere 9 without a distal constriction. Furthermore, male *C. hermani* lack the apicolateral processes on tergite 9 and the stouter distal posteromedial projection of aedeagus present in *C. puracensis*.

Wirth and Lee (1967) mention an undescribed Costa Rican species that is almost certainly the same as that described here as *C. hermani*.

The male and female were associated by the presence of shared wing pattern and body coloration. In addition, they represent the only species of the *alticola* species group in Costa Rica and Panama.

Types.—Holotype ♂. Panama. 8 km W Boquete, 21-IX-1993, 1,600 m. A. Borkent, CD1583 [CNCI]; allotype ♀. Costa Rica, 4 km N Sacramento, 10-X-1993, 2,750 m. A. Borkent, biting human, CD1609 [CNCI]. Paratypes, 4 ♀, as follows: same data as allotype. 1 ♀ [MLPA]; Costa Rica, 15 km N San Isidro de el General, 2,250 m. 12-III-1999. A. Borkent, biting human, CD5000, 2 ♀ [CNCI]; Costa Rica, 15 km N San Isidro de el General, 2,250 m. 13/14-III-1999. A. Borkent, light trap, CD5002. 1 ♀ [INBC].

Derivation of specific epithet.—This species, the only one described herein which is known to bite humans, is named after the junior author’s brother and dear friend Herman Borkent in recognition of his loving support through all the years.

*Culicoides* (*Hoffmania*) *annetae* Spinelli and Borkent, new species

(Figs. 1B, 2F–J, 3A–F, 10A)

Diagnosis.—Medium sized adults in the *guttatus* species group very similar to *C. ocmuarensis* Ortiz, from which it can be distinguished by the slender third palpal segment with capitate sensilla in a shallow pit as well as in 2–3 other shallow depressions, the shorter proboscis, the distal pale spot in cell r₃ barely abutting the wing margin, the parameres broadly fused at their bases, and the aedeagus with a truncated apex.

Description.—Male. Similar to female with usual sexual differences. Wing length 0.94 mm; width 0.36 mm; CR 0.60. *Genitalia* (Fig. 2J). Tergite 9 with apicolateral processes very close together, posterior margin rounded, distinctly notched posteromedially; sternite 9 with moderately deep posteromedial excavation. Gonocoxite twice as long as broad; gonostylus slightly curved, apex pointed. Parameres (Fig. 2I) stout, broadly fused at base, apices slender, with minute fringing hairs. Aedeagus with low basal arch, extending 0.20 of total length; lateral arms slightly convex; posteromedial projection elongate, apex truncated.

Female. *Head*: Dark brown. Eyes bare, contiguous by distance equal to diameter of two ommatidia. Flagellum (Fig. 2F) brown, bases of flagellomeres 1–8 pale; AR 1.15 (1.10–1.18, n = 4); sensilla coeloconica on flagellomeres 1, 9–13. Palpus (Fig. 2G)
Fig. 2. Adult structures of *C. hermani* (A–E) and *C. annettiae* (F–J): (A, F) female antenna; (B, G) female palpus; (C, H) female spermathecae, duct ring; (D, I) parameres in ventral view; (E, J) male genitalia in ventral view.
dark brown; third segment slender with capitate sensilla in shallow pit and 2–3 other shallow depressions; long, slender portion beyond pit; PR 3.85 (3.70–4.00, n = 4); P/H ratio 0.92 (0.90–0.94, n = 4); Mandible with 16–17 (n = 4) teeth. Thorax: Scutum dark brown, with sublateral yellowish brown patches; scutellum, postscutellum dark brown. Legs dark brown, fore, mid knees, broad apex of hind tibia yellowish; hind tibial comb with five spines, second from spur longest. Wing (Fig. 1B), length 1.02 (0.94–1.14, n = 4) mm; width 0.47 (0.44–0.52, n = 4) mm; CR 0.66 (0.64–0.67, n = 4); with contrasting pattern; crossvein r-m pale; vein R1, pale; transverse distal pale spot in cell r1, barely abutting wing margin; two distal pale spots in cell m1 (apical one very faint, nearly imperceptible in one paratype); distal pale spot in cell m2 large, rounded, broadly abutting wing margin; pale spot in cell cu1a connected with pale line bordering lower margin of vein CuA1; anal cell with two distal pale spots; apices of veins M1, M2, pale, apices of veins CuA1 and CuA2 dark. Macrotrichia scattered on distal fourth of wing, absent in cell cu1a, anal cell. Halter brown. Abdomen: Dark brown. Two pyriform, unequal spermathecae (Fig. 2H), measuring 49 (48–50, n = 3) by 41 (38–44, n = 3) μm, and 43 (42–44, n = 3) by 37 (34–40) μm; rudimentary third, ring present. Pupa. Female exuvia pale yellowish brown. Length 2.30 mm. Body surface generally smooth with spicules present on head, between abdominal segments, dorsally a on anal segment. Operculum (Fig. 3D) with OL 0.14 mm; OW 0.16 mm; OW/OL 0.87; with well-developed anteromarginal seta located on tubercle, with pore at tubercle base; well-developed medial projection situated near dorsal margin. One long, one shorter anterodorsal setae on short, rounded tubercle (Fig. 3C). One long, one short, slender dorsolateral setae (Fig. 3C). One slender dorsomedial seta (Fig. 3C). Six dorsal sensilla, i a thick, moderately elongate spine, ii, iii short, slender, iv elongate, slender seta, v, vi pores (Fig. 3B). Two ventromedian setae minute, slender with bases abutting. Two ventrolateral setae elongate, one longer than other, bases close. Respiratory organ (Fig. 3E) brown, pedicel stout; mid third with sparse scale-like pointed spicules, with 9–10 spiracles on apical half; P/H 0.21. Metathorax completely divided but abutting medially, with scutum not protruding beyond posterior margin of metathorax. Abdomen with setae separate from one another (none on common tubercle). Segment 4 setal pattern (Fig. 3A) with 2 d.a.s.m. with i short, ii elongate; 5 d.p.m. with i very short, ii, iii pores, iv short, thick, v elongate, slender; l.a.s.m. short, thick spine; 3 l.p.m. with i, iii moderately sized, thick, ii elongate, slender; 3 v.p.m. with i short, slender, ii, elongate, slender, iii very short peg. Anal segment (Fig. 3F) length 0.20 mm, width 0.15 mm; dorsal surface with sparse, posteriorly directed tubercles on mid portion, also present on posterolateral processes, latter directed posteriorly.

Distribution.—Culicoides annetiae is recorded from lowland areas on both the east and west coasts of Costa Rica (Fig. 10A).

Bionomic information.—The holotype, allotype and some paratypes were collected with a light trap near the Tarcoles River estuary. A single female reared from a pupa was collected from a freshwater spring situated just west of Reserva Carara. The female from 10 km NW Cahuita was collected with a light trap at Aviarios del Caribe, a lodge situated on the delta of the Estrella River on the east coast. Adults were present in December and January.

Taxonomic discussion.—Culicoides annetiae is a member of the guttatus species group within the subgenus Hoffmania Fox. This new species keys out in Wirth and Blanton (1959) to couplet 7 and within that couplet would run to C. diabolicus Hoffman except that C. annetiae has a dark halter knob. The male further differs from C. diabolicus in possessing an aedeagus with a truncated apex. Spinelli et al. (1993) reviewed the Culicoides guttatus group for
Fig. 3. Pupal structures of *C. annettae*. (A) abdominal segment four; (B) right dorsal setae; (C) dorsolateral (dl), dorsomedial (dm), anterodorsal (ad) setae; (D) operculum; (E) respiratory organ, dorsomedial (dm), dorsolateral (dl) setae; (F) anal segment in dorsal view.
the Neotropics and C. annettae keys out to C. ocumarensis in couplet 14 of that work. However, C. annettae may be distinguished from that species by the features mentioned above in the diagnosis.

*Culicoides paraignacioi* Spinelli shares the slender third palpal segment and the truncate apex of aedeagus with *C. annettae*. However, the third palpal segment of *C. paraignacioi* bears an unique, definite sensory pit and crossvein r-m is clearly dark on its anterior half.

Of the 38 Neotropical species of *Culicoides* in the subgenus *Hoffmania*, only four have been described as pupae: *C. charrius* Spinelli and Martinez, *C. hylas* Macfie, *C. insignis* Lutz and *C. maruim* Lutz. The pupa of *C. annettae* has a more spinose respiratory organ than *C. hylas*, a respiratory organ with a row of spiracles distributed along its apical half (apical in *C. charrius*, *C. insignis* and *C. maruim*).

The male and female were associated by similar pigmentation patterns and were collected together at Tarcoles.

Types.—Holotype ♂, allotype ♀, Costa Rica, Tarcoles, 1-1-1994, A. Borkent, CD1730 [CNCI]. Paratypes, 3 ♀, as follows: same data as holotype. 1 ♀ [MLPA]; Costa Rica, 2 km NE Tarcoles, 17-XII-1993, A. Borkent, CD1714, 1 ♀ (with pupal exuvia) [CNCI]; Costa Rica, 10 km NW Cahuita, 9-XII-1993, A. Borkent, CD1700, 1 ♀ [INBC].

Derivation of specific epithet.—This species is named for the junior author’s wife, who shared the joys and many of the tasks of an expedition to Costa Rica in 1993–1994 which resulted in the collection of all the type material.

*Culicoides* (*Culicoides*) *hondurensis*

Spinelli and Borkent, new species

(Figs. 1C, 4A–F, 10B)

Diagnosis.—Large adults in the subgenus *Culicoides* very similar to *C. luteovenus* Root and Hoffman, from which it can be distinguished by the irregular palpal pit, the scutum without a definite pattern, the wing background white and the tip of aedeagus truncate.

Description.—Male. Similar to female with usual sexual differences. Flagellum as in Fig. 4A. Wing length 1.38 (1.26–1.52, n = 5) mm; width 0.47 (0.43–0.51, n = 5) mm; CR 0.58 (0.57–0.60, n = 5). *Genitalia* (Fig. 4F): Tergite 9 rounded posteriorly, apicolateral processes moderately developed, slender, undivided postero medial lobe well developed, with thickening on midline; sternite 9 short, with broad, shallow postero medial excavation. Gonocoxite with short dorsal, ventral roots, mesal margin with heavy spinose setae; gonostylus lightly sclerotized on distal half; apex blunt, rounded. Parameres (Fig. 4E): Separate, each with stout, abruptly bent base, stout and nearly straight basal portion, apically slender, bent, hairy. Aedeagus triangular; basal arch extending 0.25–0.33 of total length with faintly sclerotized membrane across distal half; lateral arms well sclerotized; apex slender, truncated.

Female. *Head*: Dark brown. Eyes bare, contiguous by distance equal to diameter of 2–3 ommatidia. Flagellum (Fig. 4B) uniformly dark brown; flagellomeres 1–8 va-siform, 9–13 subcylindrical; AR 0.98 (0.92–1.07, n = 10); sensilla coeloconica on flagellomeres 1, (2–3), (5–8), 9–13 (only one specimen with sensilla on flagellomeres 2–3). Palpus (Fig. 4C) brown; third segment with conspicuous irregular pit; PR 2.82 (2.55–3.10, n = 10); P/H ratio 0.76 (0.70–0.81, n = 10). Mandible with 14 (13–16, n = 10) teeth. *Thorax*: Dark brown, scutum without definite pattern. Legs dark brown, knees narrowly yellowish, hind tibia pale at extreme base; hind tibial comb with six spines, second from spur longest. Wing (Fig. 1C), length 1.36 (1.20–1.45, n = 10) mm; width 0.61 (0.58–0.65, n = 10) mm; CR 0.62 (0.60–0.65, n = 10); with white background, pattern roughly in form of three dark zig-zag bands, each more or less broken into separate dark spots centering on veins; distal pale spot in cell r 5 , occupying entire apex of cell to wing margin: distal
Fig. 4. Adult structures of *C. hondurensis* (A–F) and *C. monicae* (G–I): (A) male antenna; (B, G) female antenna; (C, H) female palpus; (E, I) female spermathecae, duct ring; (E) parameres in ventral view; (F) male genitalia in ventral view.
pale spots in cells m₁ and m₂ broadly abutting wing margin; pale spot in cell cu₃ large. Macrotrichia numerous on distal ⅔ of wing. Halter yellowish. Abdomen: Dark brown. Two pyriform, subequal spermathecae (Fig. 4D), each measuring 62 (56–70, n = 10) by 45 (42–48, n = 10) μm; rudimentary third present.

Distribution.—This species is known from a number of localities El Salvador, Honduras, (Fig. 10B), ranging from 690–991 meters.

Bionomic information.—Adults have been collected throughout the year, from January to December.

Taxonomic discussion.—This new species keys out in Wirth and Blanton (1959) to C. elutus in couplet 14. The male differs from that species by the presence in C. hondurensis of a longer, tapering aedeagus and a more stoutly developed posteromedial projection on tergite 9. The female differs from C. elutus by its larger size, the presence of sensilla coeloconica on flagellomeres 2–3 and 5–8 in many specimens, the third palpal segment with an irregular sensory pit, and apex of the hind tibia without a narrow yellowish band. Adults of this species also resemble C. neopulicaris Wirth, a species distributed from Louisiana and Texas in the USA to Costa Rica, by virtue of the irregular palpal pit and wing with white background. Adults of Culicoides neopulicaris, however, have a conspicuous dark spot in the middle of cell cu₃, the apicolateral processes of the male are practically absent, and the basal arch of the aedeagus is higher and its tip broadly rounded.

The thick spines on the inner surface of the gonocoxite appear to be a synapo- morphy of at least some species in the subgenus Culicoides. The four Neotropical species C. elutus, C. hondurensis, C. luteovenus and C. neopulicaris bear these spines, as do the males of all Nearctic species we have examined.

The male and female were associated by being collected these together at several locations and on several different dates. There are only three other species of the subgenus Culicoides in the area south of the United States and the fact that both males and females were distinctive corroborates their association.


Derivation of specific epithet.—The name of this species reflects the presence of the majority of the collecting records from Honduras.
Culicoides (Anilomyia) monicae Spinelli and Borkent, new species
(Figs. 1D, 4G–I, 10A)

Diagnosis.—Large adults in the covagarciai species group very similar to C. marshi Wirth and Blanton, from which it can be distinguished by the narrowly contiguous eyes, the more slender third palpal segment and absence of a sensory pit, and a longer proboscis.

Description.—Male. Unknown.

Female. Head: Dark brown. Eyes bare, barely contiguous, V-shaped where eyes contact. Flagellum (Fig. 4G) pale brown, flagellomeres 5–8 bottle-shaped, 9–13 subcylindrical, moderately elongated; AR 0.93 (0.91–0.96, n = 3); sensilla coeloconica on flagellomeres 1, 9–13. Palpus (Fig. 4H) dark brown; third segment very slender without sensory pit, sensilla scattered on surface; PR 6.50 (6.00–7.00, n = 3); P/H ratio 1.56 (1.52–1.60, n = 3). Mandible with 28 (n = 3) teeth. Thorax: Specimens not in position to describe scutum pattern. Legs brown; broad yellowish bands apically on fore and mid femora, basally on tibiae; apex of hind tibia yellowish. Wing (Fig. 1D), length 1.57 (1.34–1.77, n = 3) mm; width 0.72 (0.64–0.80, n = 3) mm; CR 0.64 (0.63–0.66, n = 3); predominantly pale, base broadly pale; crossvein r–m included in broad pale area abutting costal wing margin, which also includes \( \frac{3}{5} \) of first radial cell; second radial cell, except extreme base, included in large pale area; three narrow, transverse, dark bands across wing; one below level of crossvein r–m, one at level of vein R1, to cubital fork and a sinuate band from just past apex of costa to tip of vein CuA1; cell r1 with subapical, large pale spot; distal pale spot in cell m1 separated from wing margin; distal pale spots in cells m2, cu1 broadly abutting wing margin; two distal, rounded, narrowly connected pale spots in anal cell; pale spot straddling middle of vein M2. Macrotrichia scattered on distal half of wing, also present in anal cell. Halter pale. Abdomen: Brown. Two pyriform, slightly unequal spermathecae (Fig. 4I), measuring 46 (44–48, n = 3) by 38 (36–40, n = 3) \( \mu \)m, and 40 (36–44, n = 3) by 33 (30–36, n = 3) \( \mu \)m; rudimentary third present.

Distribution.—Culicoides monicae is known from two localities in Costa Rica (Fig. 10A) at mid elevations (1,000–1,800 meters).

Bionomic information.—This species is recorded from cloud forest habitat in the Talamanca mountains of Costa Rica and has been collected in March and August.

Taxonomic discussion.—Culicoides monicae belongs in the covagarciai species group of the subgenus Anilomyia. It keys to C. marshi in couplet 16 in Wirth and Blanton (1959), with the exception that C. monicae lacks the sensory pit on the third palpal segment. Wirth and Blanton (1956) reviewed the Culicoides covagarciai species group for the Neotropics, and the species also keys out to C. marshi in couplet 2 in that work (again with the exception of the sensory pit feature).

Of the nine species now recognized in the covagarciai species group, C. monicae and C. marshi have the most elongate third palpal segment. The two are easily distinguished by examination of the broadly contiguous eyes of C. marshi, which are narrowly touching in C. monicae. Culicoides efferus Fox also has a somewhat elongate palpus with a small subapical pit and its legs are uniformly light yellow.

Types.—Holotype ♀. Costa Rica, Cartago, P.N. Tapanti, 1,800 m, VIII-1997, R. Delgado, CD5016 [INBC]. Paratypes, 3 ♀, as follows: same data as type, 1 ♀ [CNCI]; Costa Rica, Cartago, P.N. Tapanti, 1,800 m, M. Alfaro, CD5043, 1 ♀ [INBC]; Costa Rica, Puntarenas. San Vito de Java, 22-III-1964, F.S. Blanton, 1 ♀ [MLPA].

Derivation of specific epithet.—The name monicae is proposed for the senior author’s wife, in recognition of her loving support throughout the past fifteen years.
**Culicoides (Anilomyia) chaverrii** Spinelli and Borkent, new species  
(Figs. 1E, 5A–I, 6A–H, 7A–B, 11A)

**Diagnosis.**—Medium sized adults in the decor species group very similar to *C. luttealae* Wirth and Blanton, from which it can be distinguished by the absence of sensilla coeloconica on flagellomeres 2–5 and 7 in most specimens, the third palpal segment not greatly swollen, the presence of a shallow sensory pit, the elongated gonocoxite, and the aedeagus with a blunt tip.

**Description.**—Male. Similar to female with usual sexual differences. Wing length 1.24 (1.16–1.40, n = 5) mm; width 0.48 (0.44–0.56, n = 5) mm; CR 0.57 (n = 5).

**Genitalia** (Fig. 5E): Tergite 9 long, with stout apicolateral processes, the postero-medial margin distinctly notched; sternite 9 short, with broad, shallow postero-medial excavation. Gonocoxite 2.5× as long as broad (basally), gradually tapering posteriorly, dorsal, ventral roots slender, the later slightly bent apically; gonostylus distinctly shorter than gonocoxite, nearly straight, with pointed recurved tip. Parameres (Fig. 5D) separate, each with bent, knobbed base; basal portion slender, slightly sinuate, tapering to very slender, recurved, simple pointed apex. Aedeagus triangular; lateral arms strongly sclerotized; basal arch angular, extending 0.50 of total length; postero-medial projection tapering to blunt tip.

Female. **Head:** Dark brown. Eyes bare, narrowly separated by distance shorter than diameter of one ommatidium. Flagellum (Fig. 5A) pale brown, especially flagellomeres 1–8; flagellomeres 1–8 short, 9–13 subcylindrical; flagellomere 9.11 as long as 7–8 combined; AR 1.45 (1.23–1.56, n = 10); sensilla coeloconica on flagellomeres 1, (2–5), 6, (7), 8–13. Palpus (Fig. 5B) dark brown; third segment with large subapical deep pit; PR 2.19 (2.02–2.30, n = 10); P/H ratio 0.69 (0.65–0.72, n = 10). Mandible with 14 (13–16, n = 10) teeth. **Thorax:** Scutum light brown or yellow, with sublateral brown longitudinal bands, very small dark patch just anterior to margin of scutellum; scutellum yellowish brown, postscutellum dark brown. Legs brown, knee spots blackish; femora with subapical, tibiae with sub basal broad pale bands; hind tibial comb with four spines, one nearest spur longest. Wing (Fig. 1E), length 1.37 (1.24–1.52, n = 10) mm; width 0.65 (0.60–0.70, n = 10) mm; CR 0.60 (0.59–0.63, n = 10); appearing yellowish with narrow, sometimes broken, transverse dark bands, spots as figured; dark transverse band across midline of cell r₃ about a third as broad as yellow bands on each side; proximal pale spot in cell r₃ large, including distal portion of second radial cell, produced beyond vein M₂; distal pale spot in cell r₃ separated from wing tip by small dark area; distal pale spots in cells m₁, m₃, cuₐ, anal cell broadly abutting wing margin; basal transverse dark band interrupted in base of cell m₃; rounded pale spot straddling middle of vein M₁ isolated. Macrotrichia abundant, extending nearly to base of anal cell. Halter pale. **Abdomen:** Tergites pale, sternites medium brown, pleura blackish. Two pyriform, subequal spermathecae (Fig. 5C), each measuring 54 (48–60, n = 10) by 45 (38–50, n = 10) μm; rudimentary third present.

**Pupa.** Male, female exuvia yellowish brown. Length 2.36 (2.20–2.50, n = 5) mm. Body surface generally smooth with spicules or very small tubercles present on dorsal and ventral surface of cephalothorax, anterolateral margins of abdominal tergites, entire dorsal and anteroventral surface of anal segment. Operculum (Fig. 6A) with OL 0.170 (0.150–0.200, n = 5) mm; OW 0.200 (0.180–0.226, n = 5) mm; OW/OL 1.18 (1.07–1.25, n = 5); central disk covered with abundant rounded tubercles; two well developed anteromarginal tubercles, bearing long, stout seta, with pore at tubercle base; well-developed medial projection situated near dorsal margin. Two anterodorsal setae on short, rounded tubercle, one long, slender, one a short peg (Fig. 5G). Three moderately thick dorsolateral setae, one shorter, one moderate in length, one
Fig. 5. Structures of C. chaverrii, adult (A–E), pupa (F–I): (A) female antenna; (B) female palpus; (C) female spermathecae; (D) parameres in ventral view; (E) male genitalia in ventral view; (F) right dorsal setae; (G) anterodorsal (ad) setae; (H) dorsolateral (dl), dorsomedial (dm) setae; (I) abdominal segment four.
elongate (Fig. 5H). One elongate, slender dorsomedial seta (Fig. 5H). Six dorsal sensilla, i, iii very short setae; ii elongate, slender, iv very elongate, slender seta, v, vi pores (Fig. 5F). Two ventromedian setae absent or perhaps a barely visible single pore. Two ventrolateral setae, one shorter, more slender than other, bases close. Respiratory organ (Fig. 6B) golden brown, pedicel very reduced; with scale-like pointed spicules, along entire length but more abundant on basal half; with 2–3 lateral, 8–9 apical spiracles; P/H 0.035 (0.020–0.047, n = 5). Metathorax completely divided medi- ally, with scutum protruding to posterior margin of metathorax. Abdomen with setae separate from one another (none on common tubercle). Segment 4 setal pattern (Fig. 5I) with 2 d.a.s.m. with i short, ii very elongate; 5 d.p.m. with i very short peg, ii, iii pores, iv short, thick, v elongate, slender, l.a.s.m. moderately elongate, thick spine; 3 l.p.m. very well developed, with i, iii moderately sized, thick, ii very elongate, thick; 3 v.p.m. with i, iii short, thick, ii, elongate, slender. Anal segment (Fig. 6C) length 0.20 mm, width 0.15 mm: posterolateral processes directed posterolaterally.

Fourth instar larva. Total length approximately 4.00 mm: Head capsule (Figs. 6D–E) yellowish brown, medium-sized, stout with rounded apex; HL 0.252 (0.240–0.266, n = 6) mm; HW 0.187 (0.180–0.200, n = 6) mm; HR 1.35 (1.20–1.48, n = 6); SGW 0.113 (0.100–0.130, n = 6) mm; SGR 1.66 (1.48–1.80, n = 6); collar somewhat darker than rest of head capsule, well-developed ventrally with short anterior apodeme, separated mediadly; dorsolateral portion thick, not extending mediadly. Frontal suture extending to near anterior margin of labrum. Ventral suture well developed. Setae all simple, arrangement and sizes as in Figs. 6D–E. Antenna short, details not visible. Eye unknown. Labrum short, wide, further details not discernible. Premandibles small, triangular, apparently unarmed. Mandible (Fig. 6G) strongly sclerotized; small, broad at base, single stout hooked tooth, medial protuberance slender, subbasal sensilla present but state uncertain. Epipharynx (Fig. 7A) with only two combs: dorsal comb sclerites short, with seven angular, lanceolate, unequal teeth/sclerite on each side; comb 4 short, with seven pointed teeth; curtains absent. Hypopharynx (Fig. 7B) with slender arms; anterior end short, triangular, with reduced minute teeth. Hypostoma (Fig. 6H) broad, without medial protuberance. With numerous small laterally placed, pointed teeth. Body pigmentation unknown. Caudal segment (Fig. 6F) greatly elongated, with six dorsal and six ventral long, stout, subequal caudal setae; CSL 0.49 (0.44–0.52, n = 3) mm; CSW 0.20 (0.16–0.24, n = 3) mm; CSR 2.46 (2.16–2.75, n = 3); anal papillae slender, forked.

Distribution.— Culicoides chaverrii is recorded from the Tilaran and Talamanca mountains of Costa Rica (Fig. 11A). The species appears to be a mid to high elevation species, recorded from 1,540–2,270 meters.

Bionomic information.—Series of specimens have been reared from larvae and pupae collected from both arboreal and ground-level bromeliads and a treehole in the Talamanca mountains. Of the seven other Neotropical species in the decor species group, the only two which are known as immatures have been also reared from bromeliads (Wirth and Blanton 1970). Adults were collected with a light trap in the Tilaran mountains (at Refugio Biológico Monteverde) and adults or reared adults have been collected in June and August.

Taxonomic discussion.— Culicoides chaverrii belongs in the decor species group of the subgenus Anilomyia. The adults of this new species key out to C. lutealaris in couplet 21 in Wirth and Blanton (1959), based on leg coloration; the wing length of C. chaverrii is somewhat shorter than that of C. lutealaris. The two species may be distinguished using the features given in the diagnosis above.

Culicoides migrigenus Wirth and Blanton is another similar species which also occurs
Fig. 6. Structures of *C. chaaverii*, pupa (A–C), fourth instar larva (D–H): (A) operculum; (B) respiratory organ, dorsomedial seta (dm); (C) anal segment in ventral view; (D) head capsule in dorsal view; (E) head capsule in ventral view; (F) anal segment in ventrolateral view; (G) left mandible in ventral view; (H) hypostoma.
in Costa Rica. However, the hind femur of *C. nigrogenus* is pale, with a conspicuous dark brown band only on its mid portion, the flagellomere 9 is longer, and the rounded pale spot straddling the middle of vein M2 is connected anteriorly to the poststigmatic pale spots in cell r3 and posteriorly to the pale spot in cell cu1.

Wirth and Blanton (1970) reviewed the *Culicoides decor* species group (as the *nigrogenus* group) for the Neotropics.

Although the immatures of two other species of the *decor* species group have been found in bromeliads, these have not been described and our description here is the first larval and pupal description of a species within the entire subgenus. The larvae have the elongate caudal setae typical of many species which occur in treeholes (Murphree and Mullen 1991).

The male and female adults were associated by rearing these from similar larvae and pupae which were collected from the same habitat.


Derivation of specific epithet.—This species is named in recognition of the contribution of Guillermo Chaverri, a curator working at INBio, who has collected and reared large numbers of Nematocera, including most of the type series of *C. chaverri*, from small aquatic habitats throughout Costa Rica.

*Culicoides* (*Diphaomyia*) *rondonrosae*

Spinelli and Borkent, new species

(Figs. 1F, 7C–E, 11A)

Diagnosis.—Only species in the subgenus *Diphaomyia* Vargas with a pale spot at crossvein r-m lying entirely distad to crossvein. cell r3 with three pale spots, cell m1 with three pale spots, a pale spot lying adjacent to anterior side of midportion of cubital stem in cell m2, anal cell with one proximal and two distal pale spots, vein...
CuA₂ with subapical pale spot, and a pale spot straddling base of vein M.

Description.—Male. Unknown.

Female. Head: Dark brown. Eyes apparently bare, separated by distance equal to diameter of one ommatidium. Flagellum (Fig. 7E) uniformly dark brown, flagellomeres vasiform, without transition in length between proximal and distal series; AR 0.83; sensilla coeloconica on flagellomeres 1, 6–8. Palpus (Fig. 7C) dark brown; third segment slender, slightly swollen distally, with moderately large, shallow subapical pit; PR 3.20; P/H ratio 1.10. Mandible with
17 small teeth. **Thorax**: Dark brown. Scutum with distinct pattern, which in slide mounted specimen appears to include many small brown punctations around seta bases. Legs brown; femora with subapical, tibiae with subbasal pale rings, broad apex of hind tibia pale; hind tibial comb with four spines, one nearest spur longest. Wing (Fig. 1F), length 0.88 mm; width 0.43 mm; CR 0.57; with second radial cell in dark spot; membrane infuscated, with distinct pattern by small, definite, rounded pale spots, as follows: pale spot at crossvein r-m lying entirely distal to crossvein in cell r₃; poststigmatic pale spots in cell r₃ well separated, posterior one smaller, proximal to anterior one; two additional pale spots in cell r₃, the distal one near apex of cell; cell m₁ with three pale spots; cell m₂ with four pale spots, one near wing margin, one anterior to cubital fork, one posterior to medial fork, one lying adjacent to anterior side of middle portion of cubital stem; cell cuₐ with two spots, anal cell with one proximal, two distal pale spots; distal pale spots in cells r₅, m₁, m₂, cuₐ and anal cell not abutting wing margin; vein CuA₂ with subapical pale spot; pale spot straddling base of vein M. Macrotrichia sparse but well distributed on distal half of wing, few in anal cell. Halter pale. **Abdomen**: Brown. Two ovoid, subequal spermathecae with very short necks (Fig. 7D), each measuring 48 by 28 μm; rudimentary third, ring present.

**Distribution**.—**Culicoides ronderosae** is known only from the holotype from southern Costa Rica (Fig. 11A) at 1,000 meters elevation, collected in June.

**Taxonomic discussion**.—The presence of a pale spot at crossvein r-m lying entirely distal to the crossvein in cell r₃ (so that at least the posterior portion of r-m is dark) is characteristic of the following five Neotropical species of the subgenus Diphaomyia: C. haematopotus Malloch, C. marinkellei Wirth and Lee, C. minasensis Felippe-Bauer, C. mirsaes Ortiz and C. tarapaca Spinelli and Wirth. The female of *C. ronderosae* is very distinctive, easily recognized from all the mentioned species not only by the wing pattern features pointed out in the species diagnosis, but also by its long proboscis.

This new species keys to couplet 64 in Wirth and Blanton (1959) where it may be recognized by the combination of crossvein r-m with the pale spot lying entirely on the distal side of r-m, reaching anterior wing margin and cell r₃ with 2 distinct and separate pale spots distal to the poststigmatic pale spots.

There is no recent revision of the Neotropical Culicoides (Diphaomyia) but Wirth et al. (1988) provide numerical characters and photos of the wing patterns of the included Neotropical species.

**Type**.—Holotype ♀, Costa Rica, Puntarenas, San Vito de Java, 22-VI-1964, collector (?) [MLPA].

Derivation of specific epithet.—This species is named for Maria M. Ronderos [MLPA] in recognition of her important and continuing research on Ceratopogonidae.

**Culicoides cummingi** Spinelli and Borkent, new species

(Figs. 1G, 8A–C, 11A)

**Diagnosis**.—Large adults in the *daedalus* species group very similar to *C. pampoiki-lus* Macfie, from which it can be distinguished by the presence of sensilla coeloconica on all flagellomeres, the wing veins CuA₁ and CuA₂ dark to their apices, with the distal pale spots in anal cell oblique and well separated, and the absence of a pale spot posterior to the medial fork.

**Description**.—Male. Unknown.

Female. **Head**: Dark brown. Eyes bare, narrowly separated by distance shorter than diameter of one ommatidium. Flagellum (Fig. 8A) pale brown, especially flagellomeres 1–8; flagellomeres 1–8 short, 9–13 subcylindrical: AR 1.49 (1.42–1.62, n = 10); sensilla coeloconica on flagellomeres 1–13. Palpus (Fig. 8B) dark brown; third segment deeply swollen, with large, deep sensory pit opening by small pore; PR 1.88 (1.70–2.15, n = 10); P/H ratio 0.80 (0.76–
Fig. 8. Adult structures of *C. cummingi* (A–C) and *C. picadoae* (D–H): (A, D) female antenna; (B, E) female palpus; (C, F) female spermathecae, duct ring; (G) parameres in ventral view; (H) male genitalia in ventral view.
Mandible with 15–16 (n = 10) teeth. Thorax: Specimens not in position to describe the scutum pattern. Legs dark brown, knee spots blackish; fore, mid femora with subapical, and all tibiae with subbasal narrow pale rings; hind tibial comb with four spines, the second from the spur longest. Wing (Fig. 1G), length 1.20 (1.06–1.30, n = 10) mm; width 0.58 (0.52–0.62, n = 10) mm; CR 0.58 (0.56–0.60, n = 10); with second radial cell in dark spot; pale spot over crossvein r-m broadly abutting costal wing margin; poststigmatic pale spot in cell r3 single, transverse; cell r5 with main body of distal pale spot large, transverse, with small distal extension from posterior side; cell m1 with elongate pale spot at wing margin; vein M2 straddled by pale spot near its base; cell m2 with pale spot at wing margin, another lying anterior to cubital fork; cell cuA1 with pale spot at wing margin, clearly separated from vein CuA1; veins CuA1, Cu1A2 dark to apex; anal cell with two oblique, well separated distal pale spots; small pale area at basal arculus, another lying on base of cubital stem. Macrotrichia dense, long, extending to bases of medial, anal cells. Halter pale. Abdomen: Brown. Two oval, subequal spermathecae (Fig. 1C), each measuring 32 (30–36, n = 7) by 26 (24–28, n = 7) μm; rudimentary third, sclerotized ring present.

Distribution.—Culicoides cummingi is known only from mid elevations (1,050–1,800 meters) in the Talamanca mountains of Costa Rica (Fig. 11A).

Bionomic information.—This species is recorded from cloudforest habitat and has been collected from July till November. One specimen was collected with a malaise trap.

Taxonomic discussion.—Culicoides cummingi is a member of the *daedalus* species group, a group not placed to subgenus. This new species keys to couplet 51 in Wirth and Blanton (1959) where it may be distinguished from both *C. pampoikilus* and *C. commatis* Wirth and Blanton by the presence of three discrete pale spots in the anal cell in *C. cummingi*. Additional features distinguishing *C. cummingi* and *C. pampoikilus* are given in the diagnosis above.

*Culicoides cummingi* shares the following features with *C. commatis*: presence of a small distal extension from the main body of distal pale spot in cell r3, veins CuA1 and CuA2 are dark to their apices, and by the absence of a pale spot posterior to the medial fork. However, *C. commatis* differs by its smaller size (wing length 1.02 mm), the presence of sensilla coeloconica only on flagellomeres 1, 3, 5, 7, 9–13, a stouter third palpal segment, the mandible with only 12 teeth, and the main body of the distal pale spot in cell r3 not abutting the anterior wing margin.

No revision of the *daedalus* species group is available but some salient features, and especially those of the wings, are given by Wirth et al. (1988).


Derivation of specific epithet.—This species is named after Jeffery M. Cumming [CNCI] in recognition of his important contributions to Dipterology and his much appreciated assistance to the junior author for many years.

*Culicoides picadoae* Spinelli and Borkent, new species

(Figs. 1H, 8D–H, 11B)

Diagnosis.—Large adults in the *daedalus* species group very similar to *C. dimni* Wirth and Blanton, from which it can be distinguished by the poststigmatic pale spot in cell r3, including distal portion of vein R3, the absence of pale spot in cell r3 lying on
anterior side of vein M1, the distal pale spots in cells m1 and m2 broadly abutting wing margin, and the pale spot in cell cua, clearly separated from vein CuA1.

Description.—Male. Similar to female with usual sexual differences. Wing length 1.04 mm; width 0.44 mm; CR 0.54. Genitalia (Fig. 8H): Tergite 9 moderately short, broad, with large, triangular apicolateral processes, posteromedial margin distinctly notched; sternite 9 with very broad, shallow posteromedial excavation. Gonocoxite twice as long as greatest width, with ventral root very finely-pointed, dorsal root longer, slender; gonostylus distinctly shorter than gonocoxite, with slender hooked pointed apex. Parameres (Fig. 8G) separate, each with basal knob bearing long anterior projection; posteromedial projection slender, bent at base; midportion moderately swollen, straight; distal portion abruptly narrowed to slender, twisted, simple, filiform tip. Aedeagus with basal arch extending 0.50 of total length; lateral arms slender, moderately curved at tips; posteromedial projection tapered to simple, broad, truncated tip.

Female. Head: Dark brown. Eyes bare, narrowly separated by distance shorter than diameter of one ommatidium. Flagellum (Fig. 8D) with flagellomeres 1–8 pale, short, 9–13 brown, subcylindrical; AR 1.52; sensilla coeloconica on flagellomeres 1, (5), (7), 9–13. Palpus (Fig. 8E) dark brown; third segment large, moderately swollen, with small, shallow sensory pit opening by small pore; PR 2.25; P/H ratio 0.81. Mandible with 14 teeth. Thorax: Scutum dark brown, with sublateral pale bands. Legs dark brown, knee spots blackish; fore, mid femora with subapical, all tibiae with subbasal narrow pale rings; hind tibial comb with five spines, the two nearest the spur longest, subequal. Wing (Fig. 1H), length 1.60 mm; width 0.76 mm; CR 0.59; with base of second radial cell in dark spot: pale spot over crossvein r-m large, broadly abutting costal wing margin; poststigmatic pale spot in cell r3 single, transverse, quadrate, including distal portion of vein R3, from where it turns abruptly forward to meet costa; distal pale spot in cell r5 of same shape and size of poststigmatic pale spot and also of the dark spot between them; cell m1 with elongate pale spot broadly abutting wing margin; vein M2 straddled by pale spot near its midlength; cell m3 with rounded pale spot at wing margin, another lying anterior to cubital fork; cell cua, with rounded pale spot broadly abutting wing margin, clearly separated from vein CuA1; apices of veins M1, M2, CuA1 and CuA2 dark; anal cell with two oblique, narrowly separated distal pale spots, the posterior one abutting wing margin, one rounded pale spot far from wing margin in basal part of cell. Macrotrichia extending to bases of cell m3, anal cell. Halter pale. Abdomen: Brown. Two subspherical, unequal spermathecae (Fig. 8F), measuring 32 and 24 μm in diameter, respectively: rudimentary third, ring present.

Distribution.—This species is known only from two locations in the Talamanca mountains of Costa Rica (Fig. 11B), and appears to be a mid to high elevation species, recorded from 2,250–2,900 meters.

Bionomic information.—The holotype from 15 km N San Isidro de el General was taken with a light trap at Reserva Avalon, a few kilometers SW of División, in an area of oak cloudforest. The allotype was collected with a malaise trap in an open patch of vegetation surrounded by oak cloudforest. Adults have been collected in March and some time during the end of September to the end of November.

Taxonomic discussion.—Culicoides picadoae is a member of the daedalus species group, a group not placed to subgenus. This new species keys to couplet 44 in Wirth and Blanton (1959) where it may be distinguished by the presence of two pale spots in cell r5 and one distal pale spot in cell m3. Wirth et al. (1988) provide a useful summary of features of species of the daedalus species group.

Culicoides picadoae is very similar to C.
*Culicoides zumbadoi* Spinelli and Borkent, new species  
(Figs. 11, 9A–E, 11B)

Diagnosis.—Small adults in the *eublepharurus* species group very similar to *C. florenciae* Messersmith, from which it can be distinguished by the narrowly separated eyes, the shorter flagellomeres 11 and 12 and proboscis, the reduced number of mandibular teeth, and the poststigmatic pale spots in cell r₃ lying obliquely, the posterior one barely perceptible.

Description.—Male. Similar to female with usual sexual differences. Wing length 0.80 mm; width 0.31 mm; CR 0.57. *Genitalia* (Fig. 9E): Tergite 9 elongate, slender, with short, triangular apicolateral processes, posteromedial margin not notched; sternite 9 with narrow, shallow postero medial excavation. Gonocoxite 2.5× as long as broad, with ventral root well developed foot-shaped, anterior and posterior portion stout, dorsal root longer, slender; gonostylus about equal in length to gonocoxite, with rounded, slightly hooked apex. Parameres (Fig. 9D) separate, each with simple basal knob; midportion bent, with expanded portion; distal portion bent anteriorly, gradually narrowing to slender, simple, filiform tip. Aedeagus with basal arch extending 0.56 of total length; lateral arms slender, moderately curved; posteromedial projection tapered to simple, narrow, rounded tip.

Female. *Head*: Brown. Eyes with numerous inter-ommatidial spicules, apparently narrowly separated. Flagellum (Fig. 9A) uniformly brown, flagellomeres 6–8 each longer than each of 9–12; AR 0.73; sensilla coeloconica on flagellomeres 1, 6–12. Palpus (Fig. 9B) brown; third with segment subapical, shallow rounded pit; PR 2.30; P/H ratio 0.67. Mandible with 13–14 teeth. *Thorax*: Uniformly brown. Legs brown; tibiae with subbasal pale rings, narrow apex of hind tibia pale; hind tibial comb with four spines, second from spur longest. Wing (Fig. 11), length 0.80 mm; width 0.37 mm; CR 0.60; brownish infuscated. with only

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dummi, from which it can be distinguished by the absence of a pale spot at midlength of vein M₁. The male genitalia of *Culicoides antefurcatus* Wirth and Blanton is very similar to that of *C. picadoae* except that *C. antefurcatus* lacks the posteromedial excavation of sternite 9, has a somewhat proportionally longer gonostylus, and the mid portion of the paramere is more slender.

Eight of the 11 Neotropical species of the *daedalus* species group are known from both sexes (*C. antefurcatus*, *C. commatis*, *C. crescentis* Wirth and Blanton, *C. daedaloides* Wirth and Blanton, *C. luglani* Jones and Wirth, *C. phaeonotus* Wirth and Blanton, *C. daedalus* Macfie and *C. pam poikilus*). *Culicoides beaveri* Wirth and Barreto and *C. dummi* are known only as females and *C. pseudocrescentis* Tavares and Luna Dias only from the male. Of the nine other species of the *daedalus* species group we have recorded or which are expected to be in Costa Rica (Table 2), the male and female of *C. picadoae* share a similar wing pattern and differ from each of these other species. Therefore, although the male and female are rather different in size, we have considered them to be conspecific. They may actually represent two species.

Types.—Holotype ♂, Costa Rica, 15 km N San Isidro de el General, 2.250 m, 13/14-III-1999, A. Borkent, CD5002 [INBC]; allotype ♀, Costa Rica, San Jose, 4 km E Villa Mills, 2,900 m, 26-IX/29-XI-1996, A. Picado, B. Gamboa, CD5012 [INBC].

Derivation of specific epithet.—We are pleased to name this species after Annia Julia Picado Calvo, a highly skilled and knowledgeable parataxonomist working at INBio. She has produced many thousands of superb slide preparations of Ceratopogonidae, has collected a large number of specimens for the collection (including the allotype of this species) and has helped in numerous other tasks in both the field and laboratory. Muchas gracias por su excelente trabajo Annia!
Fig. 9. Adult structures of *C. zumbadoi* (A–E) and *C. trifidus* (F–J); (A, F) female antenna; (B, G) female palpus; (C, H) female spermathecae, duct ring; (D, I) parameres in ventral view; (E, J) male genitalia in ventral view.
moderately distinct pattern of pale spots; second radial cell in dark spot; pale spot over crossvein r-m small, abutting costal wing margin; poststigmatic pale spots in cell r, lying obliquely, posterior one barely perceptible; distal pale spot in cell r1 transverse, slightly concave distally, not abutting wing margin or vein M1; two pale spots in cell m1, distal one well separated from wing margin; cells m2, cuam, anal cell with distal, rounded pale spots, first two abutting wing margin. Macronotrichia present on distal half of wing, few in cell cuam, anal cell, in one row to base of cell m2. Halter brown. Abdomen: Brown. Two ovoid, slightly unequal spermathecae with moderately long necks (Fig. 9C), measuring 44 by 34 mm, neck 10 \( \mu \text{m} \) and 42 by 32 \( \mu \text{m} \), neck 8 \( \mu \text{m} \); rudimentary third, ring present.

Distribution.—This species is known from only two specimens collected near the eastern coast of Costa Rica (Fig. 11B).

Bionomic information.—The male and female were collected with an aerial net near the water tank supplying water to the administration building in Reserva Carara, in mature lowland rainforest in July. The junior author collected very regularly at this location from July 2, 1993 till Jan. 24, 1994 and the presence of only two specimens suggests that the population of this species was low during this time.

Taxonomic discussion.—Culicoides zumbadoi is in the eublepharus species group and unplaced to subgenus. The following six species of the eublepharus group also have two spermathecae: C. caladasi Browne, C. caucaensis Wirth and Lee, C. florenciae, C. guarani Ronderos and Spinelli, C. pabloi Browne, and C. tamboensis Wirth and Lee. The new species may be distinguished from C. florenciae as indicated in the diagnosis above. Another similar species, C. guarani, mainly differs from C. zumbadoi in the greater contrasting wing pattern, each of flagellomeres 6–8 shorter than each of flagellomeres 9–12, flagellomeres 6–8 lacking sensilla coeloconica, and the fore and mid femora with subapical pale rings.

This new species keys out to the first half of couplet 94 in Wirth and Blanton (1959), except that flagellomeres 9–12 have sensilla coeloconica. Wirth and Blanton (1959: 420) provide a short diagnosis of the eublepharus group (as transferrans group) which requires some modification. The group now includes species in which the terminal flagellomeres are not elongated and species with two spermathecae. Wirth et al. (1988) provide numerical characters and wing photographs of the species included in this species group.

The male and female were associated by sharing the same patterns of pigmentation and being collected together at the same place and date.

Type.—Holotype \( \delta \), allotype \( \Omega \). Costa Rica. 2 km NE Tarcoles, 20-VII-1993, A. Borkent. CD1481 [CNCI].

Derivation of specific epithet.—We are pleased to name this species after Manuel A. Zumbado [INBCJ], who has led the development of the outstanding Diptera collection at INBio and has been so supportive of our work.

**Culicoides triditus** Spinelli and Borkent, new species

(Figs. 1J, 9F–J, 11B)

Diagnosis.—Medium sized adults in the leoni species group very similar to C. be
narrochi Ortiz and Mirsa, from which it can be distinguished by the posterior poststigmatic pale spot located distinctly proximal to the anterior one, the reduced size of the distal pale spots in cell m1 and the anal cell, and the sclerotized neck of spermatheca.

Description.—Male. Similar to female with usual sexual differences. Wing length 0.85 (0.80–0.90, \( n = 2 \)) mm; width 0.31 (0.30–0.32, \( n = 2 \)) mm; CR 0.56 (0.55–0.57, \( n = 2 \)). Halter pale, Genitalia (Fig. 9J): Tergite 9 long, with stout, triangular apicolateral processes, small posteromedial notch; sternite 9 short, with broad, deep, posteromedial excavation, Gonocoxite 2.2× as long as broad, ventral root large, foot-shaped, posterior heel pointed, dorsal root
slender; gonostylus distinctly slender, only slightly curved. Parameres (Fig. 9I) separate, each with large, basal knob; basal portion slender, abruptly bent near base, distal portion sinuate, with evident ventral lobe, beyond which tapers to simple filamentous tip, recurved anteriorly. Aedeagus with lateral arms stout, strongly sclerotized; basal arch rounded, extending 0.25 of total length; posteromedial projection stout, with three pointed lobes, the medial one slightly longer than lateral ones.

Female. Head: Brown. Eyes with numerous interommatidial spicules, narrowly separated by distance shorter than diameter of one ommatidium. Flagellum (Fig. 9F) pale brown, flagellomere 8 slightly longer than 9; AR 0.81; sensilla coeloconica on flagellomeres 1, 6–8. Palpus (Fig. 9G) pale brown; third segment slightly swollen with moderately large, shallow pit; PR 2.25; P/H ratio 0.67. Mandible with 12 teeth. Thorax: Scutum dark brown, with sublateral, faint pale brown bands; scutellum, postscutellum dark brown. Legs dark brown; fore and mid femora with subapical, tibiae with subbasal pale rings, hind tibia pale distally; hind tibial comb with four spines, one nearest spur longest. Wing (Fig. 1J), length 0.75 mm; width 0.38 mm; CR 0.61; with second radial cell in dark spot; pale spot over crosseein r-m small, barely abutting costal wing margin; poststigmatic pale spot in cell r₃ more or less separated into two distinct small round spots, posterior one located distinctly proximal to anterior one; distal pale spot in cell r₃ small, rounded, located in center of cell, not abutting wing margin; two pale spots in cell m₁, the distal one well separated from wing margin; cell m₂ with very small distal pale spot not abutting wing margin, another lying anterior to cubital fork; cell cuₐ with rounded pale spot barely abutting wing margin, reaching distal portion of vein CuA₃; anal cell with one distal, very reduced pale spot well separated from wing margin. Macrotrichia very sparse on distal fourth of wing. Halter missing. Abdomen: pale brown. One pyriform spermathecae with sclerotized neck (Fig. 9H), measuring 42 by 36 mm, neck 10 μm; rudimentary third, ring present.

Distribution.—This species is known from the eastern lowland rainforest of Costa Rica (Fig. 11B).

Bionomic information.—The specimens from La Selva were collected with a light trap. The single male from 3 km E Cahuita was swept in a swamp forest in Cahuita National Park. Adults have been collected in March, April and October.

Taxonomic discussion.—Culicoides trifidus is in the leoni species group which is unplaced to subgenus. There are five other members in this species group, all Neotropical (Borkent and Spinelli 2000) and male and females are known for all. Male C. trifidus differs from all these by the presence of a broad, deep, posteromedial excavation of sternite 9 and the aedeagus with three posteriorly pointed lobes. Male Culicoides hoffmani Fox, a species placed in the subgenus Haematomyidium Goeldi have a very similar genitalia, but the parameres lack the evident distal ventral lobe, and their apices are pointed with lateral fringe of fine hairs. In addition, the female of C. hoffmani bears two well developed spermathecae, the posterior poststigmatic pale spot is located only slightly proximal to the anterior one, and the wing macrotrichia are more abundant.

This new species key out to couplet 69 in Wirth and Blanton (1959), where it may be distinguished by the following combination of features: poststigmatic pale spots in cell r₃ more or less separated into two distinct small round spots, posterior one located distinctly proximal to anterior one; distal pale spot in cell r₃ small, rounded, located in center of cell, not abutting wing margin; two pale spots in cell m₁, the distal one well separated from wing margin; cell m₂ with very small distal pale spot not abutting wing margin, another lying anterior to cubital fork; cell cuₐ with rounded pale spot barely abutting wing margin, reaching distal portion of vein CuA₃; anal cell with one distal, very reduced pale spot well separated from wing margin. Macrotrichia very sparse on distal fourth of wing. Halter missing. Abdomen: pale brown. One pyriform spermathecae with sclerotized neck (Fig. 9H), measuring 42 by 36 mm, neck 10 μm; rudimentary third, ring present.

Culicoides trifidus differs further from C. fieldi Wirth and Blanton by the third palp segment not greatly swollen, very reduced distal pale spots in cells m₁, and anal cell, absence of a pale spot anterior to the cubital fork, and by characters of the male genitalia. Wirth et al. (1988) provide numerical characters and wing photographs of the species included in the leoni species group.

The male genitalia of C. trifidus is very
similar to that of *C. (Haematomyidium) hoffmani* (Wirth and Blanton 1959: 436), sharing the trifid apex of the aedeagus and shape of ventral apodeme of the gonocoxite and it seems likely that the two are closely related (i.e., that the shape of the aedeagus is derived; however it likely groups other species as well). This suggests that at least some members of the *leoni* species group belong in the subgenus *Haematomyidium*. In our opinion this subgenus is poorly defined and requires further study.

The two female paratypes are missing their antennae and therefore may not belong
to this species. However, in all other features they match the allotype female very well and are therefore placed here.

The male and female were associated by sharing pigmentation patterns and being collected at the same place and time at La Selva Biological Station.

Types.—Holotype ♂, allotype ♀, Costa Rica, Heredia, Puerto Viejo de la Sarapiqui, La Selva Biological Station, 7-V-1989, B.V. Brown, CD1260 [Holotype: INBC; allotype: CNCI]. Paratypes, 1 ♂, 2 ♀ as follows: Costa Rica, 3 km E Cahuita, 29-X-1993, A. Borkent, CD1641, 1 ♂ [CNCI]; Costa Rica, Heredia, La Selva Biological Station, Puerto Viejo de la Siripiqui, 24-IV-1989, B.V. Brown, 40 m, CD1170, 2 ♀ [INBC, CNCI].

Derivation of specific epithet.—This species is named *trifidus* (three-cleft) referring to the divided apex of the aedeagus.

**Conclusions**

Our study of the Ceratopogonidae of Costa Rica is in an early stage of development. It is clear that many more habitats require sampling during the different seasons, even though we have examined many hundreds of samples from throughout the country. There are two major difficulties hampering the interpretation of the biogeography of Costa Rican *Culicoides*. First, it is obvious that the distributions of many described species are poorly understood. There are quite a number of species like *C. davidi* Spinelli which is known from Costa Rica, Colombia and Trinidad but specimens are lacking from the intermediate areas. A second difficulty lies in our virtually nonexistent understanding of the phylogenetic relationships between species of *Culicoides*. It is uncertain which species are related to one another and therefore impossible to examine broader zoogeographic patterns.

One pattern apparent from the distribution maps of the new species described here is that most are distributed at higher altitudes in Costa Rica (Figs. 10, 11). This strongly suggests that further collecting at mid to high elevations will produce additional undescribed species. Further to this, it would be helpful if future studies include distribution maps, as these more readily portray the distributions of the described species and are especially helpful in determining the relationship between endemism and altitude.

Table 2 lists the names and distributions of the 148 species of *Culicoides* which are now known from or are suspected to occur in Costa Rica. Of these, 42 are recorded for the first time (including the new species). There are eight species of *Culicoides* presently known only from Panama and these have not yet been discovered in Costa Rica (where they almost certainly occur). Our sampling has depended primarily on sweeping and malaise traps while the study of Panamanian *Culicoides* by Wirth and Blanton (1959) relied primarily on light traps and rearing. Further sampling with light traps in Costa Rica will likely produce these and other species as well. On the other hand, we are unsure about whether all of the species of *Culicoides* known only from Colombia will indeed be discovered in Costa Rica. Of these 20 species, *C. eldridgei* Wirth and Barreto, *C. brownei* Spinelli, *C. beaveri*, *C. youngi* Wirth, *C. rapososensis* Wirth and Barreto, and *C. teretipalpis* Wirth and Barreto have been collected at Rio Raposo on the west coast (lowland) and it is quite likely that these species will be found further north along the coast. *Culicoides florenciae* is recorded from about 1000 meters and the remaining 13 species are restricted to elevations above 1600 meters (*C. puracensis*, *C. suarezi* Rodriguez and Wirth and *C. marinkellei*: 3,250 m; *C. popayanensis* Wirth and Lee, *C. andicola* Wirth and Lee, *C. orjuelai* and *C. caucaensis*: 3,100 m; *C. tambouensis* and *C. andinus* Wirth and Lee: 2,500 m; *C. ameliae* Browne: 2,000 m; *C. caldasii*: 1,800 m; *C. pabloi* and *C. santanderi* Browne: 1,600 m). If these latter species are indeed restricted to higher elevations, which seems likely, they may not span the intervening eastern Panamanian
Fig. 11. Distributions of Culicoides species in Costa Rica: (A) C. chaverrii—●, C. ronderosae—★, C. cummingi—▲; (B) C. picadoae—●, C. zumbadoi—★, C. trifidus—▲.
Table 2. List of *Culicoides* known or suspected to occur in Costa Rica. [NR] indicates a new record for Costa Rica, although in some instances, the species has been previously recorded from both north and south of Costa Rica. [**] represent species expected to be discovered in Costa Rica. Distributions are arranged north to south and west to east.

<table>
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<tr>
<th>Subgenus ANILOMYIA Vargas</th>
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<tr>
<td><em>ameliae</em> Browne. Distr.—Colombia. [**]</td>
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<td><em>chaiverrii</em> Spinelli and Borkent. Distr.—Costa Rica. [NR]</td>
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<td><em>chrysonotus</em> Wirth and Blanton. Distr.—El Salvador, Costa Rica, Panama.</td>
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<td><em>covagarciai</em> Ortiz. Distr.—Honduras, El Salvador, Costa Rica, Panama, Colombia, Venezuela.</td>
</tr>
<tr>
<td><em>efferus</em> Fox. Distr.—Guatemala, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Ecuador, Peru, Bolivia.</td>
</tr>
<tr>
<td><em>hayesi</em> Matta. Distr.—Mexico (Tamaulipas), Honduras. [**]</td>
</tr>
<tr>
<td><em>lutealaris</em> Wirth and Blanton. Distr.—Costa Rica, Panama.</td>
</tr>
<tr>
<td><em>marshi</em> Wirth and Blanton. Distr.—Costa Rica, Panama, Colombia. [NR]</td>
</tr>
<tr>
<td><em>metagonotus</em> Wirth and Blanton. Distr.—Nicaragua, Costa Rica, Panama, Colombia, Ecuador.</td>
</tr>
<tr>
<td><em>monicae</em> Spinelli and Borkent. Distr.—Costa Rica. [NR]</td>
</tr>
<tr>
<td><em>nigrigenus</em> Wirth and Blanton. Distr.—Mexico (Veracruz) and Central America south to northwestern Argentina. [**]</td>
</tr>
<tr>
<td><em>popusaxensis</em> Wirth and Lee. Distr.—Colombia. [**]</td>
</tr>
<tr>
<td><em>rostratus</em> Wirth and Blanton. Distr.—Panama. [**]</td>
</tr>
<tr>
<td><em>trapidoi</em> Wirth and Barreto. Distr.—Costa Rica, Colombia, Brazil. [NR]</td>
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<thead>
<tr>
<th>Subgenus AVARITA Fox</th>
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</thead>
<tbody>
<tr>
<td><em>andicola</em> Wirth and Lee. Distr.—Colombia. [**]</td>
</tr>
<tr>
<td><em>hermani</em> Spinelli and Borkent.—Costa Rica, Panama. [NR]</td>
</tr>
<tr>
<td><em>orjuela</em> Wirth and Lee. Distr.—Colombia. [**]</td>
</tr>
<tr>
<td><em>puracensis</em> Wirth and Lee. Distr.—Colombia. [**]</td>
</tr>
<tr>
<td><em>pusilloides</em> Wirth and Blanton. Distr.—Guatemala, Belize, Honduras, Nicaragua, Costa Rica, Panama.</td>
</tr>
<tr>
<td><em>pusillus</em> Lutz. Distr.—USA (Florida) south to northern Argentina.</td>
</tr>
<tr>
<td><em>sanarezi</em> Rodriguez and Wirth. Distr.—Colombia. [**]</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Subgenus BELTRANMYIA Vargas</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>crepuscularis</em> Malloch. Distr.—Broadly distributed in Nearctic south to Costa Rica.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subgenus CULICOIDES Latreille</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>eluus</em> Macfie. Distr.—Mexico (Chiapas, Oaxaca) south to Panama. [NR]</td>
</tr>
<tr>
<td><em>luteovenus</em> Root and Hoffman. Distr.—Mexico (DF, Chiapas, Oaxaca) south to Panama. [NR]</td>
</tr>
<tr>
<td><em>neopulicaris</em> Wirth. Distr.—USA (Texas and Louisiana) south to Costa Rica.</td>
</tr>
</tbody>
</table>

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<tr>
<th>Subgenus DIPHAOMYIA Vargas</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>evansi</em> Wirth and Blanton. Distr.—Honduras, Costa Rica, Panama. [NR]</td>
</tr>
<tr>
<td><em>hondurensis</em> Spinelli and Borkent. Distr.—Honduras, El Salvador. [**]</td>
</tr>
<tr>
<td><em>iriartei</em> Fox, 1952. Distr.—Honduras, Costa Rica, Panama, Colombia, Venezuela, Brazil (Pará).</td>
</tr>
<tr>
<td><em>marinkellei</em> Wirth and Lee. Distr.—Colombia. [**]</td>
</tr>
<tr>
<td><em>miriae</em> Ortiz. Distr.—Panama, Venezuela, Trinidad. [**]</td>
</tr>
<tr>
<td><em>ronderosae</em> Spinelli and Borkent. Distr.—Costa Rica. [NR]</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Subgenus DRYMODESMYIA Vargas</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>jamaicensis</em> Edwards. Distr.—USA (Texas, Florida), Central America and Caribbean south to Colombia and Venezuela.</td>
</tr>
<tr>
<td><em>panamensis</em> Barbosa. Distr.—Mexico (Chiapas, Veracruz, Nayarit), Jamaica, Guatemala, Honduras, El Salvador, Costa Rica.</td>
</tr>
<tr>
<td><em>pilosus</em> Wirth and Blanton. Distr.—Costa Rica, Panama, Brazil (Pará).</td>
</tr>
<tr>
<td><em>poikilonotus</em> Macfie. Distr.—Mexico (Chiapas), Central America south to Brazil (Bahia), Colombia, Trinidad and Venezuela. [NR]</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Subgenus GLAPHIROMYIA Vargas</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>scopus</em> Root and Hoffman. Distr.—Mexico (DF), Costa Rica, Panama.</td>
</tr>
</tbody>
</table>
Table 2. Continued.

**Subgenus HAEMATOMYIDIDIUM Goeldi**

*aenuliductus* Wirth. Distr.—Costa Rica, Panama. [NR]

*bayano* Wirth. Distr.—Costa Rica, Panama. [NR]

*darlingtonae* Wirth and Blanton. Distr.—Costa Rica, Trinidad. [NR]

*debilipalpis* Lutz. Distr.—Widespread from USA (Maryland, Kentucky, Nebraska south to Louisiana and Florida), Honduras south to Argentina.

*eldridgeti* Wirth and Barreto. Distr.—Colombia. [**]

*filiductus* Wirth. Distr.—Belize, Honduras, El Salvador, Panama. [**]

*germanus* Macfie. Distr.—Costa Rica, Guyana. [NR]

*ginesi* Ortiz. Distr.—El Salvador, Costa Rica, Panama, Colombia, Venezuela, Trinidad, Brazil (Pará).

*glabrior* Macfie. Distr.—Honduras, Costa Rica, Panama, Colombia, Ecuador. Trinidad, Guyana, Surinam, Brazil (Pará). [NR]

*hoffmani* Fox. Distr.—Caribbean to Trinidad, Belize, Costa Rica.

*initiator* Ortiz. Distr.—Panama, Venezuela.

*paraeus* (Goeldi). Distr.—USA (Colorado, Nebraska, Pennsylvania, Wisconsin south to Louisiana and Florida) south to Argentina.

*quasiparaeus* Clastrier. Distr.—Honduras, El Salvador, Costa Rica, Panama, Colombia, Peru, French Guiana, Brazil (Amazonas, Rondônia). [NR]

*spurios* Wirth and Blanton. Distr.—Costa Rica, Panama. [NR]

*youngi* Wirth and Barreto. Distr.—Colombia. [**]

**Subgenus HOFFMANIA Fox**

*aenettae* Spinelli and Borkent. Distr.—Costa Rica. [NR]

*batesi* Wirth and Blanton. Distr.—Guatemala, Colombia, Ecuador, Brazil (Pará), Bolivia. [**]

*brownii* Spinelli. Distr.—Colombia. [**]

*davidi* Spinelli. Distr.—Costa Rica, Colombia, Trinidad. [NR]

*diabolicus* Hoffman. Distr.—Mexico south to Venezuela and Ecuador (no records in Caribbean).

*filarifer* Hoffman. Distr.—Mexico (Chiapas, Veracruz) south to northern Brazil.

*foxi* Ortiz. Distr.—Mexico, Carribean and Central America south to Bolivia and northeastern Argentina.

*franklinii* Spinelli. Distr.—Mexico (Guerrero), Honduras, El Salvador, Costa Rica, Panama, Colombia, Brazil (Pará), Bolivia. [NR]

*fusipalpis* Wirth and Blanton. Distr.—El Salvador, Costa Rica, Panama, Colombia, Ecuador, Guyana, French Guiana, Brazil (Amazonas, Bahia, Pará, Rio de Janeiro), Bolivia.

*heliconiae* Fox and Hoffman. Distr.—Honduras to Ecuador; Venezuela, Trinidad and Tobago, Grenada.

*hylas* Macfie. Distr.—Mexico (Veracruz) south to Brazil (Amazonas) and Peru.

*insignis* Lutz. Distr.—USA (Alabama, Georgia, Florida), Central America and Caribbean south to central Argentina.

*ocumarensis* Ortiz. Distr.—Mexico (Oaxaca, Tabasco) south to northern Brazil.

*palpalis* Macfie. Distr.—Mexico (Chiapas) to Brazil (Amazonas) and Peru.

*paraigaeaci* Spinelli. Distr.—Belize, Costa Rica, Colombia, French Guiana, northern Brazil.

*pappori* Wirth and Blanton. Distr.—Costa Rica, Panama, Colombia, Brazil (Amazonas).

*pseudodiabolicus* Fox. Distr.—Mexico Puente Nacional) south to Peru and northern Brazil.

*tidwellii* Spinelli. Distr.—Honduras, Costa Rica, Panama, Colombia, Ecuador.

*trinidadensis* Hoffman. Distr.—Coastal, Central America and Caribbean south to Venezuela, Colombia, Ecuador and Surinam.

*verecundus* Macfie. Distr.—Mexico (Chiapas) to Ecuador.

*vanziner* Wirth and Blanton. Distr.—Honduras, Costa Rica, Panama.

**Subgenus MACFIELLA Fox**

*phlebotomus* (Willistone). Distr.—Mexico (Sinaloa) and Caribbean south to Ecuador and Brazil (Ceara, Goias, Maranhao, Pernambuco).

*willistoni* Wirth and Blanton. Distr.—Mexico (Sonora), Honduras, Panama. [**]
<table>
<thead>
<tr>
<th>Subgenus</th>
<th>Name</th>
<th>Distr.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATAEMYIA</strong> Vargas</td>
<td>azurens</td>
<td>Wirth and Blanton.</td>
<td>—Panama. [**]</td>
</tr>
<tr>
<td></td>
<td>dalessandroi</td>
<td>Wirth and Barreto.</td>
<td>—Costa Rica, Panama, Colombia. [NR]</td>
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<td></td>
<td>dicacius</td>
<td>Wirth and Blanton.</td>
<td>—Costa Rica, Panama, Colombia, Ecuador.</td>
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<td></td>
<td>majingae</td>
<td>Wirth and Blanton.</td>
<td>—Panama. [**]</td>
</tr>
<tr>
<td></td>
<td>volcanensis</td>
<td>Wirth and Blanton.</td>
<td>—Panama, Colombia. [**]</td>
</tr>
<tr>
<td><strong>OEACTA</strong> Poey</td>
<td>alahialimis</td>
<td>Barbosa.</td>
<td>—Costa Rica, Panama, Colombia, Ecuador. [NR]</td>
</tr>
<tr>
<td></td>
<td>barbosai</td>
<td>Wirth and Blanton.</td>
<td>—USA (Florida) south to Ecuador. [NR]</td>
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<td></td>
<td>cancer</td>
<td>Hogue and Wirth.</td>
<td>—Mexico (Sinaloa), El Salvador, Costa Rica.</td>
</tr>
<tr>
<td></td>
<td>furen (Poey).</td>
<td>Distr.</td>
<td>—USA (Massachusetts south to Florida and Texas), Mexico (Campeche, Santiago, Sinaloa, Veracruz) and Caribbean south to Ecuador and coastal Brazil.</td>
</tr>
<tr>
<td></td>
<td>goegasi</td>
<td>Wirth and Blanton.</td>
<td>—Costa Rica, Panama, Colombia.</td>
</tr>
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<td><strong>unplaced, acotylus Species Group</strong></td>
<td>acotylus</td>
<td>Lutz.</td>
<td>—Mexico (DF), Honduras, Panama, Venezuela, Trinidad, Surinam, Brazil (Mato Grosso, Pará). [**]</td>
</tr>
<tr>
<td></td>
<td>carsiomenus</td>
<td>Wirth and Blanton.</td>
<td>—Panama, Colombia, Brazil (Pará). [**]</td>
</tr>
<tr>
<td></td>
<td>teretipalpis</td>
<td>Wirth and Barreto.</td>
<td>—Colombia. [**]</td>
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<tr>
<td><strong>unplaced, caridei Species Group</strong></td>
<td>raposoensis</td>
<td>Wirth and Barreto.</td>
<td>—Colombia. [**]</td>
</tr>
<tr>
<td><strong>unplaced, daedalus Species Group</strong></td>
<td>aniefaractus</td>
<td>Wirth and Blanton.</td>
<td>—Panama. [**]</td>
</tr>
<tr>
<td></td>
<td>beaveri</td>
<td>Wirth and Barreto.</td>
<td>—Colombia. [**]</td>
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<td></td>
<td>commatis</td>
<td>Wirth and Blanton.</td>
<td>—Panama. [**]</td>
</tr>
<tr>
<td></td>
<td>crescentis</td>
<td>Wirth and Blanton.</td>
<td>—Mexico (Chiapas) to Colombia, northeastern Argentina. [NR]</td>
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<td></td>
<td>cunningi</td>
<td>Spinelli and Borkent.</td>
<td>—Costa Rica. [NR]</td>
</tr>
<tr>
<td></td>
<td>daedaloides</td>
<td>Wirth and Blanton.</td>
<td>—Panama, Colombia. [**]</td>
</tr>
<tr>
<td></td>
<td>daedalus</td>
<td>Macfie.</td>
<td>—USA (Arizona, New Mexico), Mexico (Chiapas) to Colombia. [**]</td>
</tr>
<tr>
<td></td>
<td>dunn</td>
<td>Wirth and Blanton.</td>
<td>—Costa Rica, Panama.</td>
</tr>
<tr>
<td></td>
<td>pampokillus</td>
<td>Macfie.</td>
<td>—USA (Arizona, New Mexico), Mexico (Chiapas, Oaxaca) to Venezuela. [NR]</td>
</tr>
<tr>
<td></td>
<td>phaeonotus</td>
<td>Wirth and Blanton.</td>
<td>—Panama. [**]</td>
</tr>
<tr>
<td></td>
<td>picidade</td>
<td>Spinelli and Borkent.</td>
<td>—Costa Rica. [NR]</td>
</tr>
<tr>
<td><strong>unplaced, dasypopus Species Group</strong></td>
<td>dasypopus</td>
<td>Macfie.</td>
<td>—Colombia, Ecuador, Venezuela, Guyana, Brazil (Amazonas, Mato Grosso, Pará). [**]</td>
</tr>
<tr>
<td></td>
<td>rodriguezi</td>
<td>Ortiz.</td>
<td>—Panama, Venezuela. [**]</td>
</tr>
<tr>
<td><strong>unplaced, eublepharus Species Group</strong></td>
<td>caldisi</td>
<td>Browne.</td>
<td>—Colombia. [**]</td>
</tr>
<tr>
<td></td>
<td>canoensis</td>
<td>Wirth and Lee.</td>
<td>—Colombia. [**]</td>
</tr>
<tr>
<td></td>
<td>eublepharus</td>
<td>Macfie.</td>
<td>—Costa Rica, Panama, Colombia, Venezuela, Ecuador, northern Brazil.</td>
</tr>
<tr>
<td></td>
<td>florentina</td>
<td>Messersmith.</td>
<td>—Colombia. [**]</td>
</tr>
<tr>
<td></td>
<td>pabloi</td>
<td>Browne.</td>
<td>—Colombia. [**]</td>
</tr>
<tr>
<td></td>
<td>propriipennis</td>
<td>Macfie.</td>
<td>—Mexico (Chiapas) to Panama, Ecuador, Venezuela and northern Brazil. [NR]</td>
</tr>
<tr>
<td></td>
<td>rangeli</td>
<td>Ortiz and Mirsa.</td>
<td>—Mexico (Oaxaca), to Ecuador, Bolivia, Venezuela, Trinidad, Brazil.</td>
</tr>
<tr>
<td></td>
<td>tamboensis</td>
<td>Wirth and Lee.</td>
<td>—Colombia. [**]</td>
</tr>
<tr>
<td></td>
<td>zumbadoi</td>
<td>Spinelli and Borkent.</td>
<td>—Costa Rica. [NR]</td>
</tr>
</tbody>
</table>
Table 2. Continued.

**Subgenus unplaced, flavialis Species Group**

*balsapambensis* Ortíz and León. Distr.—Costa Rica to Ecuador, Brazil.

*castillae* Fox. Distr.—Guatemala, Honduras, Costa Rica, Panama, Ecuador, Venezuela, Trinidad.

*flavialis* Mache. Distr.—Honduras, Costa Rica, Panama, Colombia, Venezuela, Trinidad, Guyana, Brazil (Amazonas, Pará).

*leopoldoi* Ortíz. Distr.—Honduras and El Salvador south to Bolivia and northeastern Argentina.

*tetrathyris* Wirth and Blanton. Distr.—Honduras, Costa Rica, Panama, Ecuador, Trinidad, Surinam, northern Brazil. [NR]

**Subgenus unplaced, leoni Species Group**

*fieldi* Wirth and Blanton. Distr.—Honduras, Costa Rica, Panama. [NR]

*gabaldoni* Ortíz. Distr.—Mexico (Tabasco) south to Ecuador, Venezuela, Trinidad, Brazil and Paraguay.

*glabellus* Wirth and Blanton. Distr.—Honduras to Ecuador, Trinidad, Brazil (Bahia, Pará).

*trifidas* Spinelli and Borkent. Distr.—Costa Rica. [NR]

**Subgenus unplaced, limai Species Group**

*galindoi* Wirth and Blanton. Distr.—Costa Rica, Panama, [NR]

*l. barrettoi* Ortíz. Distr.—Colombia. [**]

*tenutilobus* Wirth and Blanton. Distr.—Guatemala, Honduras, El Salvador, Panama. [**]

*vernouxi* Wirth and Blanton. Distr.—Costa Rica, Colombia, Brazil (Pará), Bolivia. [NR]

**Subgenus unplaced, monticola Species Group**

*andinus* Wirth and Lee. Distr.—Colombia. [**]

*magnipalpis* Wirth and Blanton. Distr.—Panama. [**]

*monticola* Wirth and Lee. Distr.—Costa Rica, Panama, Colombia, Ecuador.

**Subgenus unplaced, pachymerus Species Group**

*almirantei* Wirth and Blanton. Distr.—Costa Rica, Panama. [NR]

*atelis* Wirth. Distr.—Panama. [**]

*caprilesi* Fox. Distr.—Panama, Colombia, Venezuela, Brazil (Mato Grosso, Pará). [**]

*obnoxius* Fox. Distr.—Colombia, Venezuela. [**]

*pachymerus* Lutz. Distr.—Guatemala, El Salvador, Costa Rica, Panama, Colombia, Brazil (Amazonas). [NR]

*uniradiatus* Wirth and Blanton. Distr.—Panama, Colombia. [**]

**Subgenus unplaced, reticulatus Species Group**

*aureus* Ortíz. Distr.—Panama, Venezuela, Brazil (Amazonas), Bolivia, Paraguay, northeastern Argentina. [**]

*guyanensis* Floch and Abonnenc. Distr.—Panama, Venezuela to French Guiana, Trinidad and Tobago, Brazil (Pará, Pernambuco, Recife, São Paulo). [**]

*lanei* Ortíz. Distr.—Mexico (Veracruz), Honduras, Costa Rica, Panama, Venezuela, Trinidad, Brazil (Pará). [NR]

*lyrinotatus* Wirth and Blanton. Distr.—Nicaragua, Panama, Brazil. [**]

*macrostigma* Wirth and Blanton. Distr.—Costa Rica, Panama, Colombia.

*paucisquamicus* Barbosa. Distr.—Costa Rica to Peru and Bolivia, Venezuela, Trinidad, Brazil (Amazonas, Pará).

*pigmanii* Ortíz. Distr.—Belize to Colombia, Venezuela, Trinidad, Brazil (Bahia, Pará).

*reticulatus* Lutz. Distr.—Honduras, Costa Rica, Panama, Colombia, Brazil (Bahia, Rio de Janeiro, Pernambuco, São Paulo).

**Subgenus unplaced, stigmatilis Species Group**

*stigmatilis* Wirth. Distr.—Mexico (Oaxaca), Guatemala, Costa Rica, Panama. [NR]

**Subgenus unplaced, venezuelensis Species Group**

*venezuelensis* Ortíz and Mirsa. Distr.—Costa Rica south to Central Argentina and Chile. [NR]

**Miscellaneous Unplaced Species**

*arubae* Fox and Hoffman. Distr.—USA (Texas), Caribbean (Aruba and Grenada) south to Colombia and Venezuela. [**]

*trilineatus* Fox, 1946. Distr.—Central America and Caribbean, Paraguay (?).

*wokai* Fox. Distr.—Costa Rica, Panama. [NR]
lowlands to the higher elevations of western Panama and Costa Rica.

There are now 285 species of *Culicoides* recognized in the region south of the United States (with the inclusion of the new species here) and this represents about 26% of the total diversity of Ceratopogonidae in this region. We believe that this percentage is in part an artefact produced by the lack of descriptions of a large number of undescribed species in some non-pestiferous genera such as *Dasyhelea* Kieffer, *Atrichopogon* Kieffer and *Stilobezzia* Kieffer. However, it remains clear that *Culicoides* is a huge and diverse group in the Neotropical Region and a great amount of research is required to better understand this genus. We plan to continue our study of Costa Rican *Culicoides* and further investigation is sure to reveal more undescribed species and new records, in addition to enhancing our understanding of the distribution of these insects.

**ACKNOWLEDGMENTS**

The junior author expresses his heartfelt thanks and appreciation to his wife Annette for her continuing support of this taxonomic work. In addition, he is grateful to his brother and sister-in-law, Herman and Pieta Borkent, who helped finance a portion of the expedition to Costa Rica in 1993–1994. Five of the ten new species described here were collected during that collecting trip.

All the specimens used as the basis for the descriptions here were expertly mounted on microscope slides by Annia Picado (INBC). Her remarkable skills at providing such excellent preparations ensured that we could study all taxonomically important features with ease.

We acknowledge the support of the Global Environment Facility of the World Bank through the “Biodiversity Resources Development Project” developed by the National Institute of Biodiversity (INBio), the National System of Conservation Areas (SINAC), Ministry of the Environment and Energy (MINAE) in Costa Rica. El Servicio de Parques Nacionales kindly provided permission to the junior author to collect in the numerous National Parks and Reserves in Costa Rica.

Doug A. Craig (U. of Alberta) went far beyond the call of collegial duty by taking and arranging the wing photographs in Fig. 1 and we are very grateful for his help. We also extend our thanks to Heather Proctor (U. of Alberta) for the use of photographic and microscope equipment.

We express our thanks to Bill (W. L.) Grogan and Steve (C. S.) Murphree for much appreciated reviews of this paper.

**LITERATURE CITED**


Wirth, W. W. and F. S. Blanton. 1956. Studies in Pan-


A NEW SPECIES OF *RHYACOPHILA PICTET* (TRICHOPTERA: RHYACOPHILIDAE) FROM GREAT SMOKY MOUNTAINS NATIONAL PARK, WITH ILLUSTRATIONS OF FEMALES OF *R. APPALACHIA* MORSE AND ROSS AND *R. MYCTA* ROSS

**David A. Etnier, Charles R. Parker, and Ian C. Stocks**

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**Abstract.**—*Rhacophila celadon* Etnier, Stocks, and Parker, n. sp., a large species of the *R. nigrita* species group, is described from areas in Great Smoky Mountains National Park, Tennessee and North Carolina, based on males, females, and larvae. The male is virtually identical to that of *R. nigrita*, but differs consistently from that species in aspects of the genitalia. The female and larva differ remarkably from those of *R. nigrita*. Females of *Rhacophila appalachia* and *R. mycta* are illustrated.

**Key Words:** Trichoptera, Rhyacophilidae, *Rhacophila*, Great Smoky Mountains National Park, Tennessee, North Carolina

During June of 1996, Etnier and students began a study of benthic macroinvertebrates from nine localities in the Sams Creek watershed of the Middle Prong Little River system, Great Smoky Mountains National Park (GSMNP), near the boundary of Blount and Sevier counties, Tennessee. This study was in conjunction with an attempt to reclaim a portion of Sams Creek for native brook trout (*Salvelinus fontinalis* (Mitchill)). A light trap sample from Sams Creek about 200 m below the mouth of Starkey Creek, elevation 963 m, 6–7 June 1996, contained 3 males and 2 females of a species in the *Rhacophila nigrita* subgroup of the *R. invaria* species group sensu Schmid (1970) or *R. nigrita* complex sensu Prather and Morse (2001). The collection included two additional species of the *R. nigrita* subgroup—1 male and 1 female of *R. nigrita* Banks and 34 males and 1 female of *R. appalachia* Morse and Ross. Based on male genitalia, the species in question was very similar to *R. acutiloba* Morse and Ross, a species described from New Hampshire and widespread in the Northeast, extending south to North Carolina. A large but uncommon *Rhacophila* larva with glossy dark reddish brown head and thoracic sclerites, and strikingly bluegreen thoracic and abdominal membranous areas was also encountered in the Sams Creek study. The larva closely conformed to the description of *R. acutiloba* associated by Neves (1977) and described as *Rhacophila* species 2 by Flint (1962), but lacked the pale areas on the posterior corners of the pronotum and posterior portion of the fronthoelypeus. During February of 1997, ICS found this same larva to be more abundant in Alum Cave...
Creek, also in GSMNP. That creek was sampled on 10 April 1997 to obtain pupae that would allow us to confirm the tentative larva/adult association. Adults from this collection began emerging on 25 April, and were identical to those collected earlier in Sams Creek. We examined a paratype male of *R. acutiloba*, and the differences we had noted between our specimens and the illustration of the male of that species (Morse and Ross 1971) were striking and consistent, indicating that we had discovered an undescribed species whose description follows.

**Methods**

Pupal cases were held with little mortality for several days in jars filled with stream water and kept cold in a cooler. At the laboratory we removed the pebble case under a dissecting microscope and transferred the pupal cases, one to three per jar, to loosely covered 4–8 oz jars with the pupae barely covered with water. The jars were placed in an incubator set to maintain temperature and daylength conditions similar to those from the pupal habitat. Mature pupae that emerged from the pupal capsule often failed to complete the final molt to winged adults, but the addition of a toothpick or other object as an emergence platform appeared to be helpful.

*Rhyacophila celadon* Etnier, Stocks, and Parker, new species

(Figs. 1–5, 9)

*Rhyacophila appalachia*: Prather and Morse 2001, fig. 40. ♀.

Types.—Holotype: Mature ♀ pupa. Alum Cave Creek ca. 500 m east of U.S. Highway 441 on Alum Cave Trail, GSMNP, Sevier County, Tennessee, collected 10 April 1997, emerged 25 April 1997. D. A. Etnier and I. A. Stocks, deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). Allotype: Mature ♂ pupa, same data, emerged 29 April 1997 (USNM). Paratypes: Same data as holotype, Illinois Natural History Survey (INHS), mature ♀ pupa, emerged 25 April 1997, ♂, emerged 27 April 1997; Clemson University (CUAC), mature ♀ pupa, emerged 6 June 1997, mature ♂ pupa, emerged 27 April 1997; Royal Ontario Museum (ROM), mature ♀ pupa, emerged 27 April; University of Tennessee (UT) 1.840. ♀, emerged 30 April. Alum Cave Creek at footbridge at Alum Cave Trail trailhead, U.S. Highway 441, GSMNP, Sevier County, Tennessee, 10 April 1997: ROM, mature ♀ pupa, emerged 2 May 1997; UT 1.769, mature ♀ pupa, emerged 5 May, UT 1.770, mature ♀ pupa, emerged 12 May. Sams Creek, light trap at camping area (not designated) ca. 200 m below mouth of Starkey Creek, GSMNP, Sevier County, Tennessee, 6–7 June 1996. Ex UT 1.280, UT 18.27: California Academy of Sciences (CAS). ♀, ♂; University of Minnesota (UMSP). ♂, ♀; UT 1.280. ♀. Thunderhead Prong ca. 100 m below mouth of Sams Creek, GSMNP, Blount County, Tennessee, 7 June 1996, hand-picked. 1 ♂, 1 ♀. UT 1.286. Clingmans Creek at pumphouse, elevation 1579 m, 3.9 km NE Forney Ridge Parking Lot, 35°33′36″N, 83°29′1″W. GSMNP, Swain County, North Carolina. 1–2 June 1989. UT 1.840, 2 ♀. Lights near Cosby Creek Ranger Station, elevation 533 m, 35°46′40″N, 83°12′49″W, GSMNP, Sevier County, Tennessee. 17 May 2001, CUAC, 1 ♀, ROM, 1 ♀. All mature pupae are metamorphotypes (MMT) accompanied by larval sclerites.

Additional material.—Alum Cave Creek at footbridge below Rock Step Cave Pass, Alum Cave Trail, GSMNP, Sevier County, Tennessee, 23 February 1997. Ex UT 1.315: USNM, 1 larva; INHS, 1 larva; UT 1.316, 5 larvae. Alum Cave Creek at second footbridge east of US 441, GSMNP, Sevier County, Tennessee. 2 March 2001. UT 1.764. 3 larvae, 1 prepupa. Alum Cave Creek ca. 3,500 m east of US 441, Sevier County, Tennessee. 29 February 2000. UT 1.774. 5 larvae.

Sams Creek system, GSMNP, Tennessee:
Starkey Creek ca. 400 m above Sams Creek, Sevier County, 2 February 1997, Ex UT 1.321, 1 larva each to CUAC, ROM, and UMSP; UT 1.778, 1 larva. Starkey Creek immediately above Sams Creek, Sevier County, 6 June 1996, UT 1.779, 2 larvae. Sams Creek ca. 800 m above Starkey Creek, Blount County, 2 February 1997, UT 1.317, 1 larva; UT 1.319, 2 larvae. Sams Creek ca. 100 m below Churn Hollow, Sevier County, 1 February 1997, UT 1.309, 1 larva; UT 1.311, 3 larvae + 1 larva to CAS. Thunderhead Prong ca. 100 m below Sams Creek, Blount County, 7 June 1996, UT 1.293, 1 larva. Eastern tributary (seep) to Sams Creek about halfway between Devils Bench Branch and Churn Hollow, Sevier County, 7 September 1996, UT 1.780, 1 larva.

Road Prong ca. 3.2 km below Indian Gap, GSMNP, Sevier County, Tennessee, 16 May 1975, UT 1.772, 2 mature ♀ pupae, 1 larva.

Oconaluftee River along U.S. Highway 411 ca. 16 km south of Tennessee border, Swain County, North Carolina, 9 March 1997, UT 1.320, 1 larva.


The male differs from *R. appalachia* and *R. carpenteri* in having the tenth tergite (Fig. 1a) rectangular to subrectangular in lateral view. It differs from *R. accola* in
lacking the deep, C-shaped emargination in the sclerotized tip of the phallus (Fig. 1a) and in having the ninth tergite tapering to its mesal emargination (Fig. 1b) rather than truncate on either side of the emargination in *R. accola*. It differs from *R. mycta* in the much smaller distal end of the anal sclerite, in lacking a dorsal swelling near the distal margin of tergite IX, and in lacking a distinct dorsal lobe on the distal segment of the inferior appendages. It is most similar to *R. acutiloba* and *R. nigrita*. It differs from the former in having the lobes of the anal sclerite bluntly rounded (Fig. 1b) rather than laterally produced into a blunt but acute point in *R. acutiloba*. It differs consistently from *R. nigrita* in having the crest of tergum X with only its dorsal fourth separated from the posterior end of segment IX (entire anterior margin of crest of X separated from IX in *R. nigrita*), and in having the anal sclerite long and straight in lateral view, and extending forward to near or slightly within segment IX (not even extending completely under the crest of X, and decurved posteriad in *R. nigrita*). The dorsal margin of the tenth tergite is usually slightly concave (Fig. 1a) versus usually slightly concave in *R. nigrita*. The sclerotized paired dorsal lobes near the tip of the phallus are smoothly pointed in *R. celadon* (Fig. 1a), but more rounded and often with a ventral swelling in *R. nigrita*.

The female (Fig. 2) differs from *R. fuscata* (Walker) and from *R. accola, R. acutiloba* (see Ruiter 2000), *R. carpenteri, R. invaria* (Walker), *R. mycta, R. nigrita*, and *R. parantra* Ross of the *R. invaria* group in having both dorsal and ventral posterior margins of segment VIII deeply and broadly emarginate. It differs from *R. alabama* Harris, *R. appalachia*, and *R. banksi* Ross in lacking paired projections on the posterior ventral margin of segment VIII. It differs from *R. carolae* Harris, *R. kondratieffi* Parker, and *R. shenandoahensis* Flint in lacking a long median projection on the ventral emargination of segment VIII. It differs from *R. vibox* Milne in having the ventral emargination of segment VIII smoothly rounded (doubly emarginate in *R. vibox*) and in having the dorsal emargination with a short median projection (smoothly rounded in *R. vibox*). The female of *R. tricornuta*, also in the *R. invaria* group, is unknown.

The larva (Fig. 3a) differs from all other *R. nigrita* group larvae in having seta 5 (Williams and Wiggins 1981) of the forefemur situated on a prominent, bluntly pointed protuberance.

**Description.—** *Male*: Length 12.2–13.5 mm, forewing length 11.4–12.0 mm (*N* = 4). Forewing dark brown with stigmatic area and a band centered on vein *R*<sub>1</sub> and about width of *R*<sub>1</sub>-Sc interspace darker brown. Transparent spot present just proximal to basal fork of vein *M*, and extending to fork and on anterior half of crossvein *mcu*. Head and thorax dark brown, legs yellowish brown with dark brown tibial spurs, spur formula 3-4-4. Abdomen with tiny ventromedian spine near posterior margin of segment VII. Segment IX, in lateral view (Fig. 1a) with dorsal margin smoothly convex and posterior margin smoothly concave from posterior dorsal projection to connection with tergite X. Posterior dorsal projection of IX (dorsal view, Fig. 1b) forming an angle of about 80°, and with a U-shaped mesal emargination. Tergite X, lateral view, subrectangular, but appearing distinctly triangular in cleared specimens due to approximate 45° angle of its posterior concavity or groove. Bottom of concavity or groove extends from anterior dorsal to posterior ventral extent of tergite X, and areas posterior and dorsal to this “line” form a darkened triangle due to additional sclerotized surfaces (sides of concavity) light must pass through. Anal sclerites (lateral view) straight, with posterior ends slightly inflated, and with stem extending anteriad to or slightly past posterior margin of IX. Anal sclerites bluntly rounded in dorsal view. Inferior appendages with distal segment slipper-shaped, dorsal lobe scarcely differentiated. Phallic apparatus with paired...
membranous ventral lobes and sclerotized, pointed, nearly straight parameres. Aedeagus sclerotized, with upturned ventral tip (Fig. 1a) and nearly triangular basal lobes.

**Female:** Length 12.8–14.5 mm, forewing length 11.0–13.0 mm (N = 7). Head, eye size, thorax, wing color, legs, and tibial spur counts as in male. Small median ventral spine on posterior margin of segment VI. Abdominal segment VIII with short posterior spine laterally in middle of ventral half of segment (Fig. 2a). Segment VIII dorsally with W-shaped emargination, and ventrally with broad, deep, smoothly rounded U-shaped emargination (Fig. 2b).

**Pupa:** Pupal cases in preservative ranged from 12.3 to 16.6 mm (N = 11).

**Larva:** Last instar larva 18 to 27 mm long (N = 19, mean = 21.5). In life, head and pronotum shiny dark reddish brown; membranous areas a brilliant bluegreen (Fig. 4). Head (Fig. 5) parallel sided in dorsal view, 2.4 mm long to anterior margin of frontoclypeus, 1.0 mm wide, with pale circle around eye and paler at posterior margin. Pale muscle scars more conspicuous on molted larval sclerites than on larvae, forming a transverse band of about 10 muscle scars in 2 poorly defined rows, concave anteriad, across base of triangular portion of frontoclypeus. Genae with prominent dorsal, lateral, and ventral groupings of muscle scars, all of which extend from rear of sclerite anteriad to level of band of muscle scars on frontoclypeus. Dorsal muscle scars about 25, arranged in 3 rows posteriad, one row extending anteriad, with a distinct gap between 1 or 2 anterior muscle scars and remainder of row. Lateral muscle scars about 45, arranged in 4 rows posteriad and 3 rows anteriad. Ventral muscle scars about 20–25, arranged in 2 rows posteriad, and 1 row anteriad. In all three groups of muscle scars on genae, posterior ones are difficult to see against pale background. Right mandible with 3 apical teeth, middle tooth longest, dorsal tooth shortest. Left mandible with 2 apical teeth, dorsal tooth half as long as ventral tooth. Maxillary palp with second segment slightly longer than combined third and fourth segments. Pronotum concolorous, slightly less dark than head, with an arc of 7–10 ten small muscle scars anteriad, concave laterad, and about 25 larger ones posteriad in 6 rows at posterior margin, with only 3 rows extending anteriad to middle of sclerite. About 5 additional muscle scars along mesal margin on posterior half of sclerite. Legs brownish yellow, foreleg slightly darker and much thicker than other legs. Forefemur highly modified (Fig. 3a), with anterior margin forming a sharp edge, and midway with a bluntly pointed protuberance bearing a short, stout seta. Foretrochanter with anterior margin concave and bearing 3 short, stout setae, one proximal, one subdistal, and one distal. Anteriodistal end of foretrochanter not extending as far forward as base of femur, thus forming a distinct notch [anterior margin of femur and trochanter of foreleg forming a straight line, femur lacking a protuberance, and trochanter very slightly concave in larvae of *R. appalachi*a, *R. banksi*, *R. mycra*, *R. nigrita* (Fig. 3b), *R. parantra*, and *R. vibox*]. In six earlier instar larvae of *R. celadon* (6.5–16.5 mm), foretrochanter distinctly concave anteriad, notch between trochanter and base of femur apparent, and forward projecting tubercle on femur developed or anterior margin of femur sharply and acutely pointed. Membranous areas of thorax and abdomen strikingly bluegreen (Fig. 4), this color disappearing in preservative. Anal claw not strongly curved, and with two teeth, proximal one tiny and often difficult to see; a long seta arising from a slightly elevated protuberance proximal to suture in middle of anal claw.

**Biological.—**Some larvae reach final instar in early February. In the laboratory, mature pupae emerged from their pupal case from 25 April through 6 June. Adults have been taken from 17 May through 7 June. Two larvae 8.0–8.5 mm long, collected on 2 February, and two larvae 16.5–18 mm long, from 6 June, suggest that emergence dates extend well into June, and probably into
Fig. 4. *Rhyacophila celadon*, last instar larva, dorsal.
July. We have taken this species from cool first through third order streams at elevations of 533 m (1,749 ft, Cosby Creek Ranger Station) to about 1,280 m (4,200 ft, upper Sams Creek and Road Prong). The two seeps sampled during the Sams Creek investigation produced numerous larvae of *R. appalachia/nigrita*, but only one larva of *R. celadon* (UT 1.780).

Etymology.—Celadon is a Korean ceramic pottery noted for its bluegreen glaze, similar to the strikingly bluegreen membranous areas of live larvae of this species.

Discussion.—Initially we were surprised that this large, fairly common species of *Rhyacophila* with such an attractive larva could have gone so long undescribed. In preparing the diagnoses, it soon became obvious that the male was so similar to *R. nigrita*, especially in genitalia characters, that it might seem prudent to accept the differences as being intraspecific variation (see Prather and Morse 2001). Finding adults (Sams Creek) and metamorphotypes (Road Prong) sympatric with those of *R. nigrita* strongly suggested that two species were involved. Associating the female of *R. celadon*, with segment VIII trenchantly different from that of *R. nigrita* and all known females of the *R. invaria* group, convinced us of its species level status. It was gratifying to find diagnostic morphological differences in the larval forefemur, in addition to less reliable differences in pigmentation. Examination of larval sclerites of numerous metamorphotypes of the sympatric *R. appalachia* and *R. nigrita* suggests that the reduced number of muscle scars on the head may offer reliable characters to separate these two species from *R. celadon*. In contrast, we find less darkly pigmented specimens of *R. appalachia*, prevalent in GSMNP, to be inseparable from larvae of sympatric *R. nigrita*. The spinelike supports on the anterior margin of the pronotum (easily counted in shed larval sclerites) may offer an additional character for separating larvae in the *R. invaria* species group. They number over 20 per sclerite in *R. celadon*, about 15–20 in *R. appalachia* and *R. nigrita*, and only 10–13 in *R. banksi*, *R. invaria*, and *R. parautra*.

The Prather and Morse (2001, fig. 40) illustration of the female of *Rhyacophila appalachia* is actually that of *R. celadon*, with dorsal and ventral views reversed. This illustration is presumably based on one or more of four females from Mount Sterling Creek at State Highway 284, elevation 1,057 m, GSMNP, Haywood County, North Carolina, 22 May 1996, housed at UMSP. We base our identification of the female of *R. celadon* on metamorphotype females, in which larval forefemora clearly have the diagnostic seta-bearing tubercle of *R. celadon*. The female they suspected to be that of *R. mycta* (fig. 60) we consider to be the female of *R. appalachia*, based on metamorphotype females taken syntopically with metamorphotype males, and adult males and females taken together in a light trap with males and females of both *R. celadon* and *R. nigrita*. We provide an additional ventral and lateral view of segment VIII for female *R. appalachia* (Fig. 6).
Based on the following, we consider Fig. 7 to represent the female of *R. mycta*. We have males of *R. mycta* from two widely separated GSMNP localities (near LeConte Creek, TN, 603 m, and at Andrews Bald, NC, 1,767 m) associated with females similar to the one illustrated in Fig. 7, as well as mature female pupae from the bog at Andrews Bald. The female of *R. mycta* is very similar to that of *R. nigrita*, differing in having the dorsal apex of VIII emarginate, the lateral margin with a low but distinct projection near its midlength, the ventral margin slightly to strongly produced medially, and the vaginal sclerites shorter and stouter than in *R. nigrita* (Figs. 10, 11). For comparison, we also have included ventral and lateral views of the vaginal sclerites of *R. appalachia* and *R. celadon* (Figs. 8–9). Females of *R. nigrita* in which the dorsal margin of VIII is notched have been noted and regarded as variants of *R. nigrita* (Prather and Morse 2001). In addition, we have a female we believe to be *R. mycta* which lacks the dorsal emargination of VIII, but otherwise possesses the characters
Figs. 8—11. Vaginal sclerites of Rhyacophila females. a, lateral; b, ventral. 8, R. appalachia. 9, R. celadon. 10, R. mycta. 11, R. nigrita.

described above. Females such as these may be very difficult to assign to either R. mycta or R. nigrita. A closer examination of associated series of both species is called for. We have noted considerable intraspecific variation in the shape of segment VIII in females, including in R. appalachia, where the posterior dorsal emargination varies in depth, and from U-shaped to V-shaped; the ventral emargination may have a broad, shallow, median projection, and the lateral borders of the emargination may be parallel to divergent. Females of R. appalachia and R. mycta have been sent to USNM, INHS, CUAC, and UMSP.

The virtually identical male genitalia of several members of the R. invaria species group (R. celadon/R. nigrita, R. banksi/R. parantra) which are easily separable as females, and the presence of “unusual” R.
invariag group females we have seen suggest that additional valid but undescribed species in the R. invariag group exist.

Prather and Morse (2001) provide keys to males, females, and larvae of the Eastern Nearctic Rhyacophila. To accomodate R. celadon, we present the following changes and additional couplets.

**Key to Males**

*R. celadon* males should key to couplet 18 in Prather and Morse, which can be re-placed by the following:

18(16') Segment X quadratde in lateral view, with high rectangular to subrectangular crest; anal sclerites large, wide in dorsal view .......................... 18a
18' Segment X not quadratde, with low, somewhat flattened crest; anal sclerites small, narrow in dorsal view .......................... *R. appalachia*

18a(18) Crest of X free of posterior edge of segment IX for only apical fourth of its height, dorsal margin of crest usually slightly convex: anal sclerite with long root originating near anterior of X, nearly in IX. Forewing length 11–12 mm .......................... *R. celadon*
18a' Crest of X nearly entirely free of posterior edge of segment IX, dorsal margin usually slightly concave; anal sclerite with short root, originating near mid-length of X. Forewing length less than 10 mm .......................... *R. nigrita*

Females of all of the species discussed in this paper are keyed in Prather and Morse with the exception of *R. mycta*, although two are misidentified. In couplet 25', replace *R. mycta* with *R. appalachia*. In couplet 29', replace *R. appalachia* with *R. celadon*. *R. mycta* is accommodated by the following modifications to couplets 17–19.

17(11) Dorsal margin extending posteriorly much farther than ventral margin, with lateral margin rising from venter to dorsum at nearly 45° angle .......................... 17a
17' Dorsal margin not extending posteriorly farther than ventral margin, often not extending as far posteriorly as ventral margin .......................... 18

17a(17) Posterodorsal margin with mesal projection, rarely emarginate .......................... *R. nigrita*
17a' Posterodorsal margin emarginate, rarely with mesal projection .......................... *R. mycta*
18(17') Posterodorsal margin with mesal projection .......................... *R. carpenteri*
18' Posterodorsal margin emarginate or notched .......................... *R. mycta*
19(18) Posteroventrally with mesal projection .......................... *R. carpenteri*
19' Posteroventrally emarginate .......................... *R. fuscula*

The larva of *R. celadon* will key to *R. nigrita* in existing keys to *Rhyacophila* larvae, including Prather and Morse. However, the diagnostic seta-bearing tubercle of *R. celadon* is so highly distinctive that larvae of this species should be easily distinguishable.

**Other Material Examined**

*Rhyacophila appalachia*: UT 1.244, 1 ♀, Ripshin Bog, Carter Co., TN, 29 May 1995; UT 1.771, 1 ♀, Sams Creek 200 m below mouth of Starkey Creek, GSMNP, Sevier County, Tennessee. 6–7 June 1996 + 34 ♀♂, same data, in UT 1.279; UT 1.552, 2 ♀. Thunderhead Prong 100 m below mouth of Sams Creek, GSMNP, Blount Co., TN, 7 June 1996 (1 ♀ to USNM); UT 1.732, 1 MMT ♀, 2 MMT ♀, creek on east side of State Highway 66, 0.7 road miles north of Brown Mountain Road, Stokes Co., NC, 14 April 2001 (1 ♀ to CUAC); UT 1.737, 4 MMT ♀, 4 MMT ♀, creek at Cove Road/Rough Creek Road junction, 1.7 road miles above Suttontown Road, Haywood Co., NC, 28 April 2001 (1 ♀ to INHS, 1 ♀ to UMSP).

*Rhyacophila mycta*: Andrews Bald, acid bog area, elevation 1757 m, GSMNP, Swain Co., NC, Malaise trap, 24 May–6 June 2001, UT 1.845, 3 ♀♂, 1 ♀; same data, 10 May–19 June 2002, 1 ♀ and 1 ♀ each to CUAC, INHS, and UMSP; same data, hand picked from bog and seeps, 11 June 1991, UT 1.844, 3 ♀ pupae, 1 prepupa. Spring seep behind Twin Creeks Laboratory, GSMNP, near LeConte Creek, Sevier Co., TN, 29 May 1998 sweep netting, 1 ♀; same data, 15 August 1997, 1 ♀, 1 ♀ (to USNM).

*Rhyacophila nigrita*: larval foreleg drawn from UT 1.224, 1 MMT ♀, 1 pupa, 2 larvae, Matthew Creek 2.25 air km above its mouth, Sevier Co., TN, 7 June 1994; female vaginal sclerites drawn from specimen
collected Surry Fork, ca. 100 m upstream of confluence with Roaring Fork, 35°41'24"N, 83°27'29"W, GSMNP, Sevier Co., TN, 8 June 1989.

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Kathy R. Zeiders of the Illinois Natural History Survey kindly provided a paratype male of *Rhyacophila acutiloba* for our examination. Elizabeth L. Etnier easily won the “name that insect” contest with her suggestion of the species epithet *celadon*. Discover Life in America, the organization directing the All Taxa Biodiversity Inventory for GSMNP, generously assumed a portion of the cost of publishing the Richard T. Bryant color photo of the larva of *R. celadon*. Brian Scholtens provided the Cosby Creek female paratypes.

LITERATURE CITED


A NEW GENUS AND NEW SPECIES OF MIRINE PLANT BUG (HETEROPTERA: MIRIDAE: MIRINI) FROM THE RYUKYUS, JAPAN

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Abstract.—A new genus of mirine plant bug, Neolygopsis, is established for the new species, N. nakatai, recently found on Ishigaki Island of the Ryukyus, Japan. The genus is considered to be a relative taxon of Lygocoris Reuter 1877, based on the similar shape of the male genitalia.

Key Words: Heteroptera, Miridae, new genus, new species, Ryukyus, Japan

The large plant bug tribe Mirini Hahn belongs in Mirinae, the largest subfamily of the family Miridae (Schuh 1995). Currently including 161 described species in 50 genera in Japan (Yasunaga 2001, Yasunaga et al. 2002). Through the courtesy of Mr. T. Nakata (JIRCAS, Subtropical Station, Ishigaki City), I obtained three specimens of a unique plant bug belonging to the tribe Mirini, recently found on Ishigaki Island of the subtropical Ryukyus. This mirid, apparently representing an undescribed species, at first sight resembles a member of the mirine genus Stenotus Jakovlev in having a similar color pattern and body shape, but examination of the male and female genitalia indicates that it cannot be placed in either Stenotus or any other known genus of the tribe Mirini. In this paper, therefore, a new genus Neolygopsis is proposed to accommodate the new species, N. nakatai.

All measurements in the text are given in millimeters. Terminology of the male genitalia mainly follows Yasunaga (1991). The type specimens are deposited in the collection of Zoological Laboratory, Faculty of Education, Okayama University, Japan (ZEOU).

Neolygopsis Yasunaga, new genus

Diagnosis.—Distinguished from other genera of the tribe Mirini Hahn by comparatively small size, generally stramineous body, uniformly distributed, silvery, reclining pubescence on subshining dorsum, dark setae on head and pronotum, short antennal segment I that is shorter than eye in lateral view, long antennal segment III that is longer than IV, and several unique sclerites exhibited on vesica (Fig. 10).

Description.—Body generally stramineous, 3.6–4.0 mm in length, relatively small, slender, nearly parallel-sided; dorsal surface subshining, with uniformly distributed, silky, reclining pubescence. Head short, subvertical, with silvery, reclining pubescence and dark, erect setae; vertex narrowly margined basally, with a shallow, mesal sulcus. Antenna slender, rather short; segment II weakly narrowed at base, slightly longer than basal width of pronotum; segments III and IV filiform; segment III shorter than IV. Rostrum slightly exceeding apex of mesocoxa (Fig. 3). Pronotum shallowly rugose, with dark, short, suberect setae in addition to silky pubescence; collar flat, about as thick as base of antennal segment II; scutellum rather flat, shining.
weakly rugose. Hemelytra parallel-sided, not declivous at cuneal fracture. Tibiae with prominent, dark brown spines. Male genitalia: Genital segment (Figs. 4, 5) with a pair of noticeable protuberances at bases of parameres (Fig. 5). Parameres as in Figs. 4, 5, 7, 8; left paramere (Fig. 8) with broadened sensory lobe and apically hooked hypophysis; right paramere (Fig. 7) with a protuberance at apex of sensory lobe and prominent, tapered hypophysis. Vesica (Figs. 6, 9, 10) bilobate, with two distinct (ventral and basal) sclerites and a spiculum; ejaculatory duct expanded apically, guitar-shaped; gonoporal rim distinct. Female genitalia: Sclerotized rings small, situated laterally; dorsal sac with a broad, rounded sclerite mesally (Fig. 11). Posterior wall of bursae with wide lateral lobe and narrow interramal lobes (Fig. 12).
Figs. 7–10. Male genitalia of *Neolygopsis nakatai*. 7. Right paramere. 8. Left paramere. 9. Vesica in dorsal view. 10. Same, in ventral view. Scale bars = 0.1 mm. Abbreviations: b. Basal sclerite; s, spiculum; v, ventral sclerite.

Etymology.—Derived from the mirine genus *Neolygus* Knight, to which the new genus seems to be allied; gender feminine.

Type species.—*Neolygopsis nakatai* Yasunaga, new species.

Discussion.—This new genus is similar in external appearance to *Stenotus*, from which it is easily distinguished by the smaller size, dark setae and silvery pubescence on the head and pronotum, subshining dorsum, vertical head, a pair of protruberances at posterolateral apices of the male genital segment, and highly sclerotized vesica. Structures of the male genitalia suggest that the relationship between *Neolygopsis* and *Stenotus* is only superficial.

On the other hand, the shape of the parameres, the sclerites on the vesica and the posterior wall of bursae of *Neolygopsis* resemble those found in *Neolygus*. Although the new genus is readily distinguished from *Neolygus* by many generic level differences in the external structures, the similarity exhibited in the male and female genitalia appears to suggest that *Neolygopsis* is most closely related to *Neolygus* among known mirine genera.

*Neolygopsis* is currently known by a single representative, *N. nakatai*, from subtropical Ishigaki Island of the Ryukyus.

*Neolygopsis nakatai* Yasunaga, new species
(Figs. 1–10)

Description.—Body generally pale stramineous, partly tinged with red or sanguineous. Head pale brown; jugum and lorum each with a sanguineous spot; tyulus with a sanguineous, mesal stripe. Antenna yellowish brown; segments III and IV somewhat darkened: lengths of segments I–IV (♂♂/♀♀): 0.34–0.36/0.36, 1.19–1.22/1.30, 0.68–0.76/0.81, 0.71–0.79/0.83. Rostrum pale reddish brown; apical half of segment IV dark brown. Pronotum with 4
sanguineous striae; anterolateral corners of scutellum reddish. Hemelytra pale stramineous; inner margins of claval and cuneus, and inner half of corium pale red; membrane pale grayish brown, with yellowish veins. Coxae and legs yellowish brown; coxae and femora partly pale red; extreme apices of meso- and metafemora, and extreme base (knee) of metatibia narrowly darkened; tarsi pale brown; tarsomeres III broadly darkened; lengths of metafemur, tibia and tarsus: 1.13–1.19/1.25, 1.79–1.82/1.94, 0.50–0.52/0.52; lengths of meta-tarsomeres I–III: 0.16–0.17/0.17, 0.20–0.23/0.18, 0.24–0.25/0.29. Abdomen wholly stramineous. Male and female genitalia as described for genus.

Dimensions ♂/♀: Body length 3.6–3.7/4.0; head width including eyes 0.92–0.94/0.96; vertex width 0.25–0.28/0.33; rostral length 1.42–1.46/1.47; basal pronotal width 1.08–1.14/1.22; width across hemelytra 1.21–1.23/1.43.


Paratypes.—1 ♂, same locality and collector except for date, 12. vi. 2002 (ZEOU); 1 ♀, same locality and collector, 28. vi. 2002 (ZEOU); 3 ♂ 3 ♀, same locality and collector, 4. v. 2003 (ZEOU).

Etymology.—Named for Mr. Tadafumi Nakata, who collected and offered me all available material; a noun in the genitive case.

Distribution.—Japan (Ryukyus: Ishigaki Island).

Remarks.—Because all known specimens of this new species were collected by light traps, no information is currently available on the biology.

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LITERATURE CITED


DESCRIPTION OF THE THIRD INSTAR LARVA OF HEMIPHILEURUS DISPAR KOLBE (COLEOPTERA: SCARABAEIDAE: DYNASTINAE: PHILEURINI)

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Abstract.—The larva of the dynastine scarab beetle Hemiphileurus dispar Kolbe from Dominican Republic, Hispaniola, and Greater Antilles is described. A key to the larvae is provided for the known species of the tribe Phileurini in the New World, which now includes ten species of larvae in six genera.

Key Words: Hemiphileurus, larvae, Hispaniola

Larvae of nine American species in six genera in the tribe Phileurini have been previously described (Ritcher 1966; Vanin et al. 1983; Morelli 1991, 1992). The known larvae of Phileurini are distinguished from other American dynastine larvae by the following combination of characters (following Vanin et al. 1983): chaetoparia of epipharynx with few or no sensillium among the setae; left mandible with two fused teeth (S1+S2) before the scissorial notch, one tooth (S3) immediately after the notch, and one tooth (S4) near the middle of the inner margin; each tarsal claw with two setae; and rater without palidia.

The genus Hemiphileurus Kolbe contains 28 species distributed from the U.S.A to Paraguay (Endrödi 1985, Ratcliffe 1988, Chalumeau 1988). Adults of Hemiphileurus are collected at lights, under loose bark, and inside rotten logs. Larvae are found inside rotten logs, frequently living with adults. Most of the species are associated with tropical forests from sea level to 1500 m altitude. Species live in broadleaf deciduous forests, pine-oak forests, or thorn scrub.

The larva of H. dispar is the second larva described in the genus Hemiphileurus. Ritcher (1966) described the larva of H. illatus LeConte but included it in the genus Phileurus Latreille. Larvae of H. illatus were collected in the trunk of Dasylirion sp. (Liliaceae) and in Bumelia lanuginosa (Michx.) Pers. (Sapotaceae).

We describe the third instar larva of Hemiphileurus dispar which is endemic to Hispaniola (Greater Antilles islands). A key for the known larvae of ten species in the tribe Phileurini is provided. The following description is based on Ritcher’s (1966) terminology.

KEY TO THE THIRD INSTAR LARVAE OF THE AMERICAN PHILEURINI
(Based on Ritcher 1966)

1. Lateral margins of labrum broadly rounded, not angulate ........................................ 2
   – At least one lateral margin of labrum angulate ......................................................... 5
2. Foretarsal claw longer than middle and hind tarsal claws ........................................... 3
   – Foretarsal claw similar in size to middle and/or hind tarsal claws .............................. 4
3. Epicranial setae abundant (more than 15).
Right anterior process of hypopharyngeal sclerome much shorter than basal segment of labial palpus . . . . *Actinobothrus trifolius* Luederwaldt
- Epicranial setae scarce (less than 10). Right anterior process of hypopharyngeal sclerome equal in length to basal segment of labial palpus . . . . *Homophileurus luederwaldti* (Ohaus)

4. Ocelli present. Lateral third of frons with deep, coarse, coalescent punctures
   - Ocelli absent. Anterior two-thirds of frons with scattered, small, shallow pits
   - *Triplus cylindricus* (Mannerheim)

5. Left lateral margin of labrum angulate
   - Left and right margins of labrum angulate
   - *Phileurus didymus* (L.)

6. Frons with 6 anterior frontal setae. Last segment of antenna with 4 dorsal sensory spots
   - Frons without anterior frontal setae. Last segment of antenna with 2 dorsal sensory spots
   - *Archophileurus verve* Burmeister

7. Maxilla with a row of 7 truncate, stridulatory teeth. Inner margin of left mandible, distad of molar area, with a prominent, triangular tooth
   - Maxilla with a row of 6 conical, stridulatory teeth. Inner margin of left mandible, distad of molar area, with a short, rounded tooth
   - *Phileurus fimбриatus* Burmeister

8. Frons with 2 anterior frontal setae. Haptemeral process of epipharynx sinuate
   - Frons without anterior frontal setae. Haptemeral process of epipharynx truncate

9. Last segment of antenna with 2 dorsal sensory spots. Inner margin of left mandible, distad of molar area, with a short tooth (Figs. 4a, 5b)
   - Last segment of antenna with 3–4 dorsal sensory spots. Inner margin of left mandible, distad of molar area, with a prominent, triangular tooth
   - *Hemophileurus dispar* Kolbe

**Hemophileurus dispar** Kolbe
(Figs. 1–10)

This description is based on two third-instar larvae associated with an adult collected in roots of a rotten pine stump. The specimens have the following collecting data: "Parque Nacional Almando Bermudez. La Compartación. 19°02'22"N 70°58'10"W. 7880 ft. 07 April, 1992. M.A. Ivie, W. T. Lonier, P. Sikes." (Dominican Republic).

Description.—Maximum width of head capsule 4.41 mm. *Cranium* (Fig. 2): Surface nearly smooth, covered with pits (finitely punctate), brownish. Frons sparsely punctate, with 2 exterior frontal setae, 4 posterior frontal setae, anterior frontal setae absent; anterior margin of frons with 3 setae on each side; epicranium with row of 8–9 dorso-epicranial setae, 7 postocular setae, 1 ocular seta. *Clypeus*: Dorsal surface with 1 external seta and 2 anterior setae. *Labrum*: Symmetrical with 1 dorso-lateral seta and 4 dorsal setae. *Epipharynx* (Fig. 3): Plegmata absent. Corypephora with 5 thick setae. Haptemerum with cone-like process, lacking heli. Acanthoparia without setae. Chae-toparia with about 30 setae on each side. Dexiotorma well-developed, elongated, with pternotorma slightly developed; sclerotized plate present. Laeotorma elongate, smaller than dexiotorma, with pterotorma well-developed. Sensory cone larger than pternotorma. *Mandibles*: Left mandible (Figs. 4a, 5b) with 2 scissorial teeth anterior to scissorial notch and 1 scissorial tooth.
Figs. 2–10. *Hemisphereurus dispar*, third instar larva. 2, Frontal view of head. 3, Epipharynx. 4, Dorsal view of left mandible (a) and right mandible (b). 5, Ventral view of right mandible (a) and left mandible (b). 6, Dorsal view of labium and maxilla. 7, Dorsal view of galea and lacinia of maxilla. 8, Apical antennal segment, ventral (a) and dorsal (b). 9, Spiracles, thoracic (a) and first abdominal (b). 10, Tarsus of anterior leg showing the tarsal claw. Scale bars in mm.
posterior to notch. Stridulatory area oval. Lateral edge with 5 setae. Dorsal surface in apical half with 1 thick seta. Molar area 4-lobed; dorsomolar area with 8 setae. Acia present, apex acute. Right mandible (Figs. 4b, 5a) with 2 scissorial teeth anterior to scissorial notch and 1 poorly developed scissorial tooth posterior to notch. Dorsal surface in apical half with 1 thick seta. Lateral edge with 2 setae. Molar area trilobed. Stridulatory area oval. Maxilla (Figs. 6, 7): Galea with 1 uncus at apex and 5 thick setae at base. Lacinia with 3 unci at apex and 17 thick setae at base. Stipes with 9 stridulatory teeth, last tooth truncate. Cardo with 10–11 setae. Palpus 4-segmented. Labium (Fig. 6): Hypopharynx asymmetrical, right side with well-developed, apical, truncate process; left side with well-developed posterior process. Glossa with 36–38 setae on disc and 22 on margin. Antenna (Figs. 8a, b): Dorsal surface of last segment with 2 rounded sensory spots, ventral surface with 4 rounded sensory spots. Thorax (Fig. 1): Spiracles brownish (Figs. 9a); C-shaped respiratory plate; distance between 2 lobes of respiratory plates smaller than dorsoventral diameter of bulla; bulla spiracular, slightly prominent. Dorsum of pro-, meso- and metathorax with sparse, slender setae. Tarsal claws with 2 setae (1 near base, 1 near apex). Lateral prothoracic sclerotization evident, shape irregular, 3 times longer than wide. Abdomen (Fig. 1): Spiracles of segments similar in size (Fig. 9b); respiratory plate brownish; spiracular bulla rounded slightly prominent; spiracular slit small. Dorsum of abdominal segments 1–9 with sparse spinelike setae and scattered long, slender setae; spiracular areas lacking setae or with 1–3 setae. Raster without palidia and with teges; anal lip with 37 setae on disc and with 15 long setae on margin; teges formed by 47 setae; campus with 2 long, thin setae on each side and fine, minute setae present on mid-campus; barbula with sparse, long setae; dorsal anal lobe with spinelike, long setae; anal slit straight.

Diagnosis.—The frons lacking anterior frontal setae; the haptomeral process of the epipharynx ridgelike and truncate; the last segment of antenna with 2 dorsal sensory spots; and the inner margin of the left mandible, distad of molar area, with a short, rounded tooth (Figs. 4a, 5b) will separate Hemiphileurus dispar from H. illatus (the other known larva of the genus).

In H. illatus, the last segment of the antenna has 3–4 dorsal sensory spots and the inner margin of the left mandible, distad of molar area, has a prominent, triangular tooth.

Diagnostic characters for Hemiphileurus larvae.—Based on the two known species of the genus Hemiphileurus (H. illatus and H. dispar) the larvae of Hemiphileurus are similar to those of some species of Phileurus. Larvae of these genera share three characters: angulate margin on both sides of the labrum, absence of anterior frontal setae, and the haptomeral process entire. However, larvae of more species of both genera need to be studied before we can propose precise diagnoses.

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LITERATURE CITED


Algunas observaciones sobre su biología y clave para la identificación de las larvas de tres especies de Phileurini del Uruguay. Elytron IV: 75–81.


FULVIUS CHAGUENUS CARVALHO AND COSTA
(HETEROPTERA: MIRIDAE: CYLAPINAE: FULVIIN): REDESCRIPTION AND RECOGNITION OF TYPE SPECIMENS

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Abstract.—Fulvius chaguenus Carvalho and Costa is redescribed and its type specimens are recognized. In 1994, Carvalho and Costa revised the New World species of Fulvius Stål and included figures of the adult holotype and male genitalia of F. chaguenus and included it in their identification key from Paraguay, but inadvertently omitted the text description and type data for this species. Provided for F. chaguenus in this paper are a formal adult description, type data for the holotype and associated paratypes, figures of the adult and male genitalia, and diagnostic information to help separate it from other New World species of Fulvius.

Key Words: Insecta, Hemiptera, Heteroptera, Miridae, Cylapinae, Fulvius chaguenus, description, type data, Paraguay

Carvalho and Costa (1994) revised the New World species of Fulvius Stål, described 22 new species, and included an identification key to 42 species. They included F. chaguenus in their key and illustrated the holotype and male genitalia, but omitted the text description and type information for this new species. According to the International Code of Zoological Nomenclature (1999), every new name published after 1930 must satisfy Article 11 (must be a published name, must use the Latin alphabet and be properly derived, and must be formed using binominal nomenclature) and Article 13 (e.g., must be accompanied by a description or definition that states, in words, characters that are purported to differentiate the taxon). Carvalho and Costa (1994) satisfied these ICZN requirements and validated the name F. chaguenus. They did not, however, provide a formal description or identify type material. Since then, Kerzhner and Josifov (2001) cataloged the Palearctic fauna, and Ferreira and Henry (2002) described two new species of Fulvius from Brazil and discussed the biogeography of the Neotropical species. None of these authors noted the inadvertent omission of a description or type data for C. chaguenus Carvalho and Costa. Schuh (1995) cataloged the world Fulvius, but his literature review ended before the appearance of Carvalho and Costa’s (1994) paper.

In this paper, we redescribe F. chaguenus, illustrate the adult and male genitalia, give specimen data for the holotype and paratypes from Paraguay, and furnish in-
formation to help distinguish it from other species of *Fulvius*.

*Fulvius chaguenus* Carvalho and Costa (Figs. 1–9)

*Fulvius chaguenus* Carvalho and Costa 1994: 68.

Diagnosis.—Characterized by the large size (length greater than 4.00 mm in males), relatively short cuneus, and morphology of the male genitalia (Figs. 2–7), particularly the two fields of membranal spines on the vesica (Fig. 3).

Description.—*Male* (holotype first, followed by range; n = 3): Length 4.08 mm, 4.04–4.12 mm; width 1.32 mm, 1.32–1.40 mm. *Head*: Length 0.65 mm, 0.61–0.65 mm; width 0.62 mm, 0.62–0.64 mm; vertex 0.25 mm, 0.22–0.26 mm. *Rostrum*: Length 2.28 mm, 2.24–2.52 mm, extending to abdominal segment V. *Antenna*: Segment I, length 0.48 mm, 0.46–0.55 mm; II, 1.13 mm, 1.09–1.24 mm; III, 0.52 mm (holotype only); IV missing on all specimens. *Pronotum*: Length 0.53 mm, 0.51–0.60 mm; width at base 1.14 mm, 1.12–1.18 mm. *Cuneus*: Length 0.44 mm, 0.42 mm; width at base 0.30 mm, 0.26–0.30 mm.

General color dark brown to fuscous with pale or white areas on the corium and cuneus. Head uniformly dark brown, anterior area around lorum and tylus somewhat paler on some specimens, eyes fuscosus to black. Antennal segment I dark brown, segment II dark brown to fuscous, narrowly paler brown at base, apical fourth white; segments III and IV fuscous to black. *Pronotum* dark brown, calli prominent; mesoscutum and scutellum dark brown to reddish brown. Hemelytron dark brown, apex of clavus, a large spot on basal half of corium and on basal half to one third of cuneus white; membrane and veins uniformly smoky brown. Underside of body dark brown to fuscous. Pro- and mesoacoxa dark brown, metacoxa pale or white; femora uniformly dark brown; tibiae, tarsi, and claws paler yellowish brown.

*Genitalia*: Aedeagus (Fig. 2); vesica (Figs. 3, 4), with spiculum and two large fields of spines on the side near the secondary gonopore. Left paramere (Figs. 5, 6) thickened and dilated at apex, with a field of long setae at middle. Right paramere (Figs. 7, 8) small, simple. Phallotheca (Fig. 9) pointed apically.

*Female* (n = 1): Length 3.60 mm, width 1.16 mm. *Head*: Length 0.62 mm, width 0.57 mm, vertex 0.22 mm. *Rostrum*: Length 2.05 mm, extending to abdominal segment V. *Antenna*: Segment I, length 0.38 mm; II, 0.82 mm; III and IV missing. *Pronotum*: Length 0.46 mm, width at base 1.04 mm. *Cuneus*: Length 0.39 mm, width at base 0.25 mm. Similar to male in general shape and coloration.

Distribution.—Paraguay.

Discussion.—As a result of printer’s errors, Carvalho and Costa (1994) spelled the specific epithet two ways, once with a “g” in their key (p. 68) and once with a “q” on their plate (p. 91). We follow the first spelling in their publication and use “chaguenus” with a “g.”

Carvalho and Costa (1994) indicated that figure 80 of their plate (p. 91) represented the holotype of *F. chaguenus*. In many cases, it would be difficult or impossible to confidently recognize and associate omitted type material for a species. In the case of *F. chaguenus*, however, the holotype and three paratypes listed below were labeled by Carvalho and Costa (1994) and deposited in the collection of the [United States] National Museum of Natural History (USNM), Washington, DC. In addition, one of us (LAAC), a coauthor of the original paper and illustrator of the holotype and male genitalia, has verified the association of these specimens.

Type material.—Holotype ♀, Gran Chaco, Paraguay, 59–40 W, 22–23 N, 260 kilm west Paraguay Riv., VII-14-1935, Alberto Schulze (USNM). Paratypes: 2 ♀♀, 1 ♀, same data as for holotype, with dates ranging from 12–14 July 1935 (2 ♀♀, 1 ♀ USNM).
Acknowledgments

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DESCRIPTION OF A NEW SPECIES OF THE GENUS ERIOCAMOPSIS
TAKEUCHI (HYMENOPTERA: TENTHREDINIDAE) FROM JAPAN

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Abstract.—_Eriocampopsis hakusanus, n. sp._ from Japan is described and illustrated. It is the second species of the genus which is known only in Japan. A key is provided for the two species.

Key Words: Symphyta, Tenthredinidae, Allantinae, _Eriocampopsis_, new species, Japan

The genus _Eriocampopsis_ Takeuchi (subfamily Allantinae), with a single species, _E. subtruncata_ Takeuchi, occurs only in Japan. Recently, I captured four specimens from Mt. Hakusan, Ishikawa Prefecture, and these agree with and key to _Eriocampopsis_ in Takeuchi’s (1952) key. They differ from _E. subtruncata_, however, by the coloration of the femora and sawsheath, shape of the clypeus, and presence of an occipital carina. Therefore, I concluded that they represent a new species, and I describe and illustrate it below.

**KEY TO SPECIES**

1. Femora dirty yellow except for black apices; sawsheath black; clypeus subtruncate; occipital carina almost absent . . . . . _subtruncata_ Takeuchi

2. Femora black; apical margin of sawsheath reddish brown; clypeus shallowly emarginate (Fig. 2); occipital carina fully developed up to ocellar furrows (Fig. 1) . . . . . _hakusanus_, n. sp.

_Eriocampopsis hakusanus_ Togashi, new species

(Figs. 1–11)

Female.—Length, 6 mm. Body including antenna and legs black with following reddish brown or pale brown; apical portion of mandible and apical margin of sawsheath.

**Head:** Postocellar area transverse, convex; OOL:POL:OCL = 1.3:1.0:1.2; interalar, postocellar, and lateral furrows distinct and deep (Fig. 1); frontal area gently concave; median fovea distinct and deep, circular in outline; lateral fovea distinct and deep, circular in outline; anteno-ocular distance longer than distance between antennal sockets as 1:0:0.6; supraclypeal area gently convex; clypeus neatly flat, frontal margin shallowly emarginate (Fig. 2); labrum gently convex; malar space broad, nearly as long as diameter of front ocellus; postorbital groove present (Fig. 3); occipital carina present, fully developed up to ocellar furrows (Fig. 1). Antenna nearly as long as costa of forewing, relative length of segments about 1.5:1.0:3.5:2.7:2.7:2.7:2.2:2.0:2.7; pedicel trapezoidal (Fig. 4).

**Thorax:** Basal half of notaulus broad and deep; mesoscutellum convex; mesoscutellar appendage convex; metapostnotum sunk; cenchri large, distance between them about as long as breadth of each; mesepisternum with epicnemium. Wing venation as in Fig. 6: costa of forewing swollen apically. Legs with apex of front inner tibial spur bifurcate (Fig. 7); hind basitarsus nearly as long as following three segments combined (Fig. 9); inner hind tibial spur nearly as long as apical width of hind tibia; tarsal claws with a small tooth, without basal lobe (Fig. 8).
Abdomen: Sawsheath as in Fig. 10; cercus slightly shorter than sawsheath; lancet as in Fig. 11.

Punctuation: Vertex covered with very fine setigerous punctures, shining; lower half of inner orbits and malar space moderately punctured, spaces between punctures practically impunctate, shining; hind orbit nearly impunctate, shining; occipital carina with large and deep punctures on genal side (Fig. 3); clypeus and labrum covered with very fine setigerous punctures, shining; pronotum moderately and distinctly punctured; median and lateral lobes of mesonotum covered with very fine setigerous punctures; mesoscutellum covered with fine setigerous punctures, posterior portion with distinct, deep punctures (Fig. 5); metasternal appendage practically impunctate, shining; upper half of mesepisternum and mesepimeron reticulately sculptured; mesosternum practically impunctate, shining; abdominal tergites shagreened.

Male.—Unknown.

Food plant.—Unknown.

Distribution.—Japan (Honshu).


Remarks.—This new species is separated...
from *Eriocampopsis subtruncata*, the only other species in the genus, by the black femora (dirty yellow with apices black in *E. subtruncata*), reddish-brown apical margin of the sawsheath (black in *E. subtruncata*), the shallowly emarginate clypeus (subtruncate in *E. subtruncata*), and the presence of the occipital carina (absent in *E. subtruncata*).

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**LITERATURE CITED**

TWO NEW GENERA AND FOUR NEW SPECIES OF COLPURINI (HETEROPTERA: COREIDAE: COREINAE) FROM NEW GUINEA

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Abstract.—Halohygia, new genus, with three new species H. impensa, H. inculta, and H. tensa, and Neohalohygia, new genus, with one new species, N. parallela, from New Guinea, are described in the tribe Colpurini (Coreidae). Habitus illustrations and drawings of the male and female genitalia, head, and pronotum are included.

Key Words: Insecta, Heteroptera, Coreidae, Colpurini, new genera, new species, New Guinea

The Colpurini constitute one of the dominant elements in the coreoid fauna of the Indo-Pacific (Brailovsky 2000). The tribe is abundant and diverse, and for the most part it consists of species adapted to forest habitats although there has been radiation into many other ecological niches. These insects are usually black or dark colored and are striking in the great diversity of the male genital capsule and female genital plates (Brailovsky 1990).

Here we add two new genera and four new species. Striking features of these new genera are located on the lower third of gonocoxae I which is conspicuously projected, bladelike, and directed outward and slightly upward.

The following abbreviations are used for the institutions cited in this paper: BPBM (Bernice P. Bishop Museum, Honolulu, Hawaii); RNHL (Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands); UNAM (Instituto de Biología, Universidad Nacional Autónoma de México); ZMHB (Zoologisches Museum, Humboldt Universität, Berlin, Germany).

All measurements are given in millimeters.

Halohygia Brailovsky and Barrera, New Genus

Diagnosis.—Halohygia, like the closely related genera Ashlockhygia Brailovsky and Ortega (1994) and Kerzhnerhygia Brailovsky (1993), are the only Colpurini that have the lower third of gonocoxae I conspicuously elongated, resembling a blade (Fig. 8).

Kerzhnerhygia has the antenniferous tubercle armed with a large spine, converging or diverging anteriorly. In the other two genera the antenniferous tubercle is unarmed.

Halohygia can be defined by having the femora unarmed; the pronotal disc clearly bilobed and tapering cephalad; in lateral view with the anterior lobe distinctly lower than the posterior lobe and the calli weakly convex; and the rostrum reaching the middle third of abdominal sternite IV or V, with the apical margin of endocorium punctate. In Ashlockhygia, the femora are armed; the pronotum is not clearly bilobed; the calli are remarkably raised forming a large conical lobe, separated along the midline by a short longitudinal furrow; and the rostrum reaching the middle third of abdominal ster-
nate VI, with the apical margin of the endocorium impunctate. The body of the new genus is slender and shorter than 9.60 mm, and in Ashlockhygia robust and longer than 11.30 mm.

Generic description.—Body small to medium-sized, not depressed. Head: Longer than wide, wider than long, or as long as wide, non declivant, pentagonal, and dorsally flat; tylus apically globose and entire, extending anteriorly to and laterally higher than juga; juga unarmcd, narrowed, shorter than tylus; antenniferous tubercles, genae, mandibular plate, and head in front of eye unarmcd; antennal segment I robust, thick- est, and slightly curved outward; segments II and III cylindrical, and slender, and segment IV fusiform; segment II longest, segment IV shortest, and III subequal to I; ocelli weakly elevated, and close to eye; precocellar pit deep; eyes spherical; postocular tubercle protuberant, globose; buccula rounded, elevated, short, not extending beyond antenniferous tubercle, angulate or with tiny and blunt middle projection, and posteriorly closed; rostrum reaching anterior third of abdominal sternite IV or V.

Thorax: Pronotum wider than long, trapziform, steeply declivant, clearly bilobcd, with anterior lobe including collar shorter than posterior lobe; pronotal disc tapering cephalad with anterior lobe flattened and weakly convex; in lateral view anterior lobe distinctly lower than posterior lobe; collar wide, with posterior demarcation deeply incised by a narrow groove; anterolateral margins obliquely straight, and slightly sinuate and emarginate; posterolateral margins straight to weakly convex; posterior border straight; frontal angles slightly produced forward as small rounded expansions; humeral angles obtusely rounded, not exposed; calli weakly convex, separated along midline by short longitudinal furrow; posterior margin with distinct transverse impression; posterior lobe irregularly wrinkled; anterior lobe without wrinkles. Anterior lobe of metathoracic peritreme reniform, posterior lobe sharp, small; evapora- tive area reduced; mesosternum with a shallow, median, longitudinal furrow.

Legs: Unarmcd; tibiae cylindrical, sulcate.

Scutellum: Triangular, longer than wide or as longer than width; disc with Y-shape elevation and posteriorly with a shallow lateral depression; apex subacute, and elevated as a minute bulb.

Hemelytron: Macropterous, reaching apex or slightly beyond last abdominal segment; apical margin of endocorium punctate.

Abdomen: Connexivum higher than terga; posterior angle of each connexival segment complete, not extending on a short spine; abdominal sterna with medial longitudinal furrow, extending to posterior border of sternite IV.

Integument: Body surface rather dull, clothed with short, decumbent silvery bristlelike setae; pubescence of antenna, femora and tibiae intermixed with short and erect setae; antenna minutely granulate; posterior lobe of pronotum, scutellum, clavus, corium, ventral surface of head, thorax, abdominal sterna, and exposed parts of genital segments of both sexes strongly punctate; femora with or without small tubercles or granules along ventral and eventually dorsal surface.

Male genitalia: Genital capsule: Posteroventral edge in caudal view simple, broadly and shallowly emarginate, with lateral arms short and rounded (Fig. 3), or with posterorventral edge in caudal view with broad and open notch, with lateral arms blunt and rounded (Fig. 5), or with posteroventral edge in caudal view trilobate, with lateral arms rounded, and mesial lobe acute (Fig. 4). Paramere: Body elongate, or robust, with apical third almost straight (Figs. 9–11).

Female genitalia: Abdominal sternite VII entire, without plica or fissura. Genital plates: Gonocoxae I enlarged dorsoventrally, with lower third conspicuously projected, bladelike, and directed outward and slightly upward; in caudal view closed, in
lateral view straight; paratergite VIII short, triangular, with spiracle visible; paratergite IX squarish, larger than paratergite VIII (Fig. 8).

Etymology.—From the Latin halitus, meaning odor, fragrance, exhalation.

Type species.—Halohygia impensa Brailovsky and Barrera, new species.

**Halohygia impensa Brailovsky and Barrera, new species**

(Figs. 4, 8–9)

Description.—**Measurements:** Male first, female second: Head length 1.40, 1.38; width across eyes 1.36, 1.38; interocular space 0.74, 0.76; interocellar space 0.26, 0.28; preocular distance 0.88, 0.86; length antennal segments: I, 1.48, 1.42; II, 2.32, 2.28; III, mutilated, 1.40; IV, mutilated, 0.98. Pronotum: Total length 1.80, 2.02; maximum width across anterior lobe 1.68, 1.80; maximum width across posterior lobe 2.84, 3.32. Scutellar length 1.34, 1.44; width 1.12, 1.44. Total body length 9.18, 9.40.

Male.—**Dorsal coloration:** Head dark chestnut orange, with space between ocelli and eye, and dorsal surface of postocular tubercle dark yellow; antennal segments I to III chestnut orange, and IV pale yellow with basal joint dark chestnut orange; pronotal disc dark chestnut orange with lateral margins of collar, anterolateral margins, outer margin of humeral angles, and irregular longitudinal stripe above humeral angles yellow; scutellum dark chestnut orange with apex yellow; clavus and corium dark chestnut orange, with costal margin yellow; hemelytral membrane dark amarine with veins brown; connexivum dark reddish brown with posterior margin yellow; dorsal abdominal segments bright orange with posterior margin of segment VII brown.

**Ventral coloration:** Head dark chestnut orange with anterior margin of buccula dark yellow; rostral segments I to IV pale chestnut orange with yellow reflections; thorax dark chestnut orange with inner margin of acetabulae, and irregular marks on propleural, mesopleural, and metapleural yellow; anterior lobe of metathoracic peritreme pale yellow, and posterior lobe chestnut orange; coxae and trochanters dark chestnut orange; femora and tibiae dark chestnut orange with two yellow rings, one subbasal, other near middle third; tarsi dark chestnut orange with yellow reflections; abdominal sterna ochre yellow with punctures chestnut orange; genital capsule dark reddish brown.

Rostrum reaching anterior third of abdominal sternite IV. Genital capsule: Posteroventral edge in caudal view trilobate, with lateral arms rounded and mesial lobe acute (Fig. 4). Paramere: Body robust with apical third straight (Fig. 9).

Female.—Similar to male. Connexival segments VIII and IX pale chestnut orange with posterior margin yellow; dorsal abdominal segments VIII and IX dark chestnut brown; genital plates ochre yellow with punctures chestnut orange. Rostrum reaching posterior margin of abdominal sternite IV. Genital capsule: Fig. 8.


Etymology.—From the Latin impensus, for large, referring to the size of the insect.

**Halohygia inculata Brailovsky and Barrera, new species**

(Figs. 3, 11)

Description.—**Measurements:** Male: Head length 1.22; width across eyes 1.28; interocular space 0.72; interocellar space 0.26; preocular distance 0.78; length antennal segments: I, 1.28; II, 2.04; III, 1.20; IV, 0.92. Pronotum: Total length 1.68; maxi-
mum width across anterior lobe 1.56; maximum width across posterior lobe 2.80. Scutellar length 1.28; width 1.24. Total body length 8.20.

Male.—**Dorsal coloration:** Head chestnut orange with dorsal surface of postocular tubercle yellow; antennal segments I to III ochre yellow with orange reflections, and IV pale yellow with basal joint dark brown; pronotal disc chestnut orange with lateral margins of humeral angles and irregular transverse fascia above humeral angles dirty yellow; scutellum chestnut orange with apex yellow; clavus and corium chestnut orange; hemelytral membrane dark brown; connexivum dark reddish brown with posterior margin yellow; dorsal abdominal segments bright orange with posterior margin of VII dark brown. **Ventral coloration:** Head chestnut orange with anterior margin of buccula yellow; rostral segments I to IV, mesosternum and metasternum pale chestnut orange; propleuron, mesopleuron, and metapleuron dirty yellow with punctures bright chestnut orange; anterior lobe of metathoracic peritreme dirty yellow, and posterior lobe chestnut orange; coxae, trochanters, and fore and middle femora pale orange yellow; hind femur and tibiae dark chestnut, with two yellow rings, one subbasal, other near middle third; tarsi yellow, with orange reflections; abdominal sterna bright chestnut orange with yellow marks irregularly distributed; pleural margin bright orange, with posterior margin yellow; genital capsule dark reddish brown.

Rostrum reaching anterior third of abdominal sternite V. Genital capsule; Posteroventral edge in caudal view simple, broadly and shallowly emarginate, with lateral arms short and rounded (Fig. 3). Paramere: Elongate with apical third slightly straight (Fig. 11).

Female.—Unknown.

Type material.—Holotype: ♀, Dutch New Guinea, Lager, 1050 m, (Augustafl Exp.), August 1912, S. G. Burgers (ZMHB).

Etymology.—From the Latin *incultus*, for uncultivated, referring to the relatively undistinguished nature of the species.

**Halodygia tensa** Brailovsky and Barrera, new species
(Figs. 5, 10, 13)

Description.—**Measurements:** Male: Head length 1.36; width across eyes 1.32; interocular space 0.72; interocellar space 0.24; preocular distance 0.78; length antennal segments: I, 1.28; II, 2.04; III, 1.32; IV, 1.00. Pronotum: Total length 1.72; maximum width across anterior lobe 1.64; maximum width across posterior lobe 2.76. Scutellar length 1.38; width 1.28. Total body length 8.30.

Male.—**Dorsal coloration:** Head chestnut orange with antenniferous tubercle, space between ocelli and eye, and dorsal surface of postocular tubercle yellow; antennal segment I ochre yellow with orange reflections, II and III dark orange, and IV pale yellow with basal joint dark orange; pronotal disc chestnut orange, with anterolateral margins, lateral margin of humeral angles, and irregular transverse fascia above humeral angles dirty yellow; scutellum chestnut orange with apex yellow; clavus and corium pale chestnut orange with punctures dark reddish brown; hemelytral membrane dark brown; connexivum dark reddish brown with posterior margin yellow; dorsal abdominal segments bright orange with posterior third of VII dark orange brown. **Ventral coloration:** Head dark chestnut orange, with anterior margin of buccula yellow; rostral segments I to IV dirty yellow with pale brown reflections; mesosternum and metasternum chestnut orange; propleuron, mesopleuron, and metapleuron dirty yellow with punctures bright pale chestnut orange; anterior lobe of metathoracic peritreme dirty yellow, and posterior lobe chestnut orange; coxae and trochanters pale bright orange yellow; fore and middle femora pale bright orange yellow with two yellow rings, one subbasal, other near middle third; hind femur and tibia dark chestnut orange with two yellow rings, one
subbasal, other one near middle third; tarsi ochre yellow with orange reflections; abdominal sternum ochre yellow with punctures pale chestnut orange; pleural margins dark orange brown with posterior margin yellow; genital capsule dark chestnut orange.

Rostrum reaching anterior third of abdominal sternite V. Genital capsule: Poster-oventral edge in caudal view with broad, and open notch, with lateral arms blunt and rounded (Fig. 5). Paramere: Elongate, with apical third slightly curved (Fig. 10).

Female.—Unknown.

Type material.—Holotype: ♂. Dutch
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New

Guinea, Lordberg, 1000 m, (Kais Augustafl Exp.), 29-30 November 1912, S. G.

Burgers (ZMHB).
Etymology. From the Latin tensus, for
stretched or extended, referring to the relatively narrow general shape of the insect.

—

Key TO
1

Species of Halohygia

Posteroventral edge of male genital capsule in

caudal view trilobate, with lateral arms round-

and mesial lobe acute (Fig. 4); paramere
with body robust and short (Fig. 9)
impensa Brailovsky and Barrera, new species
Posteroventral edge of male genital capsule in
ed,

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cally globose

and

entire,

flat;

tylus api-

extending anteri-

orly to and laterally higher than juga; juga

unarmed, narrowed, shorter than tylus; antenniferous tubercle, genae, mandibular
plate, and head in front of eye unarmed;
antennal segment I robust, thickest, and
slightly curved outward; segments II and III
cylindrical, slender, and segment IV fusiform; antennal segment II longest. III shortest, and IV longer than I; ocelli weakly elevated and close to eye; preocellar pit deep;

.

caudal view bilobate (Figs.

3,

5);

eyes spherical; postocular tubercle protuberant, globose; buccula rounded, elevated,

paramere

with body elongate and slender (Figs. 10-11)

beyond antenniferous
angulate, without teeth, and pos-

short, not extending
2

2.

non-declivant, and dorsally

tubercle,

Posteroventral edge of male genital capsule in

caudal view with broad and open notch, lateral

arms blunt and rounded (Fig. 5); paramere with
....
apical third slightly curved (Fig. 10)
tensa Brailovsky and Barrera, new species
— Posteroventral edge of male genital capsule in
caudal view simple, shallowly emarginate, lateral arms expanded and rounded (Fig. 3); paramere with apical third straight (Fig. 11) ...
.... inculta Brailovsky and Barrera, new species

rostrum reaching middle

teriorly

closed;

third of

abdominal

sternite IV.

Thorax: Pronotum wider than long,

tra-

peziform, steeply declivant, clearly bilobed,

with anterior lobe including collar shorter
than posterior lobe; pronotal disc tapering

cephalad with anterior lobe flattened and
convex, and

in lateral

view

distinctly

lower

than posterior lobe; collar wide, with pos-

demarcation deeply incised by a narrow groove; frontal and humeral angles obtusely rounded, and not exposed; anterolatterior

Neohalohygia Brailovsky and Barrera

New Genus
Diagnosis.
Neohalohygia resembles
Halohygia with the head dorsally flat, tylus
apically globose and entire; interocellar
space shorter than 0.35 mm; lower third of
gonocoxae I conspicuously elongate and
projected, blade-shaped (Figs. 6-7); antenniferous tubercle unarmed; pronotal disc
clearly bilobed and tapering cephalad; in
lateral view with anterior lobe distinctly
lower than posterior lobe; body shorter than
9.60
and clothed with short decumbent
silvery bristlelike setae; and postocular tubercle protuberant. In Neohalohygia, antennal segment III is the shortest, and IV longer than I, with the femora ventrally armed.
In Halohygia, antennal segment IV is the
shortest, and III subequal to I, with the femora unarmed.
Generic description.
Body small to medium sized, not depressed. Head: Longer
than wide or as long as wide, pentagonal.

mm

—

eral borders obliquely straight, slightly sin-

and emarginate; posterolateral borders
weakly convex; posterior border straight;
calli raised above pronotal disc, convex,
hemispheric, separated along midline by a
deep and short longitudinal furrow; posterior margin with distinct transverse impression; each lobe without wrinkles. Anterior
uate,

lobe of metathoracic peritreme reniform,
posterior lobe sharp, small; evaporative area

reduced; mesosternum with shallow median
longitudinal furrow.

Legs.

— Male:

late; distal third

Femora

ventrally tubercu-

of middle femur with two

rows of short and blunt ventral spines; hind
femur distally raised with two compact
rows of medium-sized ventral spines, separated by a short longitudinal furrow. Female: Fore and middle femora ventrally tuberculate; hind femur similar to male.
Scutellum: Triangular, longer than wide;


Fig. 13. Dorsal view of Halohygia tensa, male.
disc with Y-shaped elevation and posteriorly with shallow lateral depression; apex subacute and elevated as a minute bulb.

_Hemelytron:_ Macropteroptus, extending beyond last abdominal segment.

_Abdomen:_ Connexivum higher than terga; posterior angle of each connexival segment complete, not extending on a short spine; abdominal sterna with deep medial longitudinal furrow extending to anterior margin of sternite VI.

_Integument:_ Body surface clothed with short, decumbent silvery bristlelike setae; dorsally rather dull, and ventrally shining; pubescence of antenna, femora and tibiae intermixed short and erect setae; antenna minutely granulate; posterior lobe of pronotum, scutellum, clavus, corium, ventral surface of head, thorax, abdominal sterna, and exposed parts of genital segments of both sexes strongly punctate; femora with small granules or tubercles along ventral and dorsal surface.

**Male genitalia:** Genital capsule: Posteroventral edge with pronounced U-shaped concavity, scarcely deep, and enclosed by two short, robust, subacute arms (Figs. 1–2).

**Female genitalia:** Abdominal sternite VII entire, without plica or fissura. Genital plates: Gonocoxae I enlarged dorsoventrally, with lower third conspicuously projected, bladelike, and directed outward and slightly upward; in caudal view closed, in lateral view straight; paratergite VIII short, triangular, with spiracle visible; paratergite IX squarish, larger than paratergite VIII (Figs. 6–7).

_Etymology._—Named for its similarity to the genus Halohygia.

_Type species._—_Neohalohygia parallela_ Brailovsky and Barrera, new species.

**Neohalohygia parallela** Brailovsky and Barrera, new species
(Figs. 1–2, 6–7, 12)

_Description._—_Measurements:_ Male first, then female: Head length 1.24, 1.30; width across eyes 1.24, 1.28; interocular space 0.62, 0.72; intercellar space 0.22, 0.30; precocular distance 0.76, 0.86; length antennal segments: I, 1.00, 0.98; II, 1.44, 1.48; III, 0.74, 0.78; IV, 1.04, 1.08. Pronotum: Total length 1.62, 1.88; maximum width across anterior lobe 1.60, 1.80; maximum width across posterior lobe 2.80, 3.16. Scutellar length 1.28, 1.48; width 1.20, 1.40. Total body length 7.58, 8.55.

**Male.—Dorsal coloration:_** Head chestnut orange, with dorsal surface of postocular tubercle yellow; antennal segments I to III ochre yellow with orange reflections, and IV orange with a subdistal yellow ring; pronotal disc chestnut orange with anterolateral margins and irregular transverse fascia above humeral angles light yellow; scutellum chestnut orange with apex yellow; clavus and corium chestnut orange with costal margin yellow; hemelytra membrane pale brown; connexivum dark orange brown with apical margin yellow; dorsal abdominal segments II to VI bright orange and VII bright orange with apical third dark orange brown. **Ventral coloration:_** Head bright chestnut orange with area adjacent to eyes yellow; rostral segments I to IV ochre yellow with chestnut reflections; thorax bright chestnut orange with yellow marks at middle third of propleuron, mesopleuron, and metapleuron; anterior and posterior lobe of metathoracic peritreme bright chestnut orange; coxae and trochanter bright chestnut orange; femora and tibiae bright chestnut orange with two yellow rings one subbasal, other near middle third; tarsi yellow with orange reflections; abdominal sternum bright chestnut orange with irregular and scattered yellow marks; pleural margin bright chestnut orange with posterior margin yellow; genital capsule bright chestnut orange.

_Female._—Similar to male. Connexival segments VIII and IX bright orange with posterior margin yellow; dorsal abdominal segments VIII and IX bright orange; genital plates bright chestnut orange with upper margin of paratergite VIII and IX yellow.

_Type material._—Holotype: ♂, Dutch

Etymology.—From the Latin parallelus, referring to the nearly parallel sides of the body.

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LITERATURE CITED


A NEW SPECIES OF GNAMPTOGENYS ROGER OF THE SULCATA GROUP (HYMENOPTERA: FORMICIDAE) FROM BOLIVIA

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Abstract.—Gnamptogenys flava, n. sp., was discovered in litter extractions from a montane evergreen forest in Bolivia. It is a yellow species of the sulcata group. The description of the species is included, as well as a modification of the previous key to the species and a discussion of characters that separate it from the other species in the sulcata group.

Resumen.—Gnamptogenys flava, n. sp., fue descubierta en extracciones de hojarasca en un bosque montañoso de Bolivia. Es una especie amarilla del grupo sulcata. Se presenta la descripción de la especie, como también la modificación de la clave previa para identificación de las especies, y una discusión de los caracteres que la separan de otras especies del grupo sulcata.

Key Words: sulcata group, montane evergreen forest, litter extraction, Bolivia

Gnamptogenys Roger is a genus of predaceous, mostly Neotropical ants usually easily recognized by their costulate sculpture. The genus was revised recently by Lattke (1990, 1991, 1994, 1995, 2002). A recent extraction of litter from the State of Cochabamba, Bolivia, yielded a new, yellow, moderately hairy species. Its mandibles are subtriangular, the anterior margin of the clypeus is nearly straight with angular lateral corners, the promesonotal and metonotal sutures are developed poorly, and the sculpture of the body is completely longitudinally costulate.

METHODS AND MATERIALS

Measurements were made with a micrometer in a Wild stereoscope. The abbreviations follow Lattke (1990), with the addition of eye width.

HL Head Length: measured in full face dorsal view, from the anterior clypeal margin to the posterior margin of the head.

ML Mandibular Length: measured in the same plane as HL, from the anterior clypeal margin to the apices of the mandibles.

SL Scape Length: length of first antennal segment, excluding basal condyle.

ED Eye Diameter: measured along long axis in lateral view.

EW Eye Width: measured along short axis in lateral view.

HW Head Width: maximum width of head, excluding eyes, measured in full face dorsal view.

WL Weber’s Length of the mesosoma: diagonal length from the anterior, dorsal margin of the pronotum to the posterior margin of the metapleural lobe.

CI Cephalic Index: HW/HL × 100.
MI  Mandibular Index: ML/HW × 100.
SI  Scape Index: SL/HW × 100.
OI  Ocular Index: ED/HW × 100.
SSC Scape Setal Count: the number of standing hairs (not pubescence) visible in outline on the scape, in lateral view.

RESULTS AND DISCUSSION

_Gnamptogenys flava_ Pacheco, Mackay, and Morgan, new species
(Figs. 1–6)

Diagnosis.—The mandibles are subtriangular with abundant hairs, especially on the apices. the anterior margin of the clypeus is nearly straight with 6 erect hairs. The promesonotal and metesonotal sutures are poorly developed when viewed from above, and the sculpture of the body is completely longitudinally costulate, including the head, mesosoma, petiole, and dorsum of the gaster. The dorsal surface of the scape and mandibles are smooth and polished. The node of the petiole is low, and the anterior peduncle is short. The costulae on the posterior face of the propodeum are longitudinal and on the posterior face of the petiole are horizontal. The dorsum of the postpetiole (first tergite of the gaster) has longitudinal costulae, with the ventral and medial surface smooth and glossy.

Description.—HL 1.34, ML 0.69, HW 1.10, SL 1.14, ED 0.36, EW 0.27, WL 1.87; Indices: CI 82, SI 104, OI 75.

Mandibles subtriangular, when closed probably cross at midlength; anterior border of clypeus nearly straight, sharply angulate at lateral corners; frontal carinae covering most of antennal insertion; eyes large, with approximately 140 ommatidia, eyes extend 0.01 mm past sides of head; scape extends 0.40 mm past postero-lateral corner; promesonotal and metesonotal sutures poorly developed and do not break sculpture of longitudinal costulae as seen from above; metacoxal spine present, acute, length 0.30 mm; anterior face of petiole sloping posteriorly, meeting posterior face at angle and not overhanging vertical, posterior face; subpetiolar process angulate anteriorly and posteriorly.

Surfaces of clypeus, head, mesosoma, petiole, and gaster, including lateral surface of dorsum of postpetiole, longitudinally costulate; mandible, scape and medial surface of sternum of postpetiole smooth and polished.

Moderately hairy; mandible with several suberect hairs, especially at apices; 6 erect hairs on anterior border of clypeus, with several suberect hairs, few suberect hairs on dorsum of clypeus; few suberect hairs present on head; several suberect hairs on scape, with 3–6 longer, erect hairs on scape; 12 erect hairs on mesosoma; 5 erect hairs on petiole; gaster abundantly hairy, especially apex.

Female and male.—Unknown.


Etymology.—Latin from _flavus_ meaning yellow, referring to body color.

Distribution.—Known only from the type locality in Bolivia.

Discussion.—The single, concolorous yellow specimen was discovered in montane evergreen forest from litter extractions in Cochabamba, Bolivia. It is a member of the _sulcata_ group, the _sulcata_ subgroup, and the _sulcata_ species complex (= _tornata_ complex in Lattke 1995: 145) all as defined by Lattke (1995).

Lattke’s key to the New World species (1995) can be modified as follows to accommodate this new species:

50(49). Petiolar node with posterior pointed projection; posterior propodeal face with longitudinal costulae; body color uniformly brown; tropical South America

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_.. acuminata_ (Emery)

Node sometimes with slight posterior projection, but never pointed; posterior propodeal face with transverse costulae.

*rarely longitudinal*; color variable, usually with brown and ferruginous areas, rarely totally brown or yellow; México to tropical South America ........ 50a

50a(50). Metacoxal tooth vestigial or absent; propodeum without any evidence of spines or angles; usually a darker brown; México to tropical South America ........ *sulcata* (Smith)

Metacoxal tooth present; propodeum with small, epaulet angles; yellow; Bolivia ......................... *flava*, n. sp.

*Gnamptogenys flava* can be separated from *G. fernandezi* Lattke (*fernandezi* complex of the *sulcata* subgroup), by the nearly straight anterior border of the clypeus, which is convex and somewhat pointed in *G. fernandezi*. The mandibles of *G. flava* are subtriangular and do not meet along the masticatory border; they are triangular and meet along the entire masticatory border in *G. fernandezi*. 
It can be separated from members of the *sulcata* species complex by the presence of a well-developed metacoxal tooth, as well as angles on the propodeum (both lacking in *G. sulcata*) and yellow color (dark brown in *G. sulcata*). The distributions of the two species overlap. It differs from the Colombian species *G. curvoclypeata* Lattke by the nearly straight anterior border of the clypeus, which is medially convex and laterally concave in *G. curvoclypeata*. It can be separated from the northern South American *G. acuminata* Emery by the petiolar node which is acutely pointed at its apex in *G. acuminata*, and by the metacoxal spine, which is lacking in *G. acuminata*. Also, *G. flava* can be separated from the northern South American *G. tortuolosa* Smith by the longitudinal costulate on the posterior face of the propodeum (transverse in *G. tortuolosa*), the presence of angles on the propodeum (absent in *G. tortuolosa*), and the posterior angle of the apex of the petiole not overhanging the vertical posterior faces (strongly overhanging the vertical, posterior face in *G. tortuolosa*).

**Acknowledgments**

We thank Robert Anderson for the gift of the specimen, as well as for hundreds of other specimens of *Gnamptogenys*. Gary Alpert and Stefan Cover assisted in our visit to the Museum of Comparative Zoology, Harvard University, to compare this specimen with specimens of other species of *Gnamptogenys*. The research was supported by the Ernst Mayr Fund of the Museum of Comparative Zoology, and publication of the paper was funded by The National Institutes of Health. Grant # 5 G12RR08124.

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Commonly Intercepted Thrips (Thysanoptera) from Europe, the Mediterranean, and Africa at U.S. Ports-of-Entry. Part II. Frankliniella Karny and Iridothrips Priesner (Thripidae)

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Abstract.—A total of 130 species of thrips occurring in Africa, Europe, and the Mediterranean region were intercepted by U.S. agricultural quarantine officers in shipments of plants and cut flowers at the various ports-of-entry in the United States from 1983 to 1999. Of these, four species of Frankliniella (F. occidentalis Pergande, F. intonsa Trybom, F. schultzei (Trybom), and F. tenuicornis (Uzel) rank within the top ten most frequently encountered species over this time period. This paper is Part II of a guide to the identification of thrips coming into this country from those regions; it uses keys, line drawings, and scanning electron micrographs to identify the commonly intercepted species of the genera Frankliniella (with 9 species from that region) and Iridothrips (with 2 species)—both of which are characterized by the presence of ctenidia located anteriad of abdominal spiracle VIII. It is designed primarily to aid the identification capabilities of the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (USDA, APHIS) identifiers at U.S. ports-of-entry, but those interested in thrips in general will also benefit from this information.

Key Words: Thrips, pests of flowers, Europe, Africa

This paper is the second of a series intended to facilitate identification of thrips species commonly intercepted at U.S. ports on a wide range of agricultural commodities from Africa, Europe, and the Mediterranean region. It lists the most commonly encountered species of Frankliniella Priesner, 1940 and Iridothrips Karny, 1910, and presents identification keys to the relevant species. Frankliniella and Iridothrips are characterized by having ctenidia anteriad of abdominal spiracle VIII. They are similar to Baliothrips Uzel, 1895, Isochaetothrips Moulton, 1928, Microcephalothrips Bagnall, 1926, and Thrips Linnaeus, 1758. These genera differ by having ctenidia on abdominal tergite VIII located posteriad of abdominal spiracle VIII.

Frankliniella is the second largest genus of thripine Thysanoptera, with 151 New World and 7 Palearctic species (Nakahara 1997). They include major agricultural pests, and several species are vectors of various tospoviruses (Wijkamp et al. 1995). Since most species feed on pollens, they are often intercepted at U.S. ports-of-entry in a wide variety of flowers. Although Iridothrips was synonymized as an aberrant form of Frankliniella by Mound et al. (1976), it was reinstated as a valid genus by Chaisson (1986), with two species—*I. iridis* (Watson, 1924) and *I. mariae* Pelikán, 1961. Both of these species have simple sense cones on antennal segment III.

This paper is based on the adult female.
Males seldom are encountered by port inspectors; nevertheless, the male apical abdominal segments of *F. occidentalis* Pergande, 1895 are figured for the purpose of comparison (Figs. 21–22). Immature stages (Fig. 24) are not treated, since a useful key to second-instar larvae of *F. occidentalis*, *F. fusca* (Hinds, 1902), *F. nigriventris* (Uzel, 1895), *F. tenuicornis* (Uzel, 1895), *F. schultzei* (Trybom, 1910), *F. intonsa* (Trybom, 1895), and *F. pallida* (Uzel, 1895) occurring in Europe has been published (Nakahara and Vierbergen 1998).

**MATERIALS AND METHODS**

The same databases utilized by Nickle (2003) were used in this paper to provide information on the frequency of interceptions, host information, and geographic origin of the species covered. The first database contained a total of 2,437 interceptions, while the second database yielded a total of 497 specimens, providing a broad basis upon which to generalize.

Specimens used in scanning electron micrographs were obtained from recent incoming material for urgent identifications. Some of the specimens were cleared and slide mounted in Hoyer’s for preliminary identifications, then removed from the slides, placed in 80% ethanol for later preparation for scanning electron micrographs (SEMs). Specimens to be prepared for SEMs were transferred overnight into 100% ethanol. They were then critical point dried, using a Samway® critical point dryer. Dried specimens were glued to SEM stubs and photomicrographed in an Amray 1810® scanning electron microscope. The images were digitally captured and transferred to Adobe Photoshop 5.5® for Macintosh, where they were edited for publication.

Line drawing figures of specimens were rendered from images observed through a camera lucida attached to a Zeiss Axioskop 2® microscope, using both transmitted light and phase-contrast modes and modified using various methods with Adobe Photosh-

op. Morphological features are those described by Mound and Nakahara (1993).

**RESULTS**

Of 159 species of *Frankliniella* (Nakahara 1997), only ten species occur in Europe, Africa, and the Mediterranean region, and of these only four are regularly intercepted at U.S. ports-of-entry. Since *Frankliniella nigriventris* (from eastern Europe) and *F. tristis* (found in turf in Austria, Estonia, and the Ukraine) have never been intercepted in any shipments from the region and are rare, even in museum collections, they are not covered in this paper. Two species of *Iridothrips* have been described: both are found in Europe (Jacot-Guillarmod 1974), but only one (*I. iridis*) is sporadically intercepted. *Iridothrips mariae* has never been intercepted; it is covered in this paper only briefly, in the unlikely event that it too may be intercepted in future shipments from Europe. The following is a list of *Iridothrips* and *Frankliniella* species known to occur in Europe, Africa, and the Mediterranean region. Their distributions and frequency of interceptions at ports-of-entry between 1983 and 1999 are indicated in Table 1.

*Iridothrips* Karny, 1910

*iridis* (Watson, 1924)
*mariae* Pelikan, 1961 [No interceptions between 1983 and 1999]

*Frankliniella* Priesner, 1940

*boringuen* Hood, 1942
*fusca* Hinds, 1902
*intonsa* (Trybom, 1895)
*nigriventris* (Uzel, 1895) [No interceptions in this time period but may show up in future]
*occidentalis* (Pergande, 1895)
*pallida* (Uzel, 1895)
*schultzei* (Trybom, 1910)
*tenuicornis* (Uzel, 1895)
*tristis* Priesner, 1920 [No interceptions in this time period but may show up in future]
Table 1. Species of thrips intercepted at ports-of-entry (numbers represent accumulated interceptions over the period 1983–1993). Ranges of species in Europe, Africa, and the Mediterranean region are indicated with an "x". Establishment or occurrence of any of these species in the United States and South America also is indicated by an "x". Species not intercepted during this time period are indicated with "y".

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Frankliniella Karny, 1910</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>boricauen Hood, 1900</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>fisca (Hinds, 1902)</td>
<td>7</td>
<td>Neth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gossypiana Hood, 1900</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>intonsa (Trybom, 1895)</td>
<td>94</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>uigriveniris (Uzel, 1895)</td>
<td>y</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>occidentalis (Pergande, 1895)</td>
<td>448</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>pallida (Uzel, 1895)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>panamensis Hood, 1900</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>schulzei (Trybom, 1910)</td>
<td>55</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>tenuicornis (Uzel, 1895)</td>
<td>136</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>tristis Priesner, 1920</td>
<td>y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>triici (Fitch, 1855)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>undetermined species</td>
<td>72</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iridothrips Priesner, 1940</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iridis (Watson, 1924)</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>mariae Pelikán, 1961</td>
<td>y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

The 1983–99 database (see Table 1, Nickle 2003) was evaluated to determine the ranges of Frankliniella and Iridothrips species intercepted from Africa, the Mediterranean, and Europe. Since 1983, ten species of Frankliniella and one species of Iridothrips were intercepted from shipments arriving from Europe, Africa, and the Mediterranean. Three of the Frankliniella species—F. panamensis Hood (n = 2) (Figs. 4, 10, 16), F. tritici (Fitch) (n = 4), and F. gossypiana Hood (n = 1)—are Nearctic or Neotropical species and apparently do not occur in Africa, Europe, or the Mediterranean region but were among those intercepted from Europe. Frankliniella gossypiana almost certainly was not among shipments from Europe when it was intercepted at a single U.S. port within its homeland range, but F. panamensis and F. tritici are more likely to have been transported by commerce into the above foreign regions. These latter two species are included in the following key because they may again be encountered in future samples from these regions at U.S. ports-of-entry. Another Neotropical species—F. boricauen (n = 2)—is apparently now established in Kenya (Vierbergen 1995); it is also included in the key.

Of the 751 records of Frankliniella identifiable to described species in the 1983–1993 database, 59.6% of the interceptions were attributed to F. occidentalis (n = 448), with smaller percentages attributed to F. intonsa (n = 94, or 12.5%), F. schulzei (n = 55 or 7.3%), and F. tenuicornis (n = 136 or 18.1%). The 1994–1999 database shows trends of interceptions of thrips from this region, and four species of Frankliniella rank within the top 10 species intercepted (Table 2). Iridothrips iridis was intercepted only twice between 1983 and 1999 but was intercepted more frequently in previous years. Iridothrips mariae to date has not been encountered in any interceptions arriving from Europe and may actually belong to a different genus (S. Nakahara, personal communication, 2002), but it is presented in the key and figured in the event that in
Table 2. Most frequently intercepted thrips from Europe, Africa, and the Mediterranean region at U.S. ports-of-entry, 1994–1999, based on a database of 497 identified specimens. Species were ranked from most frequently intercepted to species represented by more than unique specimens.

<table>
<thead>
<tr>
<th>Species</th>
<th>Rank</th>
<th>Number of Interceptions</th>
<th>% of Total (n = 497)</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrips tabaci</td>
<td>1</td>
<td>81</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Frankliniella occidentalis</td>
<td>2</td>
<td>59</td>
<td>14.6</td>
<td>34.6</td>
</tr>
<tr>
<td>Thrips fuscipennis</td>
<td>3</td>
<td>41</td>
<td>10.1</td>
<td>44.7</td>
</tr>
<tr>
<td>Thrips major</td>
<td>4</td>
<td>32</td>
<td>7.9</td>
<td>52.6</td>
</tr>
<tr>
<td>Thrips vulgatissimus</td>
<td>5</td>
<td>22</td>
<td>5.4</td>
<td>58.0</td>
</tr>
<tr>
<td>Odontothrips karwayi</td>
<td>6</td>
<td>18</td>
<td>4.5</td>
<td>62.2</td>
</tr>
<tr>
<td>Frankliniella intonsa</td>
<td>7</td>
<td>15</td>
<td>3.7</td>
<td>65.9</td>
</tr>
<tr>
<td>Haplothrips gowdeyi</td>
<td>8</td>
<td>11</td>
<td>2.7</td>
<td>68.6</td>
</tr>
<tr>
<td>Frankliniella tenunicornis</td>
<td>9</td>
<td>10</td>
<td>2.4</td>
<td>71.0</td>
</tr>
<tr>
<td>Frankliniella schulzei</td>
<td>10</td>
<td>7</td>
<td>1.7</td>
<td>72.7</td>
</tr>
<tr>
<td>Frankliniella fuscata</td>
<td>10</td>
<td>7</td>
<td>1.7</td>
<td>75.4</td>
</tr>
<tr>
<td>Melanthrips fuscus</td>
<td>11</td>
<td>6</td>
<td>1.4</td>
<td>76.8</td>
</tr>
<tr>
<td>Thrips meridionalis</td>
<td>12</td>
<td>5</td>
<td>1.2</td>
<td>77.5</td>
</tr>
<tr>
<td>Thrips flavus</td>
<td>12</td>
<td>5</td>
<td>1.2</td>
<td>78.7</td>
</tr>
<tr>
<td>Linothrips cerealum</td>
<td>12</td>
<td>5</td>
<td>1.2</td>
<td>79.9</td>
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<tr>
<td>Thrips atratus</td>
<td>13</td>
<td>4</td>
<td>0.9</td>
<td>80.8</td>
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<tr>
<td>Haplothrips nigricornis</td>
<td>13</td>
<td>4</td>
<td>0.9</td>
<td>81.7</td>
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<tr>
<td>Aeolothrips collari</td>
<td>14</td>
<td>3</td>
<td>0.7</td>
<td>82.4</td>
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<tr>
<td>Thrips simplex</td>
<td>14</td>
<td>3</td>
<td>0.7</td>
<td>83.1</td>
</tr>
<tr>
<td>Thrips nigropilosus</td>
<td>15</td>
<td>2</td>
<td>0.5</td>
<td>83.6</td>
</tr>
<tr>
<td>Neohydatothrips samayukar</td>
<td>15</td>
<td>2</td>
<td>0.5</td>
<td>84.1</td>
</tr>
<tr>
<td>Linothrips denticornis</td>
<td>15</td>
<td>2</td>
<td>0.5</td>
<td>84.6</td>
</tr>
<tr>
<td>Aeolothrips deserticola</td>
<td>15</td>
<td>2</td>
<td>0.5</td>
<td>85.1</td>
</tr>
<tr>
<td>Thrips australis</td>
<td>15</td>
<td>2</td>
<td>0.5</td>
<td>85.6</td>
</tr>
<tr>
<td>Dendrothrips ornatus</td>
<td>15</td>
<td>2</td>
<td>0.5</td>
<td>86.1</td>
</tr>
<tr>
<td>All other interceptions</td>
<td>—</td>
<td>56</td>
<td>13.9</td>
<td>100.0</td>
</tr>
</tbody>
</table>

the future it may be intercepted from Europe at U.S. ports.

KEY TO SPECIES OF IRIDOThrips AND Frankliniella INTERCEPTED FROM EUROPE/AFRICA/MEDITERRANEAN

1. Antennal segments III–IV with simple sense cones (only rarely with weakly forked cones) (Fig. 23) (Iridothrips species) ..........................2
   Antennal segments III–IV with well-developed furcate sense cones (see Fig. 30) (Frankliniella species) ..........................3

2. Sides of head behind eyes parallel; ocellar setae III lateral of anterior ocelli (Fig. 28); posterior margin of tergite VIII with a complete row of small microtrichia (Fig. 27); intercoxal process of metasternum apically conical .................. I. mariae
   Sides of head behind eyes convergent; ocellar setae III located midway between anterior and posterior ocelli (Fig. 29); posterior margin of tergite VIII with a complete row of small microtrichia (Fig. 27); intercoxal process of metasternum apically truncate ..................... I. iridis

3 Brachypterous or aperous .......... 4
   Macropterous .......................... 5

4 Metanotum weakly reticulated with sculpture lines transversely oriented (Fig. 7); median pair of setae positioned in lateral ½ of metanotum; metanotum normally without canamiform sensilla; comb of microtrichia on posterior margin of tergite VIII interrupted medially .................. F. fusca (in part)
   Metanotum reticulated in medial ½ only, with lateral sculpture lines longitudinally converging; median pair of setae positioned in medial ½ of metanotum; metanotum with 2 canamiform sensilla; comb of microtrichia on posterior margin of tergite VIII entire ..................... F. nigripennis

5 Head prolonged anterior to eyes (Fig. 6) .......................... 6
   Head not prolonged anterior to eyes .......................... 7

6 Head weakly prolonged anterior to eyes; all antennal segments brown or nearly so; meta-
notum medially reticulated, with reticulations subquadrate .

- Pedicel of antennal segment III without distinct dilation (Fig. 30); All antennal segments brown .

F. fusca (in part)

Frankliniella Karny, 1910

Diagnosis.—Head usually wider than long; antenna normally 8-segmented, rarely 7-segmented; antennal segments III and IV each with forked sense cones; 3 ocelli present; 3 pairs of ocellar setae, with intercellar setae usually well developed and usually located midway between anterior and posterior ocelli; postocular seta IV variable in length; maxillary palpi 3-segmented; pronotum with one pair of anteroangular, one pair of anteromedial, and two pairs of posteroangular long setae, with usually 5 pairs of postermarginal setae of various lengths with second pair longest; forewings usually macropterous with two complete rows of venal setae regularly distributed, or brachypterous; tarsi 2-segmented; abdominal sternites without accessory discal setae; tergite VIII with ctenidia located anterolaterally to spiracle.

Frankliniella boricuena Hood, 1942

Frankliniella boricuena is a New World species recently thought to be now established in Kenya (Vierbergen 1995). It was intercepted twice in U.S. ports-of-entry between 1983 and 1999: at Dallas, TX, on *Ornithogalum* sp. from the Netherlands, and at Los Angeles, CA, on *Callistephus* sp. from the Netherlands.

Range.—(North America) U.S.A. (TX only), Costa Rica, Cuba, El Salvador, Jamaica, Mexico, Panama, Puerto Rico. (Africa) Kenya.

Hosts.—*Bidens pilosa; Tithonia diversifolia*; coconuts. Intercepted from Netherlands in *Ornithogalum* sp. [Dallas, TX] and *Callistephus* sp. [Los Angeles, CA].

Frankliniella fusca (Hinds, 1902) (Figs. 1, 7, 13, 30)

Frankliniella fusca is a North American species recently established in the Netherlands. Nearly all specimens intercepted
from the Netherlands have been brachypterous, but more macropterous forms may be encountered in the future. In the U. S. it is a pest of cotton, peanuts, and tobacco. In brachypterous forms of *F. fusca*, ocelli are vestigial or absent (in brachypterous *F. nigriventris*, they are present), and the microtrichia on the posterior margin of tergite VIII are small and limited to the lateral margins (in brachypterous *F. nigriventris*, they are well developed across the entire posterior margin). Macropterous *F. fusca* resembles *F. tenuicornis*; the head between the eyes is prolonged anteriorly in both species, although only weakly so in *F. fusca*. Macropterous *F. fusca* differs from *F. tenuicornis* in having broad reticulations in the median sculpture of the metanotum (median sculpture in *F. tenuicornis* is striated); also antennal segments III–IV in *F. fusca* is nearly uniformly brown; in *F. tenuicornis* they are light yellow.
Color.—Body usually brown to dark brown.

Range.—(Europe) Netherlands: (North America) U.S.A. (widely distributed); Canada, Mexico. (Oceania) Hawaii.

Hosts.—Wide variety of plants, including grasses.

**Frankliniella intonsa** (Trybom, 1895) (Figs. 2, 8, 14, 19)

*Frankliniella intonsa* is one of the four intercepted species that often reaches pest status in horticultural crops, especially in the flower industry. It is similar in morphology to *F. occidentalis* but can be distinguished from that species by its shorter antennal segment VIII, its shorter fourth postocular setae, absence of campaniform sensilla on metanotum, and its usually darker uniform brown color.

Color.—Body light to dark brown; wings clear; legs concolorous with body; head and pronotum light brown to brown. Antennal segments I and II brown; III–V yellow; VI–VIII brown.

Range.—(Europe) Widespread throughout Europe. (Asia) China, India, Israel, Japan, Korea, Mongolia, Pakistan, Taiwan, Thailand, Turkey. (North America) U.S.A. [WA only], Canada [British Columbia]. (Oceania) Australia, Philippines.

Hosts.—Various species of plants. Intercepted from the Netherlands on: *Allium* sp. (cutflowers), *Astillbe* sp. (cutflowers), *Crocosmia/Eremurus* sp. (cutflowers), *Delphinium* sp. (cutflowers), *Gentiana* sp. (cutflowers), *Lisianthus* sp. (cutflowers), *Lysimachia* sp. (cutflowers), *Scabiana* sp. (cutflowers), *Solidago* sp. (cutflowers), *Viburnum* sp. (cutflowers).

**Frankliniella occidentalis** (Pergande, 1895) (Figs. 3, 9, 15, 20–22, 24)

The western flower thrips, *F. occidentalis* is widespread throughout the world and frequently reaches pest status on a variety of crops. On the other hand, it also feeds on spider mites, and in California it has been used as part of several insect pest management programs. It is the second most commonly intercepted thrips species [*Thrips tabaci* Lindeman is the most commonly intercepted species]. Although it probably originates in western North America, it has been transported throughout the world and is well established throughout Europe, Africa, and the Mediterranean. *Frankliniella occidentalis* can be distinguished from other *Frankliniella* species by the following features: Antennal segment VIII approximately twice as long as VII (Fig. 20); postocular setae IV significantly greater than one half as long as ocellar setae III (Fig. 3); metanotal campaniform sensilla present; and a complete complement of long microtrichia evenly spaced on posterior margin of abdominal tergite VIII as in Fig. 15. Sculpture of metanotum as in Fig. 9.

Color.—Variable, but usually as follows: body yellow with abdominal tergites medially brownish; wings clear to light yellow; legs distally yellow, basally brown or yellow; head and pronotum yellow to light brown. Antennal segment I yellow; II brown; III yellow to light brown; IV–V partly yellow, VI–VIII brown.

Range.—(Europe) Widespread, including Italy (It), Netherlands (Ne), (Africa) Canary Islands, Kenya, South Africa, Swaziland. (Asia), Israel, Japan, Korea, Thailand. (Oceania) Australia, New Zealand. (North America) U.S.A., Canada, Central America, Mexico. (South America) Widespread.


Solidago sp. (cutflowers), Trachelium sp. (cutflowers).

*Frankliniella pallida* (Uzel, 1895) (Figs. 23, 30)

*Frankliniella pallida* has seldom been intercepted at U.S. ports-of-entry.

Color.—Body pale tan to yellow.

Range.—(Europe) Albania, Austria, former Czechoslovakia, Denmark, Germany, Finland, France, Hungary, Italy, Lithuania, Netherlands, Poland, Romania, Russia, Sweden, Switzerland. (Asia) Siberia, Turkistan.

Hosts.—Wide variety of flowering plants. Intercepted between 1983 and 1999 on Salvia sp. from Greece [Louisville, KY].

*Frankliniella panamensis* Hood, 1925 (Figs. 4, 10, 16)

*Frankliniella panamensis* is a Neotropical species that as yet has not been established in other regions of the world, but
several specimens have been intercepted at U.S. ports-of-entry from the Netherlands. It is regularly intercepted in ports-of-entry in shipments of flowers (especially on *Rosa* species), fruits, and vegetables from Colombia and Ecuador, and it may eventually be inadvertently transported to tropical areas of the Mediterranean and/or Africa. Although similar in appearance to *F. occidentalis*, it is often darker in color, and the microtrichia on the posterior margin of tergite VIII are greater in length and closer together than those of *F. occidentalis*.

Color.—Body usually brown, with head and pronotum, tibiae, and portion of antennae often yellow; wings may be weakly shaded.

Range.—(North and South America) Panama, Colombia, Ecuador.

Hosts.—Usually on flowers, but also recently intercepted on a variety of vegetables and fruits.
Frankliniella schultzei (Trybom, 1910)  
(Figs. 5, 11, 17)

Frankliniella schultzei is common throughout tropical regions of the world. Although originally not native to Africa, this species is now well established from Egypt and Morocco to South Africa and is frequently encountered in shipments arriving from various countries in Africa. It is found in nature in two color forms: dark brown and pale yellow. The dark form is known to be a vector of TSWV disease, but in Australia this color form is also known to be beneficial as a predator of phytophagous mites (Mound and Kibby 1998). In addition, it is a vector of the South African groundnut ringspot virus and tomato chlorotic spot virus (Wijkamp et al. 1995). It is an agricultural pest of a variety of crops, including tomatoes (Nakahara 1997). Frankliniella schultzei can be distinguished from other Frankliniella species by the position of the ocellar setae III between instead of in front of the posterior ocelli (Fig. 5), by the absence of microtrichia on abdominal tergite VIII (Fig. 17), and by the absence of metanotal campaniform sensilla. Sculpturation of metanotum as in Fig. 11.

Color.—Body brown; wings clear; femora brown with bases and apices yellowish; head and pronotum yellow to light brown. Antennal segments I and II light brown; III yellow; IV–VIII light brown.

Range.—(Europe) Austria, Balkans, Denmark, England, Germany, Finland, Italy, Netherlands, Poland, Romania, Russia, Scotland, Sweden. (Asia) China, Israel, Japan, Mongolia, Turkey. (Africa) Libya. (North America) Canada, U.S.A. (Australia) Australia.


Frankliniella tritici (Fitch, 1855)

Frankliniella tritici is a New World species recently intercepted twice in material from the Netherlands. Because it is a common species on a variety of North American commodities, it may make its way to other countries in Europe, the Mediterranean, and Africa, where it may become established.
Figs. 23–29. Morphological features of *Frankliniella* (24–25, 30–33) and *Iridothrips* species (23, 26–29).

Figs. 30–33. Antennal segment II, showing basal pedicel. 30. Frankliniella fusca. 31. F. borinquen. 32. F. tritici. 33. F. pallida.


Hosts.—Found on a wide variety of plants and often a pest species on many agricultural crops. Intercepted from the Netherlands on Freesia sp. [Atlanta, GA] and Delphinium sp. [Dallas, TX].

Iridothrips Priesner, 1940

Diagnosis.—Head as wide as long or longer than wide; antenna 8-segmented; antennal segments III and IV each usually with simple sense cones (occasionally with fork sense cones) (Fig. 23); 3 ocelli present; 3 pairs of ocellar setae, with interocellar setae well developed and located laterad of anterior ocellus or only slightly posteriad of anterior ocellus; 4 postocellar setae, all short and nearly equal in length; maxillary palpi 3-segmented; pronotum with 1 short pair of anteroangular, 1 long pair of anteromedial, and 2 long pairs of posteroangular setae and with 2–3 pairs of short anteromarginal and 5 pairs of posteromarginal setae; usually macropterous, with two complete rows of veinal setae regularly distributed on forewings; median pair of metanotal setae located well posterior of anterior margin; intercoxal metathoracic process broad, truncate (at least for I. iridis); tarsi 2-segmented; ctenidia weakly to moderately defined on abdominal tergites V–VIII, on VIII located anterolateral of spiracle; abdominal segment X longer than segment IX.

Iridothrips iridis (Watson, 1924) (Figs. 23, 26, 28)

Although infrequently intercepted, Iridothrips iridis occasionally is found associated with Iris sp. flowers and leaves. It is distinguished from its sister species, I. mariae, by the shape of the head (cf Figs. 28 and 29) and body color: I. iridis is usually dark brown, while I. mariae is pale yellow).

Color.—Body brown to dark brown with base of head, antennal segments III and IV, foretibiae, and all tarsi yellow; wings pale yellow; femora brown with bases and apices yellowish; head and pronotum brown.

Range.—(Europe) Austria, former Czechoslovakia, Denmark, England, Germany, Finland, France, Hungary, Netherlands, Poland, Scotland, Ukraine. (North America)
Canada [Montreal], U.S.A. [KS, IL, MA, MD, NH, NJ, NY, OH, OR, PA, VA, WA].

Hosts.—A pest of Iris spp.; Kniphofia uvaria; Tritonia uvaria. Intercepted from Iris sp. (cutflowers) (United Kingdom).

Iridothrips mariae Pelikán. 1961 (Figs. 27, 29)

Iridothrips mariae as yet has not been intercepted at U.S. ports-of-entry.

Range.—(Europe) former Czechoslovakia; Netherlands; Romania; Ukraine.

Hosts.—Typha latifolia; Typha angustifolia.

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Vierbergen, G. 1995. The genus Frankliniella in the


A NEW SPECIES OF BRACHYCENTRUS CURTIS (TRICHOPTERA: BRACHYCENTRIDAE) FROM THE SOUTHERN APPALACHIAN MOUNTAINS AND VARIATION IN THE CADDISFLY B. SPINAEE ROSS

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Abstract.—Description and illustrations for Brachycentrus lunatus, n. sp., from the southern Appalachian Mountains are provided. Intraspecific variation of larval color pattern previously has been noted among populations of the caddisfly Brachycentrus spinae Ross. We found a strong correlation between larval phenotype and geographical distribution. No significant adult variation was correlated with the larval B. spinae phenotypes.

Key Words: Trichoptera, Brachycentridae, Brachycentrus, Brachycentrus spinae, intraspecific variation, southern Appalachian Mountains

More than 11,000 species of Trichoptera have been described worldwide (Morse 2001). In North America, only about one-third of the continent's nearly 1,500 described Trichoptera species have larvae associated with their corresponding adults (Morse et al. 1997). Trichoptera larvae are known even more poorly in other major global regions (e.g., Morse 2002). Though numerous ecological studies have been conducted on Trichoptera species, most have focused on a single population or small number of populations, such that few species have been comprehensively investigated throughout their range. Comprehensive investigations would more likely provide information concerning geographical associations and life-history patterns.

The southern Appalachian caddisfly Brachycentrus spinae Ross exhibits considerable intraspecific variation. The original description was based entirely on adult males from one population (Ross 1948). When Flint (1984) associated larvae with adult B. spinae, he noted "perplexing" variation, but concluded that the different phenotypes represented a single species, owing to a lack of reared material and no apparent significant variation among adults. Larval head capsules vary considerably. Head capsules of larvae from the type locality, hereafter referred to as "typical," have vivid yellow markings on the frontoclypeus and parietal sclerites (Fig. 6). Other larvae, hereafter referred to as "dark-headed," have uniformly dark brown or black head capsules that appear more nearly rounded (Fig. 7). Larval variation in B. spinae has continued to perplex benthologists and taxonomists, as intraspecific variation to this extent is not frequently documented among larval Trichoptera. The present study attempts to elucidate the perceived intraspecific variation of B. spinae and provides the description of a new Brachycentrus species.

METHODS

Material for this study was acquired from the Illinois Natural History Survey (INHS), Royal Ontario Museum (ROM), Virginia
Museum of Natural History (VMNH), and Virginia Tech Museum of Natural History (VTMNH) and fresh specimens were collected from streams throughout the southern Appalachian Mountains. Specimens were collected in 80% ethanol. Adult terminalia were cleared in a heated potassium hydroxide solution. Additional material and paratypes are deposited in the Clemson University Arthropod Collection, Clemson, SC (CUAC), and the National Museum of Natural History, Smithsonian Institution, Washington, DC (NMNH).

Brachycentrus (Sphinctogaster) lunatus Harrington and Morse, new species
(Figs. 1-5)

Adult.—Length of body, including head and folded wings: 11–12 mm. Color: Wings brown, each with pale stigmal spot between radius and subcosta at distal margin. Sclerites fuscous to dark brown. Male genitalia: Preanal appendages elongate, tapered, and completely separate mesally in dorsal aspect. Tergum X divided into two lobes in dorsal aspect, each lobe rounded and narrowed apically, with one subapico-
dorsal macrochaeta projecting laterad. Inferior appendages broad basally, each projecting into sharp point directed mesad. In posteroventral aspect, mesal margin produced into subapical point, creating crescent-shaped margin between apical and subapical point.

Larva.—Length to 12 mm. Sclerites dark brown and fuscous, marked with pale yellowish bands: frontoclypeus dark with well-defined yellow spots anterolaterally and not extending to anterior margin; parietal sclerites dark, each with pale band posteriorly and between setae 16 and 17, parallel to coronal and frontoclypeal sutures; lateral pale band extending from eye to posterior margin. Femora of meso- and metathoracic legs dark dorsally, fading to yellow ventrally, their tibiae dark basally and pale distally; each tibia with three to four consecutively larger setae along basoventral margin.

Type material.—Holotype, ♂: Eastatoe Creek @ SR 100 (34.996733 N, 82.827783 W). Pickens Co., South Carolina. 20 April 2001, Coll: R.C. Harrington (INHS). Paratypes: Same collection data as holotype, 2 ♂ (CUAC), 3 ♀ (NMNH), R.C. Harrington.

Other material.—North Carolina. Henderson County, Green River at Bobs Creek Rd., 10 February 2002, 14 larvae. R. C. Harrington, D. R. Jones (CUAC); same locality but 29 March 2002, 1 larva, 1 pupa, R. C. Harrington (CUAC); same locality but 16 April 2002, 2 pupae, 1 metamorphotype, R. C. Harrington (CUAC); McDowell County, Old Fort, at bridge Northwest of town, 1 April 1971, 1 larva, J. C. Morse and F. Sherberger (CUAC). South Carolina, Pickens County, Eastatoe Creek @ State Route 100, 14 March 2001, 12 larvae. R. C. Harrington (CUAC); same locality but 8 March 2002, 12 larvae. R. C. Harrington (CUAC): Eastatoe Creek near highway 143, 15 February 1995, 1 larva, 1 pupa, Y. J. Li (CUAC): “Rocky Bottoms Creek @ SR-39-100” (actually Eastatoe Creek at SR 100). 1 April 76, 1 pupa, J. W. Chapin (CUAC).

Diagnosis.—Male genitalia of this species are very similar to those of Brachycentrus spinosus in the shape of the inferior appendages and tergum X. Only one macrochaeta is present, however, on each lobe of tergum X (as opposed to numerous macrochaetae for B. spinosus) and the subapical protuberance of each inferior appendage produces only a sharp point and lacks the more basal rounded portion present in B. spinosus. Larvae of this species are also very similar to those of B. spinosus but can be distinguished by the clearly defined pale markings on the frontoclypeal and parietal sclerites (as opposed to the less clearly defined pale markings on the frontoclypeal and parietal sclerites of B. spinosus).

Etymology.—lunatus (Latin) = crescent shaped, referring to the general appearance of the apical end of each inferior appendage.

Notes.—This species is a member of the Brachycentrus numerosus species group (Flint 1984) and appears to be a sister species of Brachycentrus spinosus Ross. It has been collected only from streams in upper Atlantic Coast drainages of the Appalachian Mountains.

Brachycentrus spinosus Ross
(Figs. 6–12, 13)

Populations of Brachycentrus spinosus were encountered throughout the entire southern Appalachians, conforming almost completely to the southern Appalachian ecoregion (Fig. 13). “Typical” larvae (Fig. 6) were distributed along the western edge of the Appalachians, primarily along the Tennessee–North Carolina border, and in North Carolina in the vicinity of the Tennessee–Virginia border. Uniformly dark-headed individuals (Fig. 7) were found throughout the interior southern Appalachians of North Carolina and northern Georgia. About 80% of dark-headed populations had specimens with a mottled appearance due to muscle scars along the posterior portion of the parietal sclerites. The degree of darkening also varied among pop-
Brachycentrus spinae phenotypes and allies

- B. spinae, typical
- B. spinae, dark-headed, uniformly brown
- B. spinae, dark-headed, nearly black
- B. spinae,"intermediates"
- B. lunatus, new species

Fig. 13. Distribution of Brachycentrus spinae larval phenotypes and Brachycentrus lunatus.

Not all populations were sampled in both the larval and adult stages. However, for those population for which adults were associated with larvae, adults that we consider B. spinae did not exhibit differences or trends distinct enough to warrant description. In general, adults from both the dark-headed and typical populations possessed numerous macrochaetae on each lobe of tergum X (Fig. 1). Also, inferior appendages from adults of both larval phenotypes had the same general appearance: a sharp apical point, a subapical point, and more basal "chin-like" protuberance (Fig. 12). On the other hand, although larvae of populations along the eastern Blue Ridge Escarpment bore a strong resemblance to typical populations of B. spinae, consistent differences in larval and adult characters provide evidence that they represent a distinct species described above.

Variation has been reported for several other Trichoptera, including Hesperophylax species (Parker and Wiggins 1985), Rhyacophila nigrita Banks (Prather and Morse 2001), Arctopsyche grandis (Banks) (Hauer and Stanford 1981), Hydropsyche contuber-
nalis McLachlan (Guinand et al. 1997), Diplectrona modesta Banks (Morse and Barr 1990), and Cheumatopsyche harwoodi enigma Ross, Morse, and Gordon (Gordon 1974). Despite the observed moderate larval or adult morphological variation in each situation, none of these studies concluded that multiple, distinct species exist. The unusual contrast between dark-headed and typical larvae of Brachycentrus spinae strongly suggested a complex of at least two species. From among the larval phenotypes that we eventually segregated, only B. lunatus had corresponding diagnostic characters in males. We found no corresponding adult characters to discriminate the other phenotypes in the adult form. Furthermore, the larval forms are allopatric, preventing inferences about natural reproductive isolation. The typical phenotype is restricted to the western edge of the southern Appalachians, the dark-headed phenotype in the interior southern Appalachians (with the darkest larvae occurring in the southern and eastern parts of the range), and “intermediates” in the extreme southern extent of the range (Fig. 13).

The taxonomic significance of “intraspecific” variation between dark and typical Brachycentrus spinae remains open to investigation, particularly one that uses a molecular population genetics approach. Other studies on organisms inhabiting the southern Appalachians have also found patterns of substantial variation that correlate with geography (e.g., Nalepa et al. 2002). The orientation and situation of the southern Appalachians might have once provided a refuge for northern species and served to fragment populations of less mobile southern species during peaks of Pleistocene glaciation (Hack 1969). We suspect that Brachycentrus spinae has low vagility in its adult phase due to its ephemeral adult life span and therefore may be a species that is particularly vulnerable to range fragmentation.

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LITERATURE CITED


PRIMARY CONSUMER AND DETRITIVORE COMMUNITIES 
(DIPTERA: EPHYDRIDAE) IN NEWLY 
RESTORED AND CONSTRUCTED WETLANDS

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Abstract.—Although maximum diversity of higher Diptera has been reported in the 
interface between wetlands and other ecosystems, few studies have documented successful 
restoration of wetland insects within these ecotones. The consistent collection of shore 
flies (Diptera: Ephydridae) supports the hypothesis that shore flies rapidly colonize newly 
restored and constructed wetlands at Miami Trace and Winton Woods county Parks, Ham-
ilton County, Ohio. Rapid colonization of shore flies exhibited a temporal shift that is 
associated with aquatic vegetation colonization, growth, and maturation. Species com-
position of shore-fly communities suggests that a minimum of five general nutrient sources 
were exploited in newly established wetlands, and shore flies may be an essential part of 
the establishment of complex food webs. A comparison of Sorenson and diversity indices 
suggests that shore-fly communities in constructed and restored Ohio wetlands were dis-
tinct species assemblages. Significant differences among shore-fly communities are attri-
buted to variation in species abundance. Although restored and constructed wetlands were 
flooded during 1998, variation in species abundance and monthly species accumulation 
suggests that the development of ecosystems within each wetland was asynchronous.

Key Words: restored wetlands, Diptera, Ephydridae, colonization, community diversity, 
food webs

In many regions of the United States, the 
restoration of wetlands has been initiated to 
provide habitat for vertebrate species. The 
success of bird, amphibian, and mammal 
recolonization in wetlands is directly relat-
ed to the type, quality, and abundance of 
food resources within wetland ecosystems 
(Wilson 1987). One of the major sources of 
food for waterfowl, shore birds, and fish 
species is insects (Martin and Uhler 1939, 
Zahl 1967, Clarke 1976, Murkin and Batt 
1987). During egg laying and brood rear-
ing, adult and juvenile ducks consume in-
vertebrate food (including insects) (Krapu 
and Swanson 1975, Batalle and Baldassar-
re 1993) to obtain the protein that is nec-
essary for reproduction and rapid growth 
(Driver et al. 1974). Decreased availability 
of food has been associated with duckling 
mortality (Johnson et al. 1992, King and 
Brazner 1999), and duckling brood avoid-
ance and abandonment of wetlands that 
have small numbers of invertebrates (Coo-
per and Anderson 1996). Although the im-
portance of insect resources to waterfowl 
development has been recognized, an un-
derstanding of the contributions of insects 
to wetland food webs is limited (Rosenberg 
and Danks 1987, Batzer and Wissinger 
1996, Hansen and Castelle 2000). As Batz-
er and Wissinger (1996) stated, many of the 
previous experiments and assumptions con-
cerning wetland insect ecology require re-evaluation to improve the management of insect resources as waterfowl food. Foundations for regulating insect and waterfowl communities are in the initial stages of development (Batz and Wissinger 1996).

Previously, a majority of wetland investigations have focused on plant communities, soils, hydrology, chemical processes, benthic invertebrates, and vertebrate populations, such as waterfowl (Sharitz and Batzer 1999). Although maximum diversity of higher Diptera is at the interface between mature wetlands and other ecosystems (Deonier 1965, LaSalle and Rozas 1991, Marshall 1994, Scheiring and Foote 1973, Steinly 1986, Thier and Foote 1980, Keiper et al. 2002), and the greatest production of insect biomass is found in sparse emergent vegetation zones (Voigts 1976, Orains 1980, Kaminiski and Prince 1981, McLaughlin and Harris 1990), only a few investigations have focused on the successful restoration of wetland macroinvertebrates that are found in the water column and/or sediments (Danell and Sjoberg 1982, Florida Department of Environmental Protection 1994, Brown et al. 1997). The attraction of shore flies to artificial pools and other habitats in a constructed wastewater treatment wetland at 2 days post-flooding and the establishment of shore-fly populations suggest that colonization by these species was not incidental (Keiper and Walton 2002, Keiper et al. 2002). Although two investigations have focused on Diptera that inhabit soil and consume decaying vegetation in restored Florida (Streever et al. 1996) and Washington (Hansen and Castelle 2000) wetlands, studies of primary consumer richness or abundance have not been reported.

Layton and Voshell (1991) suggested that an increase in habitat diversity would most likely lead to increases in invertebrate diversity within wetland ecosystems. It is common for detritus-feeding insects (i.e., insects that feed on decaying plant and animal tissues) to dominate areas that contain newly flooded decaying organic materials (Layton and Voshell 1991). However, as an area matures, plant detritus decreases and production of unicellular and multi-cellular algae and macrophytes increases (Layton and Voshell 1991) resulting in increased primary consumer abundance and species richness. Although Batzer and Wissinger (1996) did not monitor primary consumer communities, their review suggests that detritivore communities are not affected by macrophyte and algal growth. They suggest that detritivore populations either remain constant or increase where multi-cellular plants were cut and debris removed.

In this paper, evidence is presented to document the initial colonization of newly restored and constructed wetlands by shore-fly species that have been associated with the consumption of detritus and primary production. Temporal shifts in the richness and abundance of primary consumers and detritivores i.e., shore flies are associated with the growth of macrophytes and maturation of newly established wetlands. Shore-fly diversity, relative abundance, richness, and similarity values from these wetlands are compared. Diversity values are compared with a t-test to identify significant differences in shore-fly communities.

**Materials and Methods**

During 1997, the Hamilton County Park District completed the restoration of a single wetland at Miami Trace, and the construction of two wetlands at Winton Woods, Hamilton County, Ohio. At Miami Trace, the renewed flooding represents a restoration of a wetland that was surveyed and described before the settlement of Ohio. A single wetland was leveed at Miami Trace County Park without basin alteration, and is located northwest of New Haven and approximately, 0.55 km east (39°17'.3"N, 84°44.8"W) of a larger restored wetland complex. Before wetland restoration, the area was covered with old-field vegetation and was well drained. Post-restoration vegetation consisted of scattered stands of Ty-
pha latifolia L. and patches of filamentous algae that were surrounded by unvegetated mud shores. The Winton Woods County Park (Winton Woods, Ohio) sites consist of two basins on the northern edge of the park that are named Mallard (39°15.9'N, 84°31.1'W) and Heron (39°15.9'N, 84°30.9'W) Wetlands. These wetlands were constructed to control precipitation run-off from the surrounding watershed and to provide habitat for vertebrate species. Mallard Wetland was bordered on the south by a steep grass shore while the wetland interior contained scattered stands of T. latifolia mixed with Sparganium americanum Nuttall, Alisma subcordatum Raf., and Carex. Heron Wetland had a similar grass shore on the south side that was well drained. The shallow slope of the northern shore of Heron Wetland promoted the retention of soil water that sustained the dense growth of sedges and scattered Sagittaria latifolia Willd. on the shoreline. Emergent Ranunculus flabellarts Raf. occupied two thirds of the wetland pool. Although trace amounts of precipitation fell during July—September, the Winton Woods sites held water at a fairly constant level until mid August. During late August through September, areas of limestone sediment in both Winton Woods wetlands were exposed that was covered with sparse plant debris. As the season progressed, larger areas of sediment were exposed in Mallard Wetland and these mud shores were colonized by widely scattered clumps of Setaria glauca Kuntze (yellow foxtail), grass (-es), and Sp. americanum, while Carex sp. and Sa. latifolia grew on newly exposed mud shore at Heron Wetland. Visual evidence of leaf mining confirmed that pioneering grasses were colonized by dipteran primary consumers.

Bi-weekly collections of shore flies were initiated at Miami Trace and Winton Woods in May and continued through October 1998. Wetlands were subdivided into habitats that were characterized by substrate and vegetation types and sampled with a modified aerial sweep net (150 net sweeps per habitat) (Scheiring and Foote 1973; Regensburg 1976; Steinly 1978, 1986, 1990, 2001). One sweep sample is the combination of a back and forth movement of the net through a habitat. Sweep net sampling is a quick and inexpensive means of sampling diverse communities of invertebrates (Murkin et al. 1983, Cheal et al. 1993). The size of sampling areas and the number of net sweeps were equal among habitats. Plant debris was removed immediately from the samples and stored temporarily in petri dishes. Mounted and unpinnd specimens were identified, labeled and counted. Mounted and vialled voucher specimens are deposited in the Miami University Insect Collection.

The percentage relative abundance is calculated with the formula R. A. = Ai/N × 100, where R. A. is the percentage relative abundance, Ai is equal to the abundance of each species, and N is the total number of shore flies within the wetland. The percentage ranges are characterized as follows: 1–2% rare (r), >2–8% occasional (occ), >8–14% common (c), >14–25% abundant (a), and >25–100% very abundant (va) (Deonier 1965; Scheiring and Foote 1973; Deonier and Regensburg 1978; Steinly and Deonier 1980: Steinly 1984, 1986, 1990).

The Shannon-Wiener diversity index (H') was calculated for all wetlands because it incorporates both species richness and abundance (Scheiring 1974). Shore-fly diversity (H') values for each wetland were compared with a t-test to identify differences in shore-fly communities (Zar 1984). Diversity is calculated by: \[ H' = -\sum p_i \log_{10} p_i \] where \( p_i \) is \( n_i/N \), \( n_i \) is the number of individuals of the ith species of the habitat being considered, and \( N \) is the total number of individuals per habitat. H' is essentially dimensionless and usually not affected by sample size (N) (Olive and Dambach 1973, Scheiring 1974). Newly restored wetland habitats of comparable area were sampled for approximately the same amount of time and probable differences in richness and abundance of shore-fly species reflect bio-
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<tr>
<td>Total</td>
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<td></td>
<td></td>
<td>949</td>
<td></td>
<td></td>
<td>562</td>
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</table>

* Known Detritivore Species.
logical differences among wetlands (Scheiring 1974).

The community composition of each wetland was compared by means of the Sorensen Index of Similarity (I). Similarity is calculated with the formula $I = 2 \frac{C}{(A + B)}$, where I is the index of similarity, C is the number of species shared, A is the number of species in habitat A, and B is number of species in habitat B (Scheiring and Deonier 1979, Steinly 1984). The Sorensen index ranges from 0 when there is no similarity (no species shared) between habitats to 1 when there is complete similarity.

**Results**

During May through October of 1998, 4,818 shore flies were collected from the newly restored and/or constructed wetlands within Miami Trace and Winton Woods County Parks, respectively (Table 1). Collections from Mallard and Heron wetlands at Winton Woods, and the restored wetlands at Miami Trace contained 31, 26, and 21 (Table 1) species of shore fly within samples of 3,307, 949, and 562 specimens, respectively (Tables 1–4). Of the total number of shore flies, detritivores accounted for approximately 78, 49, and 60% of the ephydrid communities within Mallard, Heron, and Miami Trace wetlands, respectively (Table 1). Approximately 86.7%, i.e., 4,177 of the total number of shore flies collected during the season from all wetlands consisted of *Allotrichoma simplex* (Loew) (7.7%), *Discocerina obscurella* (Fallén) (48.8%), *Hydrellia griseola* (Fallén) (9.2%), *Hydrellia tibialis* Cresson (4.5%), *Paralimna punctipennis* (Wiedmann) (3.5%), *Polytrichophora orbitalis* (Loew) (4.6%), *Scatella stagnalis* (Fallén) (4.82%) and *Typopsilopa atra* Loew (3.1%). The abundance of these species ranged from occasional (occ) to very abundant (va) (Table 1). All other species were rare (r) and were represented by fewer than 100 individuals (Tables 1–4). May samples from the Heron and Mallard wetlands (Tables 2 and 3) and October collections from Miami Trace (Table 4) did not contain shore-fly specimens (Fig. 1). Although initial collection of shore flies from Mallard and Heron wetlands started in June and July, respectively, species accumulation patterns are similar (Fig. 1). Shore-fly species accumulation in the Miami Trace wetland started in May and approached asymptote during September (Fig. 1).

In the Mallard and Heron wetlands, the abundance of *Allotrichoma simplex*, *Polytrichophora orbitalis*, and *Discocerina obscurella*, increased during August and September (Table 2 and 3), respectively, while *A. simplex* and *Hydrellia griseola* appeared in May collections and abundance continued to increase through July in the restored wetlands at Miami Trace (Table 4). Although a single *Po. orbitalis* adult was collected in May in the restored wetland, additional specimens were not captured until July (Table 4). *A. simplex* and *Po. orbitalis* consume decaying organic matter (Foote and Eastin 1971, Foote 1995).

The abundance of two leaf-mining species, *Hydrellia griseola* and *Hydrellia tibialis*, and *T. atra* increased dramatically during July through August, and September in Miami Trace and Winton Woods wetlands, respectively (Tables 2–4). Also, appreciable numbers of *Paralimna punctipennis* and *Scatella stagnalis* were found in Mallard and Heron wetlands (Tables 2 and 3) during September. *Sc. stagnalis*, and *Pa. punctipennis* feed on cyanobacteria and diatoms, respectively (Foote 1995). *Hyadina albovenosa* Coquillett, *Hyadina binotata* (Cresson), *Hyadina pruinosa* (Cresson), and *Hydrellia formosa* Loew were rare (r) species (Table 1) and collected early in the season from grass shore habitat at Heron Wetland (Table 3). Although relatively large numbers of *Parydra* (Table 5) and *Notiphila* species were routinely collected in aquatic habitats and mature wetlands in Ohio (Steinly 1978, Todd and Foote 1987, Larson and Foote 1997), respectively. *Notiphila adusta* Mathis, *Notiphila loewi* Cresson, *Notiphila pauroura* Mathis, *Notiphila*
Table 2. Shore-fly community of Mallard Wetland at Winton Woods County Park.

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<td>2153</td>
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<td>-</td>
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<td>-</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>-</td>
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<td>41</td>
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<td>3</td>
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<tr>
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<td>57</td>
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<td>-</td>
<td>39</td>
<td>-</td>
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<tr>
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<td>16</td>
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<td>-</td>
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<tr>
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<tr>
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<td>12</td>
<td>54</td>
<td>301</td>
<td>1848</td>
<td>1092</td>
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</table>

phaeopsis Mathis, Parydra aquila (Fallén), Parydra breviceps Loew, and Parydra quadrituberculata Loew were rare (r) in all newly established wetlands. Additionally, Scatella favillacea Loew, Scatella obsoleta Loew, Scatella paludum (Meigen), and Sc. stagnalis were found on filamentous algal mats in the spring at Miami Trace, but the habitat was submerged by a mid-summer torrential rainfall and Scatella species and Setacera atrovirens (Loew) were not found after 18 August. In contrast, Sc. obsoleta and Sc. paludum were collected from Mallard Wetland at Winton Woods in late summer (Table 2).

A comparison of Mallard and Heron shore-fly communities with the Sorenson index suggests that the constructed wetlands contained similar assemblages (Table 6) while comparison of Miami Trace with both Winton Woods localities yielded lower similarity values (Table 6). Community diversity values (H') of 1.10 (Heron), 0.83 (Miami Trace), and 0.67 (Mallard) compared with a t-test suggest that shore-fly communities within each wetland were significantly different.

**DISCUSSION**

Monthly increases in A. simplex, D. obscurella, and Po. orbitalis abundance (Tables 2–4) suggest that detritivore colonization, continuous immigration, and/or the growth of newly established communities
were not adversely affected by low quantities of decaying organic matter. Although shore-fly primary consumers were collected from Miami Trace and Mallard wetlands, approximately 60 to 78% of the specimens collected were detritivores, respectively (Table 1). This investigation confirms that shore-fly primary consumers and detritivores rapidly colonize restored and constructed wetlands in Ohio. Although Scheiring and Deonier (1979) proposed that resource quantity increased the richness and abundance of well-adapted ephydrid species in transient habitats, the low detritus quantities, and abundance of detritivores in newly restored wetlands supports Batzer and Wissinger's (1996) contention that detritivore colonization was not affected by the growth of macrophytes and algae, and insect abundance remained constant or increased when macrophytes were cut and debris removed.

The early colonization of restored wetland ecosystems by large numbers of *A. simplex*, *D. obscurella*, and *Po. orbitalis* suggests these species are important components in the early development of viable food chains that sustain diverse predaceous invertebrate and/or vertebrate communities. During late summer, increases in the populations of *Hydrellia griseola*, *Hydrellia tibialis* (i.e., leaf miners), *T. atra*, and a diatom feeder, *Paralimna punctipennis* are associated with increased density and growth of macrophyte and diatom food resources. *Typsilopa* spp. have been associated with the consumption of decaying tissue on damaged monocot stems (Keiper et al. 2001). The increase of micro- and macrophyte production represents a significant augmenta-

### Table 3. Shore-fly community of Heron Wetland at Winton Woods County Park.

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<td>41</td>
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<td>18</td>
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<td>70</td>
<td>6</td>
<td>79</td>
</tr>
<tr>
<td><em>Parydra aquila</em></td>
<td>—</td>
<td>—</td>
<td>5</td>
<td>—</td>
<td>5</td>
</tr>
<tr>
<td><em>Parydra breviceps</em></td>
<td>—</td>
<td>3</td>
<td>10</td>
<td>—</td>
<td>13</td>
</tr>
<tr>
<td><em>Parydra quadrituberculata</em></td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td><em>Philygria debilis</em></td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td><em>Polytrichophora orbitalis</em></td>
<td>—</td>
<td>—</td>
<td>30</td>
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<td>36</td>
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<tr>
<td><em>Ptilomyia enigma</em></td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td><em>Scatella stagnalis</em></td>
<td>—</td>
<td>—</td>
<td>145</td>
<td>2</td>
<td>147</td>
</tr>
<tr>
<td><em>Typsilopa atra</em></td>
<td>13</td>
<td>9</td>
<td>58</td>
<td>45</td>
<td>125</td>
</tr>
<tr>
<td><em>Zeros flavipes</em></td>
<td>—</td>
<td>—</td>
<td>14</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71</strong></td>
<td><strong>26</strong></td>
<td><strong>613</strong></td>
<td><strong>239</strong></td>
<td><strong>949</strong></td>
</tr>
</tbody>
</table>
Table 4. Shore-fly community of a new wetland at Miami Trace County Park.

<table>
<thead>
<tr>
<th></th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug.</th>
<th>Sept.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allotrichoma simplex</td>
<td>23</td>
<td>72</td>
<td>102</td>
<td>80</td>
<td>—</td>
<td>277</td>
</tr>
<tr>
<td>Discocerina obscurella</td>
<td>—</td>
<td>—</td>
<td>5</td>
<td>24</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>Ditrichophora exigua</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Hyadina binotata</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>—</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Hydrellia griseola</td>
<td>4</td>
<td>20</td>
<td>34</td>
<td>4</td>
<td>—</td>
<td>62</td>
</tr>
<tr>
<td>Hydrellia tibialis</td>
<td>—</td>
<td>9</td>
<td>11</td>
<td>33</td>
<td>—</td>
<td>53</td>
</tr>
<tr>
<td>Hydrochaeta leucoprostum</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Notiphila adusta</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Ocelithera anatolikos</td>
<td>—</td>
<td>2</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>Paradinna punctipennis</td>
<td>—</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Parydra quadrirunculata</td>
<td>4</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>Pelina truncatula</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Phlyctina debilis</td>
<td>33</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>35</td>
</tr>
<tr>
<td>Polycnemum quadrirunculata</td>
<td>1</td>
<td>—</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Psilea dupla</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>—</td>
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<td>3</td>
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<tr>
<td>Scatella faviilacea</td>
<td>25</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>25</td>
</tr>
<tr>
<td>Scatella obsolenta</td>
<td>11</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>12</td>
</tr>
<tr>
<td>Scatella paludum</td>
<td>1</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Scatella stagnalis</td>
<td>—</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>—</td>
<td>8</td>
</tr>
<tr>
<td>Setaceca arvirens</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Tynsillula atra</td>
<td>—</td>
<td>1</td>
<td>5</td>
<td>—</td>
<td>—</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total =</strong></td>
<td>103</td>
<td>108</td>
<td>180</td>
<td>152</td>
<td>19</td>
<td>562</td>
</tr>
</tbody>
</table>

tion of nutrient resources in newly restored wetlands and a probable increase in food web complexity. Early colonization, species accumulation (Fig. 1), and temporal abundance increases of shore-fly species (Tables 2–4) may be characteristic of initial stages of food chain development and the establishment of complex food web interactions.

Although Parydra aquila, Parydra breviceps, and Parydra quadrirunculata were collected in semi-aquatic grass, sand and mud shore habitats in Ohio (Table 5) (Steinly 1978), the rarity of these species in newly restored wetlands (Tables 1–4) suggests that obligate diatom species were not abundant. Species of Parydra are specialist on particular diatoms species (Bischof and Deonier 1985). Only a few individuals within the genus Parydra were collected at Miami Trace and suggests that Parydra species are late colonizers and/or diatom spp. were not abundant.

Hydrellia formosa and four Notiphila species colonized the Winton Woods sites, while one species of Notiphila was collected at the Miami Trace wetland (Table 1). In all probability, the richness and abundance of N. adusta, N. loewi, N. paurorea, and N. phaeopsis is dependent on detritus accumulation on the root surfaces of different species of emergent vegetation (Larsen and Foote 1997) at Heron Wetland. Although eight Notiphila species were collected during 1995 through 1998 from the older Mi-

Table 5. Relative abundance of shore flies in Ohio aquatic habitats.

<table>
<thead>
<tr>
<th></th>
<th>Grass Shore</th>
<th>Mud Shore</th>
<th>Sand Shore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parydra aquila</td>
<td>occ</td>
<td>r</td>
<td>r</td>
</tr>
<tr>
<td>Parydra breviceps</td>
<td>occ</td>
<td>c</td>
<td>occ</td>
</tr>
<tr>
<td>Parydra quadrirunculata</td>
<td>occ</td>
<td>occ</td>
<td>occ</td>
</tr>
</tbody>
</table>

Abbreviations: c = common; occ = occasional; r = rare.
ami Trace complex of restored wetlands (Steinly, unpub. data), only a few adults were collected from the restored wetland (Table 1) and the low richness and abundance of Notiphila spp. are attributed to the paucity of emergent vegetation in the restored wetland.

The abundance of detritivores and leaf-miners, diatom consumers, i.e., Pa. punctipennis, and Sc. stagnalis, a possible secondary consumer of damaged monocots stems. T. atra, and a cyanobacteria feeder suggests that at least five main nutrient sources were exploited by shore flies during the early stages of wetland restoration. During the initial stages of wetland restoration, the abundance of detritivores, leafminers, a secondary consumer, an algivorous species, and consumers of cyanobacteria (e.g., Nos tima and Hyadina species) suggest that the rudiments of viable food chains were present in late spring and early summer within the Mallard and Heron wetlands. Early collection, the increase of shore-fly richness and abundance (Tables 2–4) during the summer months, and the utilization of five different nutrient resources, i.e., algae, macrophytes, damaged monocot stems, detritus, and cyanobacteria suggest that shore-fly colonization provides a foundation for the development of diverse food chains and food webs. The successful restoration and maturation of wetland food chains is dependent on establishment and growth of aquatic micro- and macrophyte and microbe communities, accumulation of detritus, and concurrent colonization and establishment of resident primary consumers and detritivores, i.e., shore flies that move nutrients into food webs. Once detritus, bacterial, and plant nutrients are assimilated by shore flies, wetland production is accessible to predaceous invertebrates (e.g., Ochthera anatolikos Clausen) and vertebrates. The abundance of insect consumer populations has been linked to waterfowl reproductive success that is dependent on the quantity and quality of insect protein (Driver et al. 1974). In some instances early emergence of the Chironomidae (Diptera) provides a large quantity of protein (McLaughlin and Harris 1990), while waterfowl utilize shore flies and other families of Diptera for food later in the season.

Superficially, the significant difference in H’ values and the high Sorenson similarity value for the Mallard and Heron richness comparison are contra indicators. Although a Sorenson index of 0.81 and monthly species accumulation (Fig. 1) suggest that shore-fly community richness values in Mallard and Heron wetlands are comparable, the significant difference in H’ values (P < .0001, t = -22.77, df = 2540) suggests that these wetlands harbored unique species assemblages. The difference in shore-fly assemblages is attributed to extreme variation of individual species abundance within each wetland (Table 1). Although, the relatively high index of similarity (Table 6) suggests that biological and physical conditions were comparable in Mallard and Heron wetlands, the variation in shore-fly species abundance and the difference in the abundance of detritivores and primary consumers suggest that ecosystem development and/or maturation within each wetland was asynchronous.

Comparison of Miami Trace to Mallard and Heron Wetlands yielded low Sorenson indices (Table 6), differences in species accumulation patterns, and H’ values that
were significantly different ($P < 0.001$, $t = 9.38$, df = 922 and $t = -5.68$, df = 863, respectively). These differences suggest that the Miami Trace species assemblage was unique. The difference in shore-fly communities is attributed to local precipitation frequency and quantity, and disparate physical and biological conditions that are unique to restored and/or constructed wetlands. Further, the difference in shore-fly communities at Miami Trace as compared to the Winton Woods wetlands is confirmed by early colonization of shore flies in May vs. June and July and early development of species accumulation asymptote (Fig. 1) in the restored wetlands.

The importance of insect primary consumers and detritivores within food chains has been acknowledged (Batzer and Wis- singer 1996, Hansen and Castelle 2000), but a comprehensive understanding of insect herbivore, detritivore, and predator communities in restored wetlands is wanting. The scarcity of information is attributed to the daunting task of identifying large numbers of invertebrate species, and species interactions within and between food webs, and the lack of sampling in shoreline habitats (Keiper et al. 2002). Additionally, the number of food chain interactions and food web dynamics may vary from one geographic region to another.

The Ephydridae are a trophically diverse family that provides a unique opportunity to study the movement of wetland production into food webs because shore-fly species are routinely collected and abundant in wetlands. Without the colonization of wetlands by shore flies and/or other insect families that contain primary consumers and detritivores, the movement of primary production and detritus into food chains and development of food webs may be limited. Design and management of wetlands that

![Graph showing shore-fly species accumulation in newly constructed and restored wetlands.](image-url)
promotes the colonization and growth of insect communities to expedite the cycling of plant resources (i.e., primary production) and energy transfer will provide a foundation for diverse food chains and complex food webs that sustain an abundance and variety of invertebrate and vertebrate species.

ACKNOWLEDGMENTS

We thank the Cinergy Corporation and Hamilton County Park District for their support that made this project possible. The cooperation of John Kline and Robert Mason was invaluable. Nancy Solomon provided statistical advice and counsel. The assistance and dedication of Kevin Hill, Chris Yeager, Brit Farrar, Jeff Eakin, and Susan Ytisma in the preparation of specimens is greatly appreciated.

LITERATURE CITED

Larson, L. and B. A. Foote. 1997. Biology of four species of Notiphipha Fallén (Diptera: Ephydridae) associated with the yellow water lily, Nuphar leu-
Two wetlands.

1984. 111-121.


NOTE

First Report of *Ixodes kopsteini* Oudemans (Acari: Ixodida: Ixodidae) from the Kingdom of Cambodia, with a Summary of Known Hosts of this Tick in Continental Southeastern Asia

The uniquely ovoviviparous tick *Ixodes kopsteini* Oudemans is a widespread parasite of emballonurid, molossid, pteropodid and vesupertilionid bats in the Oriental Zoogeographic Region and, to a lesser extent, the Afrotropical and Australian Regions (Hoogstraal and Aeschlimann 1982; Petney and Keirans 1994). In the archipelagic states of southeastern Asia, collections of this tick have been made as far southward as Bogor in western Java, Indonesia (Anastos et al. 1973), and as far eastward as Luzon in the Philippines (Kohls and Clifford 1968) and Ambon and Seram in Indonesia's Moluccan Islands (Maluku) (Kohls and Clifford 1961, Durden et al. 1990). However, outside peninsular Malaysia (Kohls and Clifford 1968) and Thailand (Gould et al. 1970, Tanskul et al. 1983), no collections of *I. kopsteini* have heretofore been reported from continental southeastern Asia, perhaps because of the human turmoil that prevailed there throughout the second half of the twentieth century. During the summer of 2001, teams from U.S. Naval Medical Research Unit No. 2 (NAMRU-2), Jakarta, Indonesia, and Cambodia's National Institute of Public Health (NIPH), Phnom Penh, conducted surveys for natural reservoirs of Nipah virus and lyssaviruses (rabies and close relatives) in Cambodia. On 11 July, while sampling a large population of the wrinkle-lipped bat, *Chaerephon plicata* (Buchanan), which has long inhabited the enormous attic space of the Royal Cambodian National Museum (Fig. 1), one of us (MJB) collected an adult male *C. plicata* (total body length 35 mm, mass 22 g) that harbored a single female *Ixodes* just above the right ear canal (not on the tragus or antitragus). The tick's location presumably Shielded it from host grooming. Subsequent examination revealed this specimen to be the first Cambodian example of *I. kopsteini*, which has been deposited (as RML 123173) in the U.S. National Tick Collection, Institute of Arthropodology and Parasitology, Georgia Southern University, Statesboro. The bat was accessioned (as voucher no. 6218) at the NAMRU-2/NIPH Laboratory, Phnom Penh. The Cambodian National Museum attic, which also harbored colonies of *Taphozous melanopogon* Temminck and *T. theobaldi* Dobson (the latter was not encountered during the 2001 surveys), is reputed to be among the largest single aggregations of bats found in an artificial structure anywhere in the world (C. E. Rupprecht, personal communication).

With one exception (Gould et al. 1970), all known collections of *I. kopsteini* from mainland Southeast Asia (Table 1) have been made from members of the so-called Mastiff bat family Molossidae, which is only modestly represented in tropical Asia (of 80 molossid species accepted by Wilson and Reeder 1993, just 8 occur in the Oriental Zoogeographic Region). However, some Southeast Asian molossids are widely distributed. *Chaerephon plicata*, in particular, has a vast range, extending from India and Sri Lanka eastward through southern China to Vietnam, Hainan Island and the Philippines, then southward through the Malay Peninsula, Sumatra, Borneo, Java, the Lesser Sunda Islands, and, southwest of Indonesia, the Cocos (Keeling) Islands in the Indian Ocean (Wilson and Reeder 1993, Nowak 1999). The range of this bat alone all but guarantees that *I. kopsteini* will eventually be found in the four Southeast Asian countries that have yet to yield col-
collections: Laos, Myanmar (Burma), Singapore, and Vietnam.

For technical assistance during this study, we warmly thank the staff of the National Institute of Public Health, Government of Cambodia. Thanks also to Charles E. Rupprecht, Rabies Section, Viral and Rickettsial Zoonoses Branch, Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia, and to Karen N. Wolf, formerly Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, Virginia. Portions of this research were funded by National Institute of Allergy and Infectious Diseases grant AI 40729 to JEK. The opinions and assertions advanced herein are those of the authors.

Table 1. Bat species known to be hosts of *Ixodes kopsteini* in continental Southeast Asia.

<table>
<thead>
<tr>
<th>Bat Species</th>
<th>Country and State/Province</th>
<th>Reference/Collection No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emballonuridae:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Taphozous theobaldi</em> Dobson</td>
<td>Thailand: Saraburi</td>
<td>Gould et al. 1970</td>
</tr>
<tr>
<td><strong>Molossidae:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Chaerephon johorensis</em> (Dobson)</td>
<td>Malaysia: Selangor</td>
<td>Kohls and Clifford 1968</td>
</tr>
<tr>
<td><em>Chaerephon plicata</em> (Buchanan)</td>
<td>Cambodia: Phnom Penh</td>
<td>RML 123173</td>
</tr>
<tr>
<td><em>Cheirogaleus torquatus</em> Horsfield</td>
<td>Thailand: Kanchanaburi and Saraburi</td>
<td>RML 112146</td>
</tr>
<tr>
<td><em>Mops mops</em> (de Blainville)</td>
<td>Malaysia: Selangor</td>
<td>Tanskul et al. 1983</td>
</tr>
<tr>
<td></td>
<td>Malaysia: Selangor</td>
<td>Kohls and Clifford 1961</td>
</tr>
<tr>
<td></td>
<td>Malaysia: Selangor</td>
<td>Kohls and Clifford 1968</td>
</tr>
</tbody>
</table>
and are not to be construed as official or reflecting the views of the U.S. Departments of the Army, Navy, or Defense.

LITERATURE CITED


Richard G. Robbins, Armed Forces Pest Management Board, Walter Reed Army Medical Center, Washington, DC 20307-5001, U.S.A. (e-mail: richard.robbins@osd.mil), Michael J. Bangs, American Embassy Jakarta, U.S. Naval Medical Research Unit No. 2, Department of Entomology, Parasitic Diseases Program, FPO AP 96520-8132 (e-mail: bangsmj@namru2.med.navy.mil), and James E. Keirans, Institute of Arthropodology and Parasitology, Georgia Southern University, P.O. Box 8056, Statesboro, GA 30460-8056, U.S.A. (e-mail: jkeirans@gasou.edu)
Mealybug Species (Hemiptera: Pseudococcidae) Found on Ornamental Crops in California Nursery Production

Mealybugs (Hemiptera: Pseudococcidae) are troublesome pests of ornamental crops throughout temperate regions of the world, including California. However, it is not certain which mealybug species are most common in California greenhouses and nurseries, and it is not known if recent, invasive species such as the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green), are present.

Surveys and collections were made between November 16, 2001 and March 7, 2003 to nurseries that reported mealybugs. Additionally, mealybugs were also sent directly to the author by growers and advisors in University of California Cooperative Extension. Mealybugs were collected or received from a total of 19 nurseries in five counties.

The mealybugs were slide-mounted according to methods adopted from Kozarzhevskaya (1968) and Williams and Granara de Willink (1992). Slide-mounted mealybugs were identified using keys by McKenzie (1967) and an unpublished manuscript by R. J. Gill.

The mealybug species most frequently found in this survey of California greenhouses were the longtailed mealybug, *Pseudococcus longispinus* (Targioni Tozzetti), and the citrus mealybug, *Planococcus citri* (Risso) (Table 1). With the exception of roses, *P. citri* fed on many short-term crops such as coleus, whereas *P. longispinus* often fed upon perennial crops such as cypress and *Phormium tenax*. The lilybulb mealybug, *Vryburgia amaryllidis* (Bouché), and the obscure mealybug, *Pseudococcus viburni* (Signoret), were commonly found as well. *Vryburgia amaryllidis* is limited to a few plant families (especially Liliaceae and Iridaceae). It occurs on the bulb and on the basal portion of the leaves. *Pseudococcus viburni* was found both on the roots and the aerial portion of the plants, most commonly on short-term crops.

Seven other mealybug species were found to occur less frequently. Many of these mealybugs were specialists found only on one species of plant. For example, the phormium mealybug, *Balanococcus diminutus* (Leonardi), is found only on *Phormium tenax*, and the noxious bamboo mealybug, *Antonina pretiosa* Ferris, is found only on bamboo species (Ben-Dov 1994).

This survey allowed us to obtain a record of the mealybug species present in greenhouses or nurseries in predominant growing areas of California. As growers are increasingly interested in incorporating natural enemies into their insect control programs, information on species composition is helpful for directing future biological control projects.

Thanks to K. Robb, S. Tjosvold and J. Newman (U.C. Cooperative Extension) for assisting with mealybug collections. We would also like to thank the University of California at Davis (arboretum and conservatory), Humboldt State University, Dramm and Echter Inc., Robert Hall Nursery, Golden State Bulb Co., Anderson Seed Co., Weidners’ Gardens Inc., Aedes and Gish Nurseries, Browns’ Plant Inc., Sea Coast Greenhouses, Suncrest Nurseries Inc., Cavanaugh Color, Kitayama Bros. Inc., Botthing Treeland Farms Inc., Sunshine Floral, Keeline Wilcox Nursery, McLellan Botanicals, and Pajaro Valley Greenhouses Inc. for allowing the collection of mealybug specimens at their nurseries. Thank you to Ray Gill for allowing the use the manuscript; The Scale Insects of California: Part
Table 1. Records of mealybugs found during the California nursery survey.

<table>
<thead>
<tr>
<th>Mealybug Species</th>
<th>Counties</th>
<th>Number of Nurseries</th>
<th>Host Plants</th>
<th>Collection Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Antonina pretosa</em> Ferris</td>
<td>Santa Cruz</td>
<td>1</td>
<td><em>Baubusa</em> sp.</td>
<td>7/31/02</td>
</tr>
<tr>
<td><em>Balanococcus diminutus</em> (Leonardi)</td>
<td>Santa Cruz</td>
<td>1</td>
<td><em>Phormium tenax</em></td>
<td>7/31/02</td>
</tr>
<tr>
<td><em>Phenacoccus defectus</em> Ferris</td>
<td>Yolo</td>
<td>1</td>
<td><em>Graptoveria</em> var. ‘spirit of 76’</td>
<td>8/5/02</td>
</tr>
<tr>
<td><em>Phenacoccus solani</em> Ferris</td>
<td>Yolo</td>
<td>1</td>
<td><em>Verbena tendaea</em> ‘alba’</td>
<td>9/16/02</td>
</tr>
<tr>
<td><em>Planococcus citri</em> (Risso)</td>
<td>San Diego</td>
<td>10</td>
<td><em>Rosa</em> sp.</td>
<td>11/16/01</td>
</tr>
<tr>
<td></td>
<td>Santa Cruz</td>
<td></td>
<td><em>Rosa</em> sp.</td>
<td>7/16/02</td>
</tr>
<tr>
<td></td>
<td>Ventura</td>
<td></td>
<td><em>Rosa</em> sp.</td>
<td>7/31/02</td>
</tr>
<tr>
<td></td>
<td>Yolo</td>
<td></td>
<td><em>Rosa</em> sp.</td>
<td>7/17/02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Rosa</em> sp.</td>
<td>2/1/03</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>mandevilla (=<em>Dipladenia</em> sp.)</td>
<td>7/16/02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Coleus blumei</em></td>
<td>7/16/02</td>
</tr>
<tr>
<td></td>
<td></td>
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<td><em>Echeveria chihuahuensis</em></td>
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4. The Mealybugs (Coccoidea: Pseudococcidae). Funding was provided by The California Association of Nurserymen and the USDA Nursery and Floriculture Research Initiative.

LITERATURE CITED


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Larval Development of *Cylindrotoma distinctissima americana* Osten Sacken, 1865 (Tipulidae: Cylindrotominae) on *Maianthemum dilatatum* (Liliaceae) in California

The genus *Cylindrotoma* Macquart is unique among North American crane flies because its members feed on the developing leaves of higher plants. Other members of the nearly worldwide subfamily Cylindrotominae feed on moss as well as higher plants (Alexander and Byers 1981).

One of us (GP) had the opportunity to collect the larvae of *Cylindrotoma distinctissima americana* Osten Sacken on leaves of the false-lily-of-the-valley (or mayberry), *Maianthemum dilatatum* (Wood) Nels. & Macbr. (Liliaceae) in northern California. This report discusses this find and briefly describes the larvae and pupae. This is the first record of this crane fly species, and of the subfamily Cylindrotominae, in California. The previously known distribution of *Cylindrotoma distinctissima americana* was from British Columbia to Oregon (Alexander 1967, Oosterbroek 2002). This is also the first record of this crane fly species feeding on *Maianthemum dilatatum*. Previously recorded host plants in North America are *Allium*, *Anemone*, *Trauttvetteria*, *Stellaria*, and *Viola* (Brodo 1967).

The host plant, *M. dilatatum*, is native to western North America from Alaska to California (Hitchcock and Cronquist 1973). It is especially abundant along the Pacific Northwest coast, where it normally grows in the shade of large trees, but can be found completely exposed, even almost adjacent to the high tide level. It is a perennial normally not reaching over 40 cm tall, that dies back in the fall and grows anew in the spring from slender rhizomes (Hitchcock and Cronquist 1973).

Populations of *M. dilatatum* harboring *Cylindrotoma* larvae were discovered in a moist forest of Sitka spruce (*Picea sitchensis* (Bong.) Carr. (Pinaceae) near Lake Earl in Humboldt County, northwestern California, on April 13, 2001.

The larval and pupal stages (n = 8) were observed and photographed at the site. The mature larvae were unlike any other leaf-feeding insects found on this plant. They were green and relatively smooth except for a pair of small protuberances on the dorsum of each abdominal segment except the last (Fig. 1). The larvae fed on the dorsal and ventral sides of the leaves, leaving large holes very similar to damage caused by sawfly larvae feeding on the same plant species in Oregon. When mature (length = 12 mm), the larvae pupated on the upper surface of the leaves in a very peculiar manner. The last molt was incompletely shed, with the posterior portion of the pupa remaining within the anterior part of the last larval skin (Fig. 2). The skin served as a holdfast to the leaf surface and could not be removed without tearing it apart. This was the only portion of the pupa attached to the leaf surface. The pupae were smooth, green, 13 mm in length, with a pair of thoracic respiratory horns as the only body projections (Fig. 2). Both the larvae and pupae were well camouflaged on the leaves. The adults (length 13 mm) emerged within two weeks after pupation (Fig. 3).

Observations reported here are similar to those reported by Cameron (1918), who studied the same species of Cylindrotominae (under the name of *C. splendens* Doane, 1900) developing on the leaves of *Trauttvetteria caroliniensis* (Walt.) Vail (= *T. grandis* Nutt.) (Ranunculaceae) in British Columbia. It is interesting that this species can develop on both monocots and dicots. In both cases (California and British Columbia) the host plants were understory herbs in damp, well shaded, forested areas.
Figs. 1–3. *Cylindrotoma distinctissima americana*. 1. Mature larva (L = 12 mm) feeding on a leaf of *Maianthemum dilatatum*. 2. Pupa (L = 13 mm) attached to a leaf of *Maianthemum dilatatum* by the dried last larval skin. 3. Adult that emerged from the pupa in Fig. 2.
Cameron (1918) reported mature larvae measuring 17 mm, which is larger than the California specimens. However the sizes of the pupae (11.7–13.3 mm) in British Columbia were similar to those in California (13 mm). According to Cameron (1918), the larvae overwinter and resume development the following spring. This could be quite possible with the California populations, although this aspect of the life cycle was not investigated.

**LITERATURE CITED**


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NOTE

Beetles (Coleoptera) Associated with the External Debris of *Atta mexicana* (F. Smith) (Hymenoptera: Formicidae) from Ojuelos, Jalisco, México

Beetles are closely associated with several species of social insects, especially with ants of the genera *Atta* Fabricius, 1804, and *Acromyrmex* Mayr, 1865 (Navarrete-Heredia 2001 recorded 411 beetle species of 25 families). In México, there are a few faunistic studies on *Atta*-beetle associations. These were done in localities from Estado de México, Morelos, and Querétaro (Hinton and Ancona 1934, 1935; Deloya 1988; Rojas 1989; Márquez-Luna 1994).

In this paper, we provide additional information on beetles associated with the external debris of *Atta mexicana* (F. Smith, 1858) in a “matorral xerófilo” plant association (“chaparral” sensu Leopold 1950), from Presa el Cuarenta, Ojuelos, Jalisco. Specimens were collected from debris of a single ant mound and are deposited in the Entomological Collection of the Centro de Estudios en Zoología with the following label data: MÉXICO: JAL, Ojuelos, Presa El Cuarenta, matorral xerófilo, 27.VII.2003. J. Cortés-Aguilar y C. I. Hermosillo cols., ex detrito de *Atta mexicana*.

In this locality, the following species were collected: *Morion lafertei* Guérin-Méneville, 1844, and one unidentified carabid (Carabidae); *Oosternum attacomis* Spangler, 1962 (Hydrophilidae); *Epiglyptus costatus* (LeConte, 1852). *Pseudister rufulus* (Lewis, 1888). *Xestipyge multilineatum* Lewis, 1888. *Hister* sp., and two unidentified histerid species (Histeridae); one unidentified Aleocharinae: *Philonthus alienus* Bernhauer and Schubert, 1914. *Platydracon fulvomaculatus* (Normann, 1837) (Staphylinidae); *Prichopus angulatus* (Percheron, 1835) (Passalidae); *Onthophagus rufescens* Bates, 1887. *Ataenius holopubescens* Hinton, 1938. *Diapterna dugesi* (Bates, 1887). *Euparixia mexicana* Gordon and McCleve, 2003 (Fig. 1) (Scarabaeidae); one unidentified scydmenid (Scydmaenidae); *Lapethus* sp. (Cerylonidae); one unidentified anthicid (Anthicidae); and *Bycrea villosa* Pascoe, 1868 (Tenebrionidae).

*Euparixia mexicana* was recently described as a cryptic species similar to *E. duncani* Brown. Actually some specimens were confused with *E. duncani* by Woodward and Cartwright (1967). It is now known from the Mexican states of Sonora, Sinaloa, and Jalisco. This species is recognized easily by the shape of the pronotum that is con-

Fig. 1. Dorsal view of *Euparixia mexicana.*
stricted only in the posterior one-third, with the posterior angles prominent and acute, and by the pronotal disc with shallow punctures separated by a flat pronotal surface (Fig. 1). Label data lacks specific host records, but A. mexicana was presumed to be the host. In this note, we record for the first time an accurate host record for this species.

One question remains on the identity of the specimens cited as E. duncani by Woodruff and Cartwright (1967) from México. Gordon and McCleve (2003) stated that E. duncani is not known from México, so do the specimens cited from Durango and Puebla belong to E. mexicana or to a new cryptic species?

Acknowledgments.—I thank my family (JLNH): G. A. Quiroz-Rocha, J. Quiroz Yañéz, L. A. Navarrete-Quiroz, and E. M. Navarrete-Quiroz (her first fieldwork at the age of 18 months), and to our friends C. I. Hermosillo Peña, Ma. F. Nuñez-Yépez, and M. Vásquez-Bolaños for their company during the fieldwork.

LITERATURE CITED


José Luis Navarrete-Heredia and Jesús Cortés-Aguilar. Centro de Estudios en Zooló gia, CUCBA, Universidad de Guadalajara, Apdo. Postal 234, 45100, Zapopan, Jalisco, México (e-mail: snavarre@cucba.udg.mx, jcortesaguilar@hotmail.com)
Homonymy in the Coccinelidae (Coleoptera), or Something Fishy About *Pseudoscymnus* Chapin

Edward Chapin (1962) discovered some anomalous characters in certain species of *Scymnus* from Japan while preparing a report on the lady beetles (Coccinellidae) of Micronesia. The species in question possess true trimerous tarsi and reduced antennae (only nine antennomeres) terminating in extraordinarily long setae. Chapin proposed the new genus *Pseudoscymnus* for these unusual lady beetles, based on *Scymnus hareja* Weise (type species) and five other species—*S. kurohime* Miyatake, *S. seboshii* Ohta, *S. sylvaticus* Lewis, *S. pilicrepus* Lewis and *S. quinquepunctatus* Weise—the last four included tentatively.

In the decades that followed Chapin’s contribution, numerous additional species have been added to the genus, including the delightfully sibilant *Pseudoscymnus tsugae* Sasaji and McClure 1997, a Japanese species which has been introduced for control of woolly hemlock adelgid, *Adelges tsugae* Annand, in the eastern United States (McClure and Cheah, in press). Unfortunately, the name *Pseudoscymnus* Chapin is a junior homonym of *Pseudoscymnus* Herre 1935 (Vandenberg 2002). Herre’s (1935) usage of the name for a genus of kitefin shark (Squaliformes: Dalatiidae) predates Chapin’s by more than a quarter century (Mould 1999) and therefore has priority according to article 52.3 of the International Code of Zoological Nomenclature (ICZN) (International Commission on Zoological Nomenclature 1999).

*Sasajiscymnus* Vandenberg, new name

*Pseudoscymnus* Chapin 1962: 50 (Type species: *Scymnus hareja* Weise 1879) (not Herre 1935, type *P. boshuensis* Herre).

Type species.—*Scymnus hareja* Weise 1879 (according to article 72.7 of the ICZN 1999).

Etymology.—The replacement name is composed of Sasaji + *Scymnus* (= a young animal, cub, whelp) masculine, and is dedicated to Hiroyuki Sasaji, a leading specialist in lady beetle systematics and an inspiration to all who wish to understand the evolution and diversity of this important group.

Remarks.—In accordance with articles 60.3 and 72.7 of the ICZN (1999), I propose *Sasajiscymnus* as a replacement name and objective synonym of *Pseudoscymnus* Chapin. The more than 50 named species (Yu and Montgomery 2000) currently considered to be in the genus *Pseudoscymnus* Chapin are hereby transferred to *Sasajiscymnus*. To maintain brevity, only the following new combinations are proposed herein: *Sasajiscymnus tsugae* (Sasaji and McClure), *S. kurohime* (Miyatake), *S. seboshii* (Ohta), *S. sylvaticus* (Lewis), *S. pilicrepus* (Lewis) and *S. quinquepunctatus* (Weise).

It is interesting to note that the name *Scymnus* also has entered into homonymy. It has been proposed at least twice as a generic name for a shark (*Scymnus* Cuvier 1816, type *Squalus americanus* Gmelin 1789, and *Scymnus* Quoy and Gaimard 1824, type *Scymnus brasiliensis* Quoy and Gaimard 1824), but senior status is held by the coccinellid genus *Scymnus* Kugelann 1794 (type *Scymnus nigrius* Kugelann 1794, by subsequent designation of Korshesky (1931)). Likewise, the binomial *Scymnus brasiliensis* appears as both a shark (*Scymnus brasiliensis* Quoy and Gaimard 1824, above, presently classified in *Isistius*) and as a lady beetle (*Scymnus brasiliensis* Weise 1929, presently regarded as a
junior synonym of *Dionius seminulatus* (Mulsant 1850) (Gordon 1999). According to Article 57.8.1 of the ICZN (1999), such homonymy between identical species-group names in combination with homonymous generic names established for different nominal genera is to be disregarded.

**LITERATURE CITED**


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First Report of the 13-Year Periodical Cicada, Magicicada periodical (Walsh and Riley) (Hemiptera: Cicadidae) in Maryland

Periodical cicadas (Magicicada spp.) are restricted to the eastern United States and attract attention from the general public because of the amazing numbers of individuals that typically emerge. Marlatt (1907) designated specific Roman numerals for the possible 17-year periodical cicada broods (I–XVII) and the possible 13-year periodical cicada broods (XVIII–XXX). The author has been engaged in determining the extent of the range of each periodical cicada brood found in the mid-Atlantic area since Brood II emerged in 1996.

Historically, only two broods of periodical cicadas have been recorded from Maryland. Brood II occurred in 1996 and was restricted to the southern Maryland counties of Calvert, Charles, and St. Mary’s, and was unexpectedly found to be absent just south of the region below Mattapany Road between St. Mary’s City and St. James, St. Mary’s County, Maryland, south to Point Lookout, an area that appeared otherwise suitable for periodical cicadas. Brood X, the most widespread and abundant brood in Maryland occurring in the central and western sections of the state, emerged in 1987 and will soon emerge again in 2004. Brood V has been recently documented in the westernmost county in Maryland, Garrett County, in 1999 (J. Zyla, in litt.). Although no 13-year cicadas had been reported from Maryland, and no emergence of any periodical cicada brood was expected in Maryland during 1998, scattered reports of periodical cicadas during May 1998 led to a survey of the magnitude and geographical extent of this emergence. In May 1998, the emergence year for 13-year Brood XIX farther south, a single live Magicicada male was presented to the author by a local residence living at the end of Denko Road in Dameron, Maryland. At first it was thought this specimen may be a two-year delayed 17-year cicada from Brood II. During the next week however, more reports of periodical cicadas surfaced. Subsequent visits to the neighborhood yielded hundreds of emerging individuals.

Because the Brood II emergence was well documented in Maryland in 1996 and its distribution mapped out, the area south of the Brood II emergence was selected for study. The same survey system used for the Brood II study was employed. Beginning with the area where the initial specimen was found, the study area was crisscrossed by vehicle and each woodlot in the study area was surveyed for the presence of Magicicada (represented by either specimens or sound recordings). Voucher specimens were collected at various sites and sent to the University of Michigan, Museum of Zoology, along with sound recordings for confirmation. These specimens were confirmed to be M. periodical (Walsh and Riley), a 13-year periodical cicada species and not M. septendecim (L.), the 17-year periodical cicada from Brood II, found just north of this area. This is the first report of Magicicada periodical in Maryland. Although specimens of M. periodical and M. septendecim are difficult to distinguish, M. periodical has a dominant call pitch (or frequency) of 1.0–1.1 kHz, while M. septendecim has one of 1.3 to 1.45 kHz (Marshall and Cooley 2000). The call recordings from the southern Maryland emergence had a dominant pitch of 1.1 kHz (D. Marshall, personal communication) confirming that the emerging cicadas were M. periodical and not M. septendecim. In addition, the M. periodical specimens were characterized by mostly orange abdominal sternites, rather than the darker coloration of M. septendecim.
The 1998 emergence of Brood XIX in Maryland was restricted to lower St. Mary's County, in and around the small town of Dameron, 8.0 miles south of Lexington Park and 1.8 miles north of Ridge. Only *Magicicada tredecim* were collected and recorded. The first occurrence was the lone individual provided to the author on May 9. The overall emergence began and became noticeable on May 15, 1998, and individuals were collected as late as June 9. The emergence density appeared similar to that observed during emergences of other *Magicicada* broods in Maryland. No chorus was heard after June 9, possibly because the weather turned unseasonably wet and cold.

Brood XIX periodical cicadas emerged in 1998 in large numbers in a very small area in St. Mary's County, Maryland. The county is isolated by water, the Potomac River on the west and the Chesapeake Bay to the east. Just north of this area, Brood II emerged in great numbers in 1996. The contact area between these two broods was Mattapany Road, which runs in a west to east direction. To the north of this road, Brood II species of *M. septendecim*, *M. septendecula* Alexander and Moore and *M. cassini* (Fisher) occurred in 1996. South of this road, *M. tredecim* of Brood XIX was present in 1998, while *M. tredecula* Alexander and Moore and *M. trecassini* Alexander and Moore were noticeably absent. There is no obvious difference between the forest types found on either side of Mattapany Road. Why a relict population of *M. tredecim* has survived in such a small area just south of and in contact with a 17-year periodical cicada brood is unknown. The nearest known location of *M. tredecim* is 60 miles due south of Dameron, Maryland, in St. James City and Charles City counties, Virginia (Sahli and Ware 1998; previously the northernmost reported localities of *M. tredecim*). This new site constitutes the northernmost known locality of Brood XIX *Magicicada tredecim* occurrence in the eastern United States (Cooley et al. 2003). The Maryland emergence is now the northernmost known occurrence of Brood XIX *Magicicada tredecim* in the eastern United States (Cooley et al. 2003) and is a considerable extension of the known geographic range of *M. tredecim*.

Acknowledgments.—I thank Patty Craig for supplying the first specimen. Thanks are also due to David Marshall, who confirmed the identity of *Magicicada tredecim* from Maryland by analysis of the specimens and song recordings sent to the University of Michigan, Museum of Zoology. I also
thank the anonymous reviewers for their suggestions and time.

LITERATURE CITED


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Areas of the mid-Atlantic region of the United States (Maryland, Virginia and the District of Columbia) experienced an unexpected sporadic emergence of periodical cicadas (*Magicicada* spp.) in 2000. Periodical cicada emergences in this area attract public attention due to their abundant numbers, with population densities approaching 1 million individuals per acre (Dybas and Davis 1962). Each regional *Magicicada* emergence in a specific year is designated as a brood. Broods have been differentiated by an assigned Roman numeral reflecting their order of emergence (Marlatt 1907). There are twelve known 17-year broods (I–X, XIII, and XIV) and three 13-year broods (XIX, XXII, and XXIII). Since Brood X is expected to emerge in 2004 in this same area, it is believed that the 2000 emergences were 4-year accelerations of Brood X. Other 4-year accelerations of Brood X in 2000 were reported from Ohio (Kritsky and Simon 1996), Indiana, and Illinois (Cooley, Richards, Marshall, personal communication).

In the past, Brood VI has been reported sporadically throughout the mid-Atlantic region. However, recent studies by Cooley and Marshall (personal communication) suggest that Brood VI occurs further west, in western portions of North and South Carolina, and northern Georgia. Because the 2000 mid-Atlantic emergence was outside the known area of Brood VI, researchers have theorized that this emergence was a 4-year acceleration of Brood X. If this hypothesis is true, then all the reports should be contained in the known range of Brood X.

Since 1996, the author has documented the presence or absence of periodical cicada broods (II, V, VIII, and IX) in the mid-Atlantic region both in the field and through reviewing historical records in the literature. To date, there has not been a single record of two different broods occurring in the same woodlot. No known populations of the four species of periodical cicadas (3 species of the 17-year cicada, *M. septendecim* (L.), *M. septendecula* Alexander and Moore, and *M. cassini* (Fisher), and one species of the 13-year cicada, *M. tredecim* (Walsh and Riley), found in the mid-Atlantic region (Pennsylvania, West Virginia, Virginia, Maryland, District of Columbia, and Delaware) overlap. In fact, many contact areas where two different broods meet are characterized by a gap where no periodical cicadas are known to occur. Based on this information, it is the author’s opinion that any populations that occur in off-years within a known well-established brood area are most likely accelerations or decelerations of that well-established brood and not a separate brood.

Brood X, in the mid-Atlantic, is found in northern Virginia, western and central Maryland, northern Delaware and southern Pennsylvania, as well as, the District of Columbia. During the unexpected 2000 emergence, reports of stragglers were solicited throughout the area. All the information obtained was organized by county and placed on a map of the known range of Brood X. Following is a list of the recorded populations that were reported to the author during May and June of 2000. All the sites reported in 2000 were within the historical boundaries of Brood X.

A total of 124 independent reports were obtained from the Maryland, Virginia, and District of Columbia area. Six were received from the District of Columbia, 90
Fig. 1. Four-year accelerations reported in 2000 by county within the historic range of Brood X.

reports were received from Maryland (7 counties), and 28 were recorded from Virginia (4 counties). No reports were obtained from outside the known historic area of Brood X. All the reported 2000 sightings were of sporadic occurrences and although they may have contained dense local emergences of periodical cicadas, they were not the wide-ranging, regional emergences typical of these species. An entomologist residing in Bowie, Prince George’s County, Maryland, recorded the daily numbers of periodical cicada exuviae collected in her yard. She reported that mud turrets began to appear on May 4. On May 9, 62 nymphs were found walking around from 10 pm to midnight. Almost 3,000 (2902) exuviae were collected from the period May 8th to June 1st, 2000. However, throughout the remainder of the neighborhood, most yards had no periodical cicadas emerging at all. This same neighborhood was the site of an abundant emergence of Brood X in 1987. There are similar reports throughout the 2000 emergence area.


Acknowledgments.—I thank Gaye Williams for her encouragement and soliciting and/or supplying many of the reports obtained. I also thank the anonymous reviewers for their suggestions and time.
LITERATURE CITED


John D. Zyla, J.F. Taylor, Inc., Lexington Park, MD 20680, U.S.A. (e-mail: jzyla@jfti.com)
Book Review


This weighty tome is a compendium of all things insect, with a few things arachnid thrown in for good measure. True to its title, all of the information is presented alphabetically in a series of articles, beginning with "Acari" and ending with "Zygentoma." Sorry, no K's, Q's, or X's! But those looking for essays covering katydids, killer bees, and queens need not despair! They are directed to "Orthoptera," "Neotropical African bees," and "Caste."

The Encyclopedia is handsomely and sturdily bound. Its colorful jacket bears what is now almost obligatory for any insect book of caliber, praise from Edward O. Wilson and a somewhat tongue-in-check foreword by May Berenbaum. The Encyclopedia is printed on heavy acid-free paper and gives every appearance of being able to survive a long life of use.

The book features 271 self-contained articles written by some of the world’s leading authorities. The list of 164 contributors reads like an international "who’s who" in entomology. Each contributor listed is further identified by their institution and a list of their titles that appear in the work. Editors Resh and Cardé are to be commended for assembling such a fine group of experts.

A guide to the Encyclopedia lays out the format of the work, including subject areas and article format. Each article is fully cross-referenced and followed by a brief bibliography that serves as an extension of the article itself rather than an exhaustive accounting of the articles’ subject. Nearly all of the articles are peppered with black and white or color illustrations and photographs. Most of the color photos used are bright, sharp images that seem to jump off the page. Curiously, the sources of many of the images used, other than letter-opening photos, are not credited in their captions, nor are those credits to be found anywhere in the book.

Readers can locate topic articles either alphabetically in the Table of Contents or find them listed in the Contents by Subject Area. In this section, twelve subject areas are identified, including anatomy, physiology, behavior, evolution, reproduction, development and metamorphosis, major groups and notable forms, interactions with other organisms, interactions with humans, habitats, ecology, and history and methodology. The content of the subject areas "interactions with humans" and "history and methodology" might have been more finely tuned and divided into three categories: medical and veterinary entomology, cultural entomology, and applied entomology. Still, the interested reader should have no trouble in locating pertinent articles of interest.

Thirty-three orders of insects are covered in the book, including the recently discovered Mantophasmatodea, the first new insect order to have been described in more than 80 years. Some readers may quibble with the usage of some ordinal names, such as Archaeognatha for Microcoryphia. Embiidina for Embioptera, and Zygentoma for Thysanura. Readers seeking information on the order Hemiptera will have to work a little harder. Listed in the table of contents, but not the contents by subjects, readers are directed to hop, skip and jump through the entire work to find separate essays on the suborders Auchenorrhyncha, Prosorrhynca (Heteroptera and Coleorrhynca for the uninitiated, including myself!) and Sternorrhynca.

Of particular interest to this reviewer, and what I think sets this book apart from other comprehensive works on insects thus far,
are the detailed articles on cultural entomology, folk beliefs and superstitions, museums and display collections, biotechnology and insects, insect zoos, photography of insects, and teaching resources. These benchmark articles are important resources for not only entomologists, but also for educators and naturalists and go a long way to increasing the utility of the Encyclopedia to an audience well beyond the entomological community.

Another useful feature is a glossary designed specifically to define approximately 800 terms within the context that they are used in the text. I think non-specialist readers in particular will find the glossary very accessible. The Encyclopedia also includes a subject index that includes taxa cited in the text.

In the Preface, the editors’ stated goal was “to convey the exciting, dynamic story of what entomology is today. It is intended to be a concise, integrated summary of current knowledge and historical background on each of the nearly 300 entries presented. Our intention has been to make the encyclopedia scientifically uncompromising; it is to be comprehensive but not exhaustive.” They also wanted to “cover the diverse interests” of not only entomological specialists and generalists, but also educators, students, hobbyists, and naturalists. To these ends the editors and contributing writers have clearly succeeded in creating a rich, spectacular volume that is a must for those who demand libraries with thorough, up-to-date, and superbly accessible information on insects.

Arthur V. Evans, Research Associate, Department of Entomology, National Museum of Natural History, Smithsonian Institution, and Department of Recent Invertebrates, Virginia Museum of Natural History. Home address: 1600 Nottoway Ave., Richmond, VA 23227, U.S.A. (e-mail: arthurevans@earthlink.net)
Book Review


As an identification manual, Janet Ciegler’s “Water Beetles of South Carolina” goes far beyond any other state-wide treatment of the aquatic beetle families. It is “Volume 3” of the “Biota of South Carolina” series which has thus far been devoted to highly speciose groups of Coleoptera. Florida is the only other southeastern state for which the entire water beetle fauna has been comparably covered at the species level in a single volume (Epler 1996, Young 1954). This book additionally includes the terrestrial Hydrophilidae (Sphaeridiinae) and several families that are semi-aquatic. While it does not describe larval stages, it offers illustrations of adult examples of each genus known to be represented in the state, and those expected to occur there. Descriptions of 374 species in 96 genera are given, with notes and citations of the most recent monographic works for each group. General distributional data are given for each species in addition to the specific localities known for the state, and often with notes on habitats and seasonal occurrence. The eye-catching color cover and photographs will get the attention of any entomologist.

Along with the keys and comparative diagnoses, the various illustrations make this volume more useful and attractive. Minor shortcomings with some of the reproduced photographs of the smaller species are evident, e.g., being out of focus, or the specimen chosen does not depict the body outline accurately (elytra separated or head de-
sion in the book is the family Lutrochidae, represented in the region by *Lutrochus laticeps* Casey (Spangler et al. 2001); no records are known for South Carolina and it does not quite fit the author’s criteria for inclusion (page 3), but the beetle would be expected to occur there as it is known from a broad area including Alabama, Tennessee and Maryland.

In the coverage of Hydrophilidae, a recent review of the distribution, habitats and literature for *Hydrobiomorpha casta* (Say), including a northern range extension for Virginia (Steiner 1996) would have been worthwhile to cite under that species. Users of this volume should be aware that the hydrophilid subfamilies Hydrochidae and Helophorinae are elevated to family level by many hydrophilid systematists, but with continuing disagreement, as reviewed by Van Tassell (2001); the author uses the tribal classification of Hansen (1991) but chose not to use his elevated familial scheme.

The book offers the user full citations of the related literature, a glossary of anatomical and other terms, appendices listing localities with physiographic regions and species newly reported for the state, and an index of taxa including synonyms. While researchers using macroinvertebrates for water quality assessment may need to consult other references in order to identify beetle larvae, this is nevertheless the most comprehensive coverage of the species for the southeastern region. It will be useful in South Carolina’s neighboring states for identification at the species level, and a good guide to genera and families of eastern North America. The book is a tool for the regional biogeographer, teacher of natural history, heritage program biologist, and museum curator, and may inspire other state-wide works of a similar caliber.

**LITERATURE CITED**


Warren E. Steiner, Jr., *Department of Entomology, NHB-187, Smithsonian Institution, Washington, DC 20560, U.S.A. (e-mail: steiner.warren@nmmh.si.edu)
Volume 105 of the *Proceedings* included four issues with a total of 1,104 pages. Ninety-seven regular papers, 23 notes, 4 book reviews, 3 obituaries, the membership list, minutes of Society meetings, reports of officers, instructions for authors, and the table of contents for volume 105 were published. About 115 manuscripts (regular papers and notes) were submitted for consideration for publication from November 1, 2002, to October 31, 2003.


I extend thanks to Ray Gagné, book review editor, for his excellent work in obtaining book reviews, and to Ray, Tom Henry, and Wayne Mathis of the Publications Committee for their encouragement and support. Also, I am grateful to the many reviewers for their time-consuming efforts and constructive reviews of manuscripts. Their contributions are essential to help increase the quality of papers published in the *Proceedings*.

Respectfully submitted,

David R. Smith, Editor

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**Treasurer**

**SUMMARY FINANCIAL STATEMENT FOR 2003**

<table>
<thead>
<tr>
<th></th>
<th>General Fund</th>
<th>Special Publication Fund</th>
<th>Total Assets</th>
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<td>$53,567.44</td>
<td>$136,748.31</td>
<td>$190,315.75</td>
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| Net Changes in Funds | $9,588.12   | ($59,969.13)    | ($50,381.01) |


Respectfully submitted,

Michael G. Pogue, Treasurer
Membership Secretary

In 2003, the Society received applications for membership from 23 people:

<table>
<thead>
<tr>
<th>Patrick B. Beauzay</th>
<th>John W. McCready</th>
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<tr>
<td>Susan Broda</td>
<td>Mark A. Muegge</td>
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<td>Ebru Gül Cilbiroglu</td>
<td>Jose Luis Navarette-Heredia</td>
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<td>Andrew Richard Cline</td>
<td>Cervantes Peredo</td>
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<td>Jane Earle</td>
<td>John Dennis Plakidas</td>
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<td>Colin Favret</td>
<td>Valerie Schawaroch</td>
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<td>Dennis Heimdal</td>
<td>Doug Strom</td>
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<tr>
<td>Ronald A. Hellenthal</td>
<td>James Bolling Sullivan</td>
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<td>Harold W. Ikerd</td>
<td>Lu Sun</td>
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<td>Kevin Kirchner</td>
<td>Nick Wiersema</td>
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<td>Heather Laflin</td>
<td>James R. Wiker</td>
</tr>
<tr>
<td>Chris Looney</td>
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</tbody>
</table>

Each applicant was sent a letter of welcome to the Society and his/her name was read at a regular monthly meeting. The number of applications decreased 8% from 2002. Other letters from the Membership Secretary included five letters to guest speakers, 11 letters to special fund contributors, two replies to requests for information, one thank you letter to an outgoing officer, and one letter of welcome to an incoming officer.

Respectfully submitted,
Holly B. Williams,
Membership Secretary

President-Elect

The 1,075th meeting of the Entomological Society of Washington was held on 11 June 2003. It consisted of the Annual Banquet, held this year at the Uniformed Services University of Health Sciences in Bethesda, Maryland. A cash bar opened at 6:00 p.m., with the formal banquet following at 7:00 p.m. Approximately 65 members and guests were in attendance. At 8:00 p.m. the speaker, Carll Goodpasture, an entomologist, geneticist and freelance photographer, was introduced by President-Elect Eric Grissell. The title of Carll’s talk was “Entomological Crossingover: Where Art and Science Meet.” The talk was illustrated with Carll’s photographs and two DVD presentations. The meeting ended at about 9:30 p.m.

Respectfully submitted,
E. Eric Grissell,
President-Elect
SOCIETY MEETINGS

1,076th Regular Meeting—October 2, 2003

The 1,076th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby room of the National Museum of Natural History, Washington, D.C., by President-elect Eric Grissell, standing in for President Jon Mawdsley, at 7:06 p.m. The meeting was attended by 18 members and 10 guests. The minutes of the 1,074th and 1,075th meetings were approved with minor modification.

There were no new applicants for membership or new members present. Four guests were introduced.

In miscellaneous business, Dave Furth announced that the ESW website has been recently updated.

For exhibits, Art Evans gave a rapid-fire slide show of impressive new shots of arthropods from Virginia, North Carolina, and Tennessee. Dave Furth displayed the books “Results of the Zoological Missions to Australia of the Regional Museum of Natural Sciences of Turin, Italy” by M. Daccordi and P. M. Giachino (eds.) and “Chrysomelidae: The Leafbeetles of Europe and the Mediterranean Area” by A. Warchalowski. Dave Furth passed around a sticky trap that had captured an invasive close relative of the venomous Brown Recluse spider in the Natural History Building basement.

Dave Furth introduced the speaker, Dr. Chris Desjardins, a Ph.D. student of the University of Maryland and Maryland Center for Systematic Entomology. His presentation was entitled “Diparine Wasp Diversity and Collecting in South Africa and Australia.” The pteromalids are generally the waste-basket family of Chalcidoidea, with some 20 to 30 subfamilies. One of them is Diparinae, a group comprising over 100 species in 31 genera, with lengths often in the 1–2 mm range. Sexual dimorphism is widespread, with many females wingless, though little is known of their habits. The subfamily is cosmopolitan, with highest generic richness in Australia and South and East Africa. Off he went, with his sights set on fresh specimens for his molecular analysis. Desperately trying to follow the uncooperative rains with his yellow pan-traps, Chris was getting pretty dejected until he was side-tracked by some harrowing trials of the field, which were eventually compensated for in chalcidooids. There were many rhinos but it was a tick that nailed him.

The meeting was adjourned at 8:25 p.m. Refreshments were provided by the Society.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

1,077th Regular Meeting—November 6, 2003

The 1,077th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby room of the National Museum of Natural History, Washington, D.C., by President Jon Mawdsley, at 7:12 p.m. The meeting was attended by 18 members and 13 guests. The minutes of the 1,076th meeting were approved as read.

There were 17 new applicants for membership, which will be re-read at the January meeting. One new member was present. Four guests were introduced.

The ESW nominating committee, Dave Furth and Dave Smith, reported that all but one of the current officers have offered to continue in their positions. Jason Hall was nominated for President-Elect. Voting will take place at the next meeting.

rows welcomed feedback on his arthropod checklist of Dyke Marsh, which can be found at http://biodiversity.georgetown.edu/index.cfm. Dave Furth had on hand the coffee-table book, “Wildlife Spectacles,” of the CEMEX publication series, by R. A. Mittermeier et al.

Dave Furth introduced the speaker, Dr. Stefan Cover, of the Museum of Comparative Zoology, Harvard University, who spoke about “Ant Systematics in the 21st Century: North America, a Case Study.” Dr. Cover asserted that a third directional advance, after phylogenetics and molecular analysis, is emerging among ant workers. The catalyst was the key to world genera published in 1990 and development of additional collecting techniques, which has resulted in a flood of new specimens and a push for biodiversity inventories. The automontage imaging system is invaluable in this endeavor, as have been the 10-day ant courses being offered for the last three years, which have trained 74 students and served as the nerve center of the colony of busy ant workers. Dr. Cover argued that the world ant fauna will never be known unless “business-as-usual” is scrapped for weaving together smaller pieces, such as regional faunal lists, making more information available on the WWW, and reliance on digital images accompanied by simplified descriptions.

The meeting was adjourned at 8:37 p.m. Refreshments were provided by the Society.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

1,078th Regular Meeting—
December 4, 2003

Despite the forecast for snow and the threat of no electrical power, and in the face of stiff competition from the annual tree-lighting gala at George W.’s place, the stalwart attendees (18 members and 9 guests) of the 1,078th regular meeting of the Entomological Society of Washington were all settled in for a long winter’s nap by President Jonathan Mawdsley at 7:05 p.m. I seriously doubt that there were visions of sugar-plums dancing in anyone’s head . . . but I could be wrong. Minutes of the 1,077th meeting were read by John Brown, pinch-hitting for Recording Secretary Stu McKamey, and were approved following trivial comments.

As the December meeting functions as the Annual Meeting for the Society, there were brief reports from the officers. Dave Smith (editor) reported that volume 105 of the Proceedings included a whopping 1,104 pages—our largest volume ever. Jon Mawdsley reported on the chores handled by Holly Williams, our corresponding secretary/membership chair (a new amalgamation of duties). Dave Furth (program co-chair) commented on the status of our program for the upcoming year. Furth also provided a brief overview of our financial state compiled by Mike Pogue, our Treasurer. With total assets of $190,315 and change, the Society is in good financial shape.

The reports were followed by the annual election of officers, with all but the president coerced into continuing to perform in their present capacity: Buck Lewis as Custodian, Dave Furth and John Brown as Program Co-chairs, Holly Williams as Corresponding Secretary, Stu McKamey as Recording Secretary, Dave Smith as Editor, Mike Pogue as Treasurer, and newly elected President-Elect Jason Hall. Jon Mawdsley will serve as Immediate Past President when President Eric Grissell takes the reins of the Society in January.

The notes and exhibitions portions of the program was mercifully brief, unlike this report, with Mawdsley displaying a new book, “The Pollinator Conservation Handbook” (published by the Xerces Society); Warren Steiner sharing a new book, “Water Beetles of South Carolina”; and Furth awing the audience with two new ‘tees’ purchased at the recent ESA meeting.

Finally, Program Co-chair Dave Furth introduced the evening’s speaker. John Stra-
zanac, from the Department of Plant and Soil Sciences/Entomology at West Virginia University, Morgantown, whose talk was titled “The Agony and the Ecstasy: Results of Seven Years of Sampling Central Appalachian Arthropod Diversity.” Dr. Strazanac presented an interesting array of factoids, methodologies, and species accumulation curves resulting from this intensive survey in West Virginia and Virginia. The primary focal groups of the sampling effort were macrolepidoptera, Symphyta, Carabidae, Araneae, and Tachinidae. Sampling techniques included canvas bands, foliage pruning, light traps, malaise traps, and pitfall traps. Dr. Strazanac estimated that well over a million specimens were handled during the course of the work.

In his final action as President of the Society, Mawdsley handed off the gavel to incoming President Grissell. It was a touching moment, as usual—yawn. In his first action as President, Grissell boldly and confidently, but in a gentler and kinder manner, adjoined the meeting at about 8:30 p.m. Refreshments following the meeting were provided by the Society, amply augmented by Ralph Eckerling, whose nog, hard stuff, and Christmas cookies added to the festive mood of the post-meeting chatter. The room was vacated by a little after 9:00 p.m. to avoid being left in the dark, something most of us are used to anyway.

Respectfully submitted,

John W. Brown

Pinch-hitting Recording Secretary
NOTICE OF NEW PUBLICATION

A Catalog of the Cecidomyiidae (Diptera) of the World

Entomological Society of Washington Memoir No. 25

This catalog, the first complete catalog of the family since 1913, lists the 5,451 species and 598 genera of living and fossil Cecidomyiidae or gall midges of the world. It provides information on species distribution, hosts, and types, and original and subsequent helpful references. Within subfamilies, genera are listed in alphabetical order but are each cross referenced in an appendix where they are arranged in an annotated classification. One new species is named, many new names, new synonyms, and new combinations are proposed, and several type species are designated. A single index lists all generic and specific names of Cecidomyiidae with their authors, as well as hosts, host family for plants, host order and family for arthropods, and order for fungi.

ENTOMOLOGICAL SOCIETY OF WASHINGTON
http://entomology.si.edu/ESW/ESWMenus.lasso

Information and Officers
    Bylaws
    History
    First 100 Years
    Past Presidents
    History of the ESW Seal
    Information for Authors
    Available Publications
    Meetings
    Members Database
    Membership Application
    Subscription
A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera), by E. Eric Grissell and Michael E. Schauf. 85 pp. 1990 .......... $10.00
Revision of the Oriental Species of *Aphisitina* Chevrolat (Coleoptera: Chrysomelidae), by Alexander S. Konstantinov and Steven W. Lingafelter. 349 pp. 2002 .......... 40.00
Revision of the Genus *Anoplophora* (Coleoptera: Cerambycidae), by Steven W. Lingafelter and E. Richard Hoebeke. 236 pp. 2002 .......... 30.00

MEMOIRS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Memoirs 2, 3, 7, 9, 10, 11, and 13 are no longer available.

No. 5. A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 298 pp. 1957 .......... 15.00
No. 12. The Holarctic Genera of Mymaridae (Hymenoptera: Chalcidoidea), by Michael E. Schauf. 67 pp. 1984 .......... 5.00
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 Elaphidini 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. 24. Holocerini of Costa Rica (Lepidoptera: Gelechioidae: Coleophoridae: Blastobasinae), by David Adamski. 147 pp. 2002 .......... 18.00
No. 25 A Catalog of the Cecidomyiidae (Diptera) of the World, by Raymond J. Gagné. 408 pp. 2004 .......... 50.00

Back issues of the Proceedings of the Entomological Society of Washington are available at $60.00 per volume to non-members and $25.00 per volume to members of the Society.

Prices quoted are U.S. currency. Postage extra on all orders. Dealers are allowed a discount of 10 percent on all items, including annual subscriptions, that are paid in advance. All orders should be placed with the Treasurer, Entomological Society of Washington, % Department of Entomology, Smithsonian Institution, P.O. Box 37012, MRC 168, Washington, D.C. 20013-7012.
CONTENTS
(Continued from front cover)

PACHECO, JOSÉ, WILLIAM MACKAY, and CYNTHIA MORGAN—A new species of Gnamptogenys Roger of the sulcata group (Hymenoptera: Formicidae) from Bolivia ................................................................. 434

PERECHO, LUIS CERVANTES—Allooeorychneus trimacula (Stein) (Heteroptera: Nabidae: Prostommatinae), a predator of Rhyparochromidae (Lygaeoidae) associated with figs in Mexico .................................................................................................................................................. 346

PINTO, JOHN D.—A review of the genus Doirania Waterston (Hymenoptera: Trichogrammatidae), with a description of a new species from North America ............................................................ 352

POINAR, GEORGE, JR. and ALEX E. BROWN—A new genus of primitive crane flies (Diptera: Tanyderidae) in Cretaceous Burmese amber, with a summary of fossil tanyderids ........................................................................................................... 339

SCHAEFER, CARL W.—Key to the genera of New World Alydidae (Hemiptera: Heteroptera) . 280

SPINELLI, GUSTAVO and ART BORKENT—New species of Central American Culicoides Latreille (Diptera: Ceratopogonidae) with a synopsis of species from Costa Rica ......................................................................................... 361

STEINLY, BRUCE A.—Primary consumer and detritivore communities (Diptera: Ephyridae) in newly restored and constructed wetlands .............................................................................................................. 460

TOGASHI, ICHIIJ—Description of a new species of the genus Eriocampopsis Takeuchi (Hymenoptera: Tenthredinidae) from Japan ................................................................................................................................. 421

WHEELER, A. G., JR. and E. RICHARD HOEBEKE—New records of Palearctic Hemiptera (Sternorrhyncha, Cicadomorpha, Heteroptera) in the Canadian maritime provinces .................................................................................... 298

YASUNAGA, TOMOHIDE—A new genus and new species of mirine plant bug (Heteroptera: Miridae; Mirini) from the Ryukyus, Japan ................................................................................................................................. 407

ZHOU, CHANG-FA, LU SUN, and W. P. McCAFFERTY—A new species of Brachycercus Curtis (Ephemeroptera: Caenidae) from China .................................................................................................................. 312

NOTES

LAFLIN, H. M., P. J. GULLAN, and M. P. PARRELLA—Mealybug species (Hemiptera: Pseudococcidae) found on ornamental crops in California nursery production ................................................................................. 475

NAVARrete-HEREdIA, JOSÉ LUIS and JESÚS CORTÉS-AGUILAR—Beetles (Coleoptera) associated with the external debris of Atta mexicana (F. Smith) (Hymenoptera: Formicidae) from Ojuelos, Jalisco, México .................................................................................................................. 481

POINAR, GEORGE, JR. and JON GELHAUS—Larval development of Cylindrotomina distinctisima americana Osten Sacken, 1865 (Tipulidae: Cylindrotominae) on Maianthemum dilatatum (Liliaceae) in California .................................................................................................................. 478

ROBBINS, RICHARD G., MICHAEL J. BANGS, and JAMES E. KEIRANS—First report of Ixodes kopsteinii Oudemans (Acar: Ixodida: Ixodidae) from the Kingdom of Cambodia, with a summary of known hosts of this tick in continental southeastern Asia ........................................................................................................ 472

VANDENBERG, NATALIA J.—Homonymy in the Coccinelidae (Coleoptera), or something fishy about Pseudoscyphus Chaplin ................................................................................................................................. 483

Zyla, JOHN D.—First report of the 13-year periodical cicada, Magicicada tredecim (Walsh and Riley) (Hemiptera: Cicadidae) in Maryland .............................................................................................................. 485

Zyla, JOHN D.—Reports of four year accelerated occurrences of the 2004 emergence of periodical cicadas, Magicicada spp. (Hemiptera: Cicadidae) Brood X in Maryland, Virginia, and the District of Columbia .............................................................................................................. 488

BOOK REVIEWS

EVANS, ARTHUR V.—Encyclopedia of Insects, Vincent H. Resli and Ring T. Cardé, editors ... 491

STEINER, WARREN E., JR.—Water Beetles of South Carolina (Coleoptera: Gyriidae, Haliplidae, Noteridae, Dytiscidae, Hydrophilidae, Hydraenidae, Scirtidae, Elmidae, Dryopidae, Limmichidae, Heteroceridae, Psephenidae, Ptinodactylidae, and Chelonariidae), by Janet C. Ciegler ................................................................................................................................. 493

MISCELLANEOUS

Reports of Officers ................................................................................................................................. 495

Society Meetings ...................................................................................................................................... 497

Notice of New Publication: A Catalog of the Cecidomyiidae (Diptera) of the World .................. 500
ADAMSKI, DAVID—A new Holcocera Clemens (Lepidoptera: Gelechioidea: Coleophoridae) from mountainous southeastern Arizona .......................................................... 649
BRAILOVSKY, HARRY—The tribe Colpurini (Hemiptera: Heteroptera: Coreidae) of the Philippine Republic, with descriptions of four new species and a synomymical note ........ 606
BUENO-SORIA, JOAQUIN and ALICIA ROJAS-ASCENSIO—New species and distribution of the genus Marilia Müller (Trichoptera: Odontoceridae) in Mexico and Central America .... 679
ÇALMASUR, ÖNDER and HIKMET ÖZBEK—Heterarthrus ochropoda (Klug) (Hymenoptera: Tentredinidae), a new record and new pest of Populus spp. (Salicaceae) in Turkey .......... 717
GAGNÉ, RAYMOND J., FRANCISCO POSADA, and ZULMA NANCY GIL—A new species of Bruggmanniella (Diptera: Cecidomyiidae) aborting young fruit of avocado, Persea americana (Lauraceae), in Colombia and Costa Rica .......................... 547
GAIMARI, STEPHEN D., LYNN S. ADLER, and SONJA J. SCHEFFER—Plant host affiliation and redescription of Phytomyza subtenella Frost (Diptera: Agromyzidae) ............... 501
GE, SI-QIN and XING-KE YANG—Two new Chinese species of Tenomerga Neboiss (Coleoptera: Cupedidae), with a world catalog of the genus ........................................ 631
HENRY, THOMAS J.—Raglius alboacuminatus (Goze) and Rhyparochromus vulgaris (Schilling) (Lygaeoidea: Rhyparochromidae): Two Palearctic bugs newly discovered in North America . .. 513
KIMSEY, LYNN S.—Taxonomic changes and new generic synonymies in the tiphiid wasp subfamily Thynninae (Hymenoptera: Tiphiiidae) ........................................ 508
KIMSEY, LYNN S.—Illustrated keys to genera of the male wasps in the subfamily Thynninae (Hymenoptera: Tiphiiidae) ......................................................... 571
MATHIS, WAYNE N. and TADEUSZ ZATWARNICKI—A review of two Nearctic shore-fly species in the genus Psilopa Fallén that were included in the genus Cressonomymia Arnaud (Diptera: Ephydridae) ........................................ 639

(Continued on back cover)
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PLANT HOST AFFILILATION AND REDESCRIPTION OF
PHYTOMYZA SUBTENELLA FROST (DIPTERA: AGROMYZIDAE)

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Abstract.—The biology of Phytomyza subtenella Frost (Diptera: Agromyzidae) was observed for the first time. This species was found to be a seed feeder on the hemiparasitic Indian paintbrush, Castilleja miniata Douglas (Orobanchaceae), in Colorado. Biological observations are provided, along with a redescription of the species and illustrations of the male genitalia. Additionally, the 17 orobanch-feeding agromyzids are discussed, along with comments on several possible lineages, based on similarities of male genitalia, within the 13 orobanch-feeding Phytomyza.

Key Words: Agromyzidae. Phytomyza subtenella, Orobanchaceae, Castilleja miniata, host plant

The agromyzid genus Phytomyza Fallén contains more than 450 described species, all of which have internally feeding, plant-parasitic larvae (Spencer and Steyskal 1986). Most species of Phytomyza are leaf-miners, but some are known to feed in other plant parts, including stems, roots, flowers, and seeds. Members of this genus attack species in nearly 30 plant families, although most individual Phytomyza species are highly restricted in diet. usually monophagous or feeding on few closely related plant species (Spencer 1990, Scheffer and Wiegmann 2000). Within Phytomyza, morphologically similar species tend to feed on closely related plants (those in the same genus or family) in a pattern suggestive of host-associated radiations (e.g., Scheffer and Wiegmann 2000). This type of pattern has been discussed for a number of other groups of highly specialized insects (Ehrlich and Raven 1964, Becerra 1997, Farrell 1998, Becerra and Venable 1999), although the processes giving rise to such patterns are not fully understood. A critical first step in investigating either the patterns or processes involved with insect diversification is gaining a clear understanding of the host affiliations of the species of interest.

Agromyzid species attacking leaves generally form an externally visible tunnel or “leafmine” as they feed, making them conspicuous to entomologists. In contrast, those species that feed deeply within tissues such as stems, roots, flowers, or fruits often provide no external symptom of their presence. These species are not readily discovered without targeted collection followed by dissection of plants. Not surprisingly, our knowledge of such species and their
host affiliations is fragmentary, limiting our ability to fully investigate host-use evolution within Agromyzidae.

Although most Phytomyza species are leafminers, a number are known to feed in stems or seeds (Spencer 1990), including one group of primarily seed feeders that has apparently radiated onto plants in the Orobanchaceae. Currently, in North America and Europe, there are 13 Phytomyza species known from this plant family (Table 1). Although phylogenetic relationships among these and other Phytomyza species have not been explored, genitalic similarities suggest that there are several distinct lineages within this group, with unknown affinities among these lineages.

Spencer (1969) first alluded to the possibility that Phytomyza subtenella Frost is a seed (or stem) feeder, citing the elongated form of the ovipositor, and later commenting that it is “almost certainly an internal feeder” (Spencer 1981). Here, we report the host plant for this species, having reared it from a hemiparasitic Indian paintbrush, Castilleja miniata Douglas (Orobanchaceae). We also report observations on its natural history and provide a redescription and more detailed drawings of genitalia than were previously available in the literature (only the basiphallus had been figured thus far, cf. Spencer and Steyskal 1986: figs. 1148, 1149).

**METHODS AND RESULTS**


Voucher specimens of the flies have been labeled as such and deposited in the California State Collection of Arthropods (CSCA) in Sacramento, CA, and the National Museum of Natural History (USNM) in Washington, DC; voucher specimens of the plants (LSA#1, 3, 5) have been deposited in the Herbarium of the Rocky Mountain Biological Laboratory, Gothic, CO.

In late summer 1996, numerous fly puparia were observed in fruits of C. miniata (voucher specimen LSA #3) at Emerald Lake, Colorado. Pupae were collected from these fruits in September and were stored in 1 oz. plastic portion cups, half at room temperature and half in a 0°C freezer in an attempt to simulate overwintering conditions. Adult emergence by either method was low (<5% of ~200 puparia), possibly due to the change in microclimate by removal from the field. In July of the following year, adult flies were collected from the bracts of C. miniata.

**TAXONOMY**

*Phytomyza subtenella* Frost  (Figs. 1–4)

*Phytomyza subtenella* Frost 1924: 89. Type locality: “Mount Rainier (Washington)”.

Figs. 1–4. *Phytomyza subtenella*, ♂ genitalia; scale bar = 0.1 mm; aa = aedeagal apodeme, bp = basiphallus, h = hypandrium, p = paramere, sd = sperm duct, ss = surstylus. 1. Epandrial complex, dorsal view. 2. Aedeagal complex, lateral view. 3. Ejaculatory apodeme, lateral view. 4. Distiphallus, ventral view.
Type: LT♀ in USNM (designated by Frick 1959, by assumption of holotype).


Diagnosis.—Face and frons mostly yellow: gena high; face and gena strongly receding in lateral view: epistoma absent; 4 fronto-orbital setae, posterior 2 reclinate, anterior 2 convergent. Notum and scutellum silver pruinose; dorsocentral setae 1+3; single row (2–6 pairs) of acrostichal setulae; forecoxa yellow; pleuron silvery-grey pruinose, except yellow only along dorsal and posterior borders of anepisternum. Dorsal edge of meron, and surrounding posterior spiracle; femora dark silver pruinose, yellow apically; tibiae and tarsi dark. Abdominal tergites and sternites brown, with yellow posterior edges. In male, paramere bilobed distally, with inner lobe straight, and outer lobe curving and overlapping with inner; basiphallus gently S-curved in lateral view with edges along middle of curve widened slightly, strongly bilobed distally in ventral aspect; apex of distiphallus a single, large, membrane-bounded opening with sclerotization giving appearance of being bilobed. In female, oviscans 1.3–1.6× longer than basal width, shining brown, with ring of long setae distally.

Adults, ♂♀.—Body length 2.3–2.8 mm. Head: Mostly yellow, except ocellar region and behind head (median occipital selerite, occiput, and postgena) silvery-grey pruinose, clypeus and palpus light brown, prementum and lateral part of antennal scape brown, and first flagellomere and arista black. Postocellar setae strong, divergent. Ocellar setae procline, as strong as posterior orbital setae, with bases same distance apart as posterior ocelli. Frons 1.5–2.0× wider than long, and 2.0–2.8× wider than eye width (when viewed from dorsal aspect); with 4 fronto-orbital setae, posterior 2 reclinate and subequal, anterior 2 convergent and subequal or with anterior most one smaller; with row of small procline setulae between fronto-orbital setae and orbital margin, anteriorly becoming slightly larger and convergent. Lunule 0.09–0.12 mm high. Gena high, 0.6–0.7× higher than eye height. Eye 1.1–1.2× higher than wide (when viewed from lateral aspect). One strong oral vibrissa, with several smaller setulae along oral margin. Face and gena distinctly receding in lateral view. Thorax: Notum and scutellum entirely silvery-grey pruinose. Chaetotaxy: 1+3 dorsocentral setae (occasionally with fine supernumerary setae), with cluster of setulae just anterior to anteriormost setae; single row (2–6 pairs) of acrostichal setulae; 1 presutural intra-alar seta; 1 poststural intra-alar seta; 1 postalar seta; 1 postpronotal seta (with several supernumerary setulae); 2 notopleural setae; 2 pairs scutellar setae; otherwise bare, with few supernumerary setulae. Pleuron silvery-grey pruinose, except yellow along dorsal and posterior borders of anepisternum, dorsal edge of meron, and surrounding posterior spiracle. Chaetotaxy: 1 proepisternal seta; 3–4 anepisternal setae along posterior edge, middle 1–2 strong, outer ones fine, occasionally with 1–2 fine setae in dorsal part, anterior of this edge; 2 katepisternal setae, posterior one stronger. Legs: Forecoxa yellow, getting darker in dorsal ½; mid- and hindcoxae dark. Femora silvery-grey pruinose, yellow distally. Tibiae and tarsi dark brown. Wing: Length 2.4–2.8 mm. Distance between end of R₁ and R₂+₃ 1.4–1.9× longer than that between R₄+₅ and M₁+₂. Halter yellow. Abdomen: Tergites and sternites brown pruinose, but yellow along posterior edges. Male genita-
lia (Figs. 1–4): Epandrium rounded, with small setae in addition to covering of small hairs; surstylistus fused to epandrium, with densely clustered hairs, many directed medially (Fig. 1). Cerci small. Hypandrium U-shaped from dorsal view, with medially directed process near middle, and with bilobed process distally on each posterior arm (Fig. 2). Paramere (postgonite of other authors) bilobed distally, with inner lobe straight, and outer lobe curving and overlapping with inner (Fig. 2). Ejaculatory apodeme 2.0× longer than high, with distal edge fan-like (Fig. 3). Aedeagus with basiphallus gently S-curved in lateral view, with edges along middle of curve widened slightly (Fig. 2); basiphallus in ventral aspect strongly bilobed distally (Fig. 4). Distiphallus sclerotized in three parts: central sperm duct (Fig. 2), paired, elongated, anteriorly-directed sclerites, and paired posteriorly-directed apical sclerites (Fig. 4); elongated sclerites confluent with apical sclerites through membrane; apex of distiphallus a single, large, membrane-bounded opening, despite appearance of being truly bilobed. Female terminalia: Oviscape 0.36–0.46 mm wide at base, length 1.3–1.6× greater than basal width; shining brown, with ring of long hairs distally; with light covering of silver-grey pruinosity in basal ¼.

Type material.—LT9 (USNM), Mt. Rainier, Washington, above Longmire’s, 5,000 ft., Aug. 3, 1995 [date handwritten]; Type No. 50021 U.S.N.M [red; number handwritten]/Phytomyza subtenella Frost [handwritten; black submargin].

Other material examined.—USA: Wisconsin, Polk Co., July, Baker (1PLT♀, USNM); California, El Dorado Co., Echo Lake [2,250 m el.], E.I. Schlinger, 23-VII-1955 (1 ♂, 1 ♀, USNM); Colorado, Gunnison Co., Emerald Lake, 3,150 m el., 39°00’41”N 107°02’32”W, reared from Castilleja miniata, S.X.1996 (emer. III-1997), Lynn Adler (1 ♂, 2 ♀, CSUA; 1 ♂, 1 ♀, USNM), hand collected from Castilleja miniata, VII-1998, Lynn Adler (1 ♂, 3 ♀, CSUA; 1 ♂, 1 ♀, USNM).

Distribution.—Canada (Alberta, British Columbia); United States (California, Colorado, Washington, Wisconsin, Wyoming). The single paratype from Wisconsin is unambiguously labelled (Polk Co. Wis., July, Baker), although the presence of this species in northwestern Wisconsin (where the elevation is below 500 m), seems unlikely, as all other known specimens are from the Rocky Mountains and the Sierra Nevada, at elevations above 2,000 m. Spencer (1969) even comments that this species is likely to be limited to this high elevation western zone, despite the record in Wisconsin, which he also considered dubious.

Behavioral observations.—Adult P. subtenella were observed on leaves and bracts of C. miniata in late July 1998 at Emerald Lake, Colorado, where most were in flower. Pairs of adults, or occasionally three adults, were observed in what appeared to be mating positions.

Approximately two weeks later, adult flies were no longer observed, but fly larvae were common inside the locules of maturing fruits. Up to three larvae were found per single fruit. Because there was no obvious damage to these fruits (i.e., no evidence of larval entry holes), it seems likely that oviposition was directly into fruits. Larvae consumed seeds while leaving behind the netlike outer seed coat, causing extensive damage (Adler 2002).

By early September, C. miniata fruits had matured and begun dehiscing, and the flies had pupariated. These puparia were found both inside and outside fruits. In the latter case, exit holes were evident in the capsule wall and at times puparia were found protruding through these holes. The duration of the puparial stage in the field is not known; field collected puparia emerged after several months in the laboratory.

Discussion

The group of Phytomyza presented in Table 1 all attack Orobanchaceae, parasitic
Table 1. *Phytomyza* species known to feed on plants in the family Orobanchaceae, arranged by host genus; *= new record; †= probable feeding site. All host genera are in the hemiparasitic tribe Rhinantheae, except for *Orobancha* which is in the holoparasitic tribe Orobanchaeae.

<table>
<thead>
<tr>
<th>Species</th>
<th>Distribution</th>
<th>Host Genus</th>
<th>Feeding Site</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. subtenuella</em> Frost</td>
<td>Nearctic</td>
<td><em>Castilleja</em></td>
<td>seeds</td>
</tr>
<tr>
<td><em>P. trivittata</em> Frost</td>
<td>Nearctic</td>
<td><em>Cordylanthus</em></td>
<td>seeds†</td>
</tr>
<tr>
<td><em>P. rasrata</em> Hering</td>
<td>Palaeartic</td>
<td><em>Euphrasia, Melampyrum, Odontites, Rhinanthus</em></td>
<td>stems</td>
</tr>
<tr>
<td><em>P. affinis</em> Fallen</td>
<td>Palaeartic</td>
<td><em>Euphrasia</em></td>
<td>seeds</td>
</tr>
<tr>
<td><em>P. flavofemorata</em> Strobl</td>
<td>Palaeartic</td>
<td><em>Melampyrum</em></td>
<td>seeds</td>
</tr>
<tr>
<td><em>P. isatis</em> Hering</td>
<td>Palaeartic</td>
<td><em>Odontites</em></td>
<td>seeds</td>
</tr>
<tr>
<td><em>P. orobanchia</em> Kaltenbach</td>
<td>Palaeartic</td>
<td><em>Orobancha</em></td>
<td>seeds, stems</td>
</tr>
<tr>
<td><em>P. diversicornis</em> Hendel</td>
<td>Palaeartic</td>
<td><em>Pedicularis</em></td>
<td>stems</td>
</tr>
<tr>
<td><em>P. pediculariaulis</em> Spencer</td>
<td>Neartic</td>
<td><em>Pedicularis</em></td>
<td>stems</td>
</tr>
<tr>
<td><em>P. pedicularidis</em> Spencer</td>
<td>Neartic</td>
<td><em>Pedicularis</em></td>
<td>stems</td>
</tr>
<tr>
<td><em>P. pedicularifolia</em> Hering</td>
<td>Palaeartic</td>
<td><em>Pedicularis</em></td>
<td>leaves</td>
</tr>
<tr>
<td><em>P. tenella</em> Meigen</td>
<td>Holartic</td>
<td><em>Pedicularis</em></td>
<td>seeds</td>
</tr>
<tr>
<td><em>P. varipes</em> Macquart</td>
<td>Holartic</td>
<td><em>Rhinanthus</em></td>
<td>seeds</td>
</tr>
</tbody>
</table>

Plants that obtain water and nutrients from other plants via root connections. Several species of this group have unknown affinities, but genitalic similarities indicate several distinct lineages. For example, one seed-feeding species, *P. flavofemorata* Strobl attacking *Melampyrum L.*, appears, by genitalic similarity, to belong to a group with three leaf-feeding species attacking non-orobanchs, including *P. digitalis* Hering attacking *Digitalis L.*, and *P. crassiseta* Zetterstedt and *P. veronicicola* Hering attacking *Veronica L.* (Plantaginaceae, Digitaliaceae). The species *P. trivittata* Frost, attacking *Cordylanthus* Nutt. ex Benth., appears very closely related by nearly identical male genitalia to *P. chelonei* Spencer, a species attacking *Chelone L.* (Plantaginaceae, Cheloneae). There appear to be at least two other distinct groups based on genitalic similarities. The first includes two stem feeders (*P. diversicornis* Hendel and *P. pediculariaulis* Spencer, both attacking *Pedicularis L.*) and two seed feeders (*P. affinis* Fallén and *P. tenella* Meigen, the former attacking *Euphrasia L.* and the latter *Pedicularis*). The second includes the seed feeder *P. subtenuella* (attacking *Castilleja Mutis ex L.f.*) and the seed/stem feeding *P. orobanchia* Kaltenbach (attacking species of the holoparasitic genus *Orobancha L.*), but also includes several additional species whose host affilations remain undiscovered (e.g., *P. cumorpha* Frey and *P. orindensis* Spencer), or attack species of the non-orobanch genus *Lupinus L.* (Fabaceae) (*P. lupini* Sehgal). Interestingly, *P. orobanchia* of this latter group has been shown to be of potential importance in controlling *Orobancha* species parasitizing tomatoes in Ethiopia (Elzein et al. 1999).

Two *Phytomyza* species, *P. lupini* and *P. lupinivora* Sehgal, feed on hosts of the genus *Lupinus*, which is in a family quite distinct from Orobanchaceae. The latter species, known only from the female holotype, is a leafminer, while the former species is an internal stem or flower-head feeder, even pupariating internally. Interestingly, Spencer (1981) speculated on a relationship between *P. lupini* and *P. subtenuella*, based on unstated similarities of the male genitalia, being distinguished by different states of the male epistoma above the mouth margin (which is lacking in *P. subtenuella*) and the color of the forecoxa. Comparing genitalia, the aedeagus is very similar in shape and size from the lateral aspect, and the distiphallus is very similar from ventral aspect; the same holds true for the genitalia of *P.*
orobanchia, P. eumorpha and P. orinensis, and in fact, the genitalia of P. eumorpha appear most similar to P. subtenella.

Castilleja species, and other Orobanchaceae, are known to parasitize species of Lupinus and obtain alkaloids, secondary compounds implicated in resistance to herbivores, as well as nitrogen resources from this association (Stermitz and Harris 1987, Stermitz et al. 1989, Arslanian et al. 1990, Boros et al. 1991, Stermitz and Pomeroy 1992). Because of the putative close relationships among some of these taxa, one can speculate on the possibility of a host switch from feeding within stems and flower-heads of lupine to feeding within the parasitic orobanchs attacking them, or vice-versa. By obtaining compounds from hosts, parasitic plants may expose herbivores to novel secondary compounds normally found in the unrelated host plant species, allowing herbivores to pre-adapt to novel hosts. However, without phylogenetic hypotheses for relationships among Phytomyza species and detailed information about host ranges, it is not possible to do more than speculate about how host-plant relationships for Phytomyza species evolved.

Few other species of agromyzids attack Orobanchaceae besides the 13 Phytomyza species listed in Table 1. Aside from the single species discussed herein, only Chromatomyia castillejae (Spencer) and its subspecies nordica Spencer are known to use Castilleja species as hosts (leafminers on Castilleja fissifolia L.f. in Venezuela and C. latifolia Hook. & Arn. in California, respectively) (Spencer 1973, Spencer 1981). Outside of Castilleja feeders, the only other orobanch feeders are Ophiomyia strigalis Spencer attacking the lower stem and root of holoparasitic Striga Lour., and the polyphagous Chromatomyia horticola Goureaux attacking Melampyrum and Rhinanthus L.

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LITERATURE CITED


TAXONOMIC CHANGES AND NEW GENERIC SYNONYMIES IN THE TIPHIID WASP SUBFAMILY THYNNINAE (HYMENOPTERA: TIPHIIDAE)

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Abstract.—A number of taxonomic changes are made in the generic status and species composition of six thynnine genera, four from Australia and two from South America. New generic synonymies are given, with Pogonothyminus Turner made a junior synonym of Zaspirothynnus Turner, Aspidothyminus Turner a junior synonym of Tmesothyminus Turner and Glottynoides Kimsey a junior synonym of Scotaena Turner. Consequently species assignments have to be changed. New combinations for Aspidothyminus are collaris (Guérin de Meneville), dispersus (Turner), humilis (Erichson), ingrediens (Turner), iridipennis (Smith), platycephalus (Turner), truncatus (Smith), and zelebori (Saussure); for Zaspirothynnus fenestratus (Smith), fulvohirits (Turner), morosus (Smith), and vestitus (Smith), and for Scotaena brunnea (Fox), clypearis (Duran), duckei (Smith), fastuosus (Smith), genisei (Kimsey), rosenbergi (Turner), and vigilii (Bréthes).

Key Words: Tiphiidae, Thynninae, Pogonothyminus, Zaspirothynnus, Aspidothyminus, Tmesothyminus, Scotaena, Glottynoides

Phylogenetic analyses of the genera of Thynninae currently underway have resulted in the need for some additional generic synonymy. The genera discussed below all end up as sister group pairs in these analyses, without diagnostic apomorphies to separate them. This prompted their reexamination, which led to the synonymies proposed below. Three genera are synonymized. Two, generic pairs are in the tribe Thynnini from Australia. The third pair is in the Scotaenini from South America. A number of species assignments need to be changed, as given below, as a result of these synonymies and from the examination of primary types in The Natural History Museum, London, and Humboldt Museum, Berlin. Species where the primary types have been examined are indicated by an asterisk (*). When types have not been seen, the generic placement given by Given (1954) is followed.

Aspidothyminus Turner

Turner (1910b) described two new genera, Aspidothyminus and Tmesothyminus, largely based on male characteristics. At the time, females were known only for Tmesothyminus. He distinguished the two genera by the structure of the male clpeus and hypopygium. However, after examining the types of the genera and a much broader selection of species than Turner had available at the time it is clear that characteristics used to distinguish these genera intergrade between the two extreme forms represented by the types of the genera, Aspidothyminus combustus Turner and Tmesothyminus zelebori Saussure. The male hypopygium in these species ranges from apically tridentate with parallel sides to having an apicomemorial spine or tooth and rounded sides (Figs. 4–7). Females associated with species placed in both groups are indistinguishable on the
generic level. Males of both genera share several apomorphic features—the subanten-
nal sclerite and frons share a well-devel-
oped longitudinal medial carina, and in the
tongue the stipes is nearly asetose, except
for a row of well-separated, short setae
along the inner margin, and the prementum
is slender, usually elongate, and asetose
(Fig. 1). The hypostomal plate on either of
the oral fossa is considerably narrower than
the oral fossa and is about as broad as or
narrower than the prementum (Fig. 1). Oth-
er male features that distinguish these gen-
era from others closely related include the
apical flagellomeres cylindrical (not lo-
butate), with two tyloids, the presence of a
small red spot on the vertex between the
hindocellus and eye margin, and epipygium
with a large, transverse carina or swelling
before a thin apical rim, which varies from
linear to trilobate to strongly swollen and
bilobate (Figs. 2–3). Females have the py-
gidium margined laterally by a carina and
subtended by a long brush of setae on met-
osal sternum V. and, most significantly,
sternum VI is apically strongly bilobate.

None of these characters were found to
clearly separate groups of species. Phylo-
genetic analyses of Aspidothynnus and
Tmesothynnus species resulted in a single,
pectinate clade, with many possible trees
and no Bootstrap support for any of the
branches. Therefore, Aspidothynnus is
chosen as the senior name and Tmesothynnus
the junior synonym (new synonym).

Species now placed in this revised As-
pidothynnus are: Lophocheilus collaris
Guérin de Meneville 1842. new combina-
tion: Aelurus combatbus Smith 1859*: Thynnus dispersus Turner 1908*. new combina-
tion: Aspidothynnus fossulatus Turner 1915*: Thynnus humilis Erichson 1842. new combina-
tion: Aspidothynnus ingre-
diens Turner 1916*, new combina-
tion: Thynnus iridipennis Smith 1859*. new combina-
tion: Tmesothynnus platyccephalus
Turner 1910c*. new combina-
tion: Thynnus polybioides Turner 1908*: Aspidothynnus
rostratus Turner 1908*: Thynnus truncatus
Smith 1859*. new combination: Thynnus
strangulatus Smith 1879*. new combina-
tion, and Thynnus zelebori Saussure 1867.
new combination.

**Zaspilothyynnus Ashmead**

Turner (1910b) described the genus Po-
gonothyynnus on the page preceding his re-
description of Zaspilothyynnus Ashmead (1903). The two descriptions are nearly
identical except for the shape of the hypo-
pygium. Males in both genera have a
strongly elevated medial platform on the
epipygium, small tooth or spine on metas-
omal sternum VI, the same configuration
of the antennal lobes and associated carina,
ranging from U-shaped to V-shaped, and
most species have a well-developed stipal
fringe (Fig. 8). The male genital capsule
structure is also the same in the types of
both genera (Figs. 17, 19), with the gono-
coxa dorsally truncate, cuspis with large,
sometimes elongate, digitate lobe on the
inner margin (Figs. 16, 18), and large earlike
digitus that folds down dorsally during cop-
ulation. Females in these genera have the
same densely ridged metasomal terga I and
II and snoutlike epipygium, which is nar-
rowed basally with a flared, flattened pos-
terior plate (Figs. 13–15). No consistent dif-
fences could be found between the two
groups. As with Aspidothynnus, phyloge-
etic analysis of the combined species of
both Pogonothyynnus and Zaspilothyynnus re-
sulted in numerous poorly supported trees,
with no support for two discrete clades that
might represent these genera. Therefore,
Pogonothyynnus Turner 1910b becomes a
junior synonym of Zaspilothyynnus Ash-
mead 1903. new synonym.

Included species in the combined Zaspis-
lothyynnus are: Thynnus andreanus Turner
1908: Thynnus atrocius Turner 1909a; Thynnus biroi Turner 1910d; Thynnus cam-
punalus Smith 1868: Thynnus carbonar-
ius Smith 1859; Zaspilothyynnus cheese-
manae Turner 1940; Zaspilothyynnus clementi
Turner 1910c; Thynnus crudelis Turner
1908: Zaspilothyynnus cyaniventeris Rohwer

1. dispersus
2. fossulatus
3. unidentified sp.
4. unidentified sp.
5. zelebori
6. fossulatus
7. combustus
8. morosus
9. dilatatus
10. interruptus
11. fulvohirtus
12. gilesi
13. fenestratus
14. carbonarius
15. biroi
16. interruptus
17. fenestratus
The genus *Glottynoides* Kimsey was described for the species *genisei* Kimsey, which has an unusually modified tongue. In the original description, a strong relationship with the genera *Scotaena* and *Rostrynus* was mentioned. Further examination of male and female characteristics of *Glottynoides* and *Scotaena* indicates that the only distinctions between these two genera are the species level characteristics of the male tongue seen in *genisei*. Therefore, *Glottynoides* Kimsey (in Genise and Kimsey 1991) is a junior synonym of *Scotaena* Klug 1810.

**new combination:** *Scotaena Klug* The genus *Glottynoides* Kimsey was described for the species *genisei* Kimsey, which has an unusually modified tongue. In the original description, a strong relationship with the genera *Scotaena* and *Rostrynus* was mentioned. Further examination of male and female characteristics of *Glottynoides* and *Scotaena* indicates that the only distinctions between these two genera are the species level characteristics of the male tongue seen in *genisei*. Therefore, *Glottynoides* Kimsey (in Genise and Kimsey 1991) is a junior synonym of *Scotaena* Klug 1810.

**new combination:**


**LITERATURE CITED**


Saussure, H. L. F. 1867. Hymenoptera. Familien der


RAGLIUS ALBOACUMINATUS (GOEZE) AND RHYPAROCHROMUS VULGARIS (SCHILLING) (LYGAEOIDA: RHYPAROCHROMIDAE): TWO PALEARCTIC BUGS NEWLY DISCOVERED IN NORTH AMERICA

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Abstract.—Two invasive Palearctic rhyparochromids (Lygaeoidea: Rhyparochromidae) are recorded for the first time in North America. Raglius alboacuminatus Goeze is reported from California, Oregon, and northern Utah, and Rhyparochromus vulgaris (Schilling), from Oregon and Washington. Although not considered major agricultural pests, these invasive bugs have become serious nuisance pests, invading homes and commercial establishments in large numbers. Provided for each are a summary of the literature, notes on the biology and habitat, diagnosis, description, and photographs of the adult to help separate these nonindigenous bugs from other North American Rhyparochromidae. In addition, Xanthochilus saturnius (Rossi), a Palearctic species known in North America only from California, is reported for the first time from Oregon.

Key Words: Heteroptera, Lygaeoidea, Rhyparochromidae, Raglius alboacuminatus, Rhyparochromus vulgaris, North America, new records, California, Oregon, Utah, Washington, invasive

Both invasive Palearctic seed bugs reported in this paper, Raglius alboacuminatus (Goeze) and Rhyparochromus vulgaris (Schilling), were discovered after they attracted attention as serious nuisance pests by homeowners and various local businesses. For Raglius alboacuminatus, these events occurred in California and Utah; for Rhyparochromus vulgaris, similar situations were documented in Oregon and Washington. While these nonindigenous insects probably will not become important agricultural pests, they may profoundly influence our environment in other ways. Both species already have affected local economies, causing anxiety among homeowners and creating costly control expenses for commercial establishments.

The first specimens of Raglius alboacuminatus were submitted to the Systematic Entomology Laboratory, ARS, USDA, Washington, D.C., in October 1999 by Alan Roe at Utah State University, Logan. Jay Karen (Utah State University), stated that specimens were found invading a local library and causing concern about possible damage to library books. Shortly thereafter, other reports of large numbers of this bug in the region invading homes and schools attracted the attention of the local television, radio, and newspaper media. One local Utah newspaper (The Herald Journal) published articles (by M. R. Weibel) with headlines, such as "New Library is Fighting Bugs" (October 11, 1999) and "North Logan Library Shakes Heebie-Jeebies"
(October 15, 1999). In 2000, very large populations of these bugs invaded several buildings of a prominent trade school at Ogden, Utah. A visit to Logan, Ogden, and surrounding areas in 2001 indicated that the populations of *R. alboacuminatus* apparently had collapsed, making it difficult to collect even a few dozen bugs. In August 2002, however, Dr. Karen reported to me that large populations had again developed in the Ogden area in numbers similar to the 2000 outbreak. I also received a specimen of *R. alboacuminatus* from Alan Hardy (California Department of Food & Agriculture, Sacramento) in October 2002 from San Jose, California, that was collected in August 2002 from a population of thousands of specimens invading a home from surrounding old fields. One report from the latter site indicated that one wall of the home was so heavily covered that it appeared “alive with bugs” (A. Hardy, personal communication). More recently, specimens from Benton County, Oregon, were discovered by John D. Lattin (Oregon State University, Corvallis).

In November 2001, I received an e-mail and digital image of another rhyparochromid from Eric LaGasa (Washington Department of Agriculture, Olympia). The images were tentatively identified as representing *Rhyparochromus vulgaris* and later confirmed by examining a series of specimens collected at Orting, Washington. These bugs were present in large numbers in and around a home, many of which were found on sidewalks, siding, and trapped in window sills. A follow-up survey of the area revealed smaller numbers of specimens over a wider area around the Orting area, including a few specimens in a local nursery. Shortly after the Washington discovery, communication with James LaBonte and Kathleen Johnson (Oregon Department of Agriculture, Salem) and John D. Lattin revealed additional specimens collected in Oregon, indicating that this rhyparochromid is well established in the Pacific Northwest.

In this paper, I summarize the known information on the two Palearctic bugs, *Raglius alboacuminatus* recently discovered in California, Oregon, and Utah, and *Rhyparochromus vulgaris* recently discovered in Oregon and Washington, and provide for each a diagnosis, description, and illustrations of the adult. In addition, *Xanthochilus saturnius* (Rossi), a Palearctic species known in North America only from California, is reported for the first time from Oregon.

The following acronyms are used for depositories cited in this paper: ODA (Oregon Department of Agriculture, Salem); OSU (Oregon State University, Corvallis); USU (Utah State University, Logan); USNM ([United States] National Museum of Natural History, Smithsonian Institution, Washington, D.C.); and WSDA (Washington State Department of Agriculture, Olympia).

*Raglius alboacuminatus* (Goeze)  
(Figs. 1–3)

*Cimex alboacuminatus* Goeze 1778: 266  
(original description).

*Rhyparochromus alboacuminatus*: Slater 1964: 1310 (catalog); Péricart 1998: 271  
(description, distribution, biological notes, illustrations).

*Raglius alboacuminatus*: Péricart 2001: 208  

Diagnosis.—This medium-sized species (Figs. 1, 2) is best recognized by the overall fuscous to black coloration, with a pale or whitish posterior pronotal lobe, a pale anterior half of the corium (with alternating linear brown and pale areas producing a striped appearance), and a white spot at the apex of corium and the apex of hemelytral membrane.

Description.—Male (n = 10): Length 4.64–5.28 mm, width 1.53–1.72 mm. Head: Width 0.98–1.03 mm, vertex 0.63–0.65 mm. Rostrum: Length 2.13–2.30 mm, extending to bases of meso-coxae. Antenna:
Segment I, length 0.36–0.43 mm; II, 0.87–1.00 mm; III, 0.85–0.93 mm; IV, 1.03–1.08 mm. Pronotum: Length 0.95–1.13 mm, basal width 1.43–1.48 mm.

Female (n = 10): Length 4.96–6.56 mm, width 1.64–2.08 mm. Head: Width 0.98–1.13 mm, vertex 0.63–0.75 mm. Rostrum: Length 2.17–2.50 mm, extending to mesothorax. Antenna: Segment I, length 0.38–0.55 mm; II, 0.85–1.15 mm; III, 0.78–1.05 mm; IV, 0.93–0.115 mm. Pronotum: Length 0.98–1.30 mm, basal width 1.48–1.88 mm.

Small to medium sized, slender, elongate-oval, generally dark brown to black with pale or white areas on the pronotum, hemelytra, and hemelytral membrane (Fig. 1). Head shiny black. Labium fuscous. Antennal segment I black, apex narrowly pale brown; segment II pale yellowish brown, narrowly fuscous at base; segments III and IV uniformly black. Pronotum rectangular, basal margin deeply emarginate, lateral margin narrowly explanate; anterior lobe uniformly shiny black, impunctate, gently and evenly swollen; narrower posterior lobe pale or whitish, basal angles black, darkly punctate across base and through middle, punctures fading laterally. Scutellum equilateral, finely punctate, dull black with narrow apex yellowish brown. Hemelytron punctate, most densely along veins; basal half largely pale or whitish; inner half of elavus dark brown, outer half white; corium pale or whitish, narrowly brown along claval suture and veins giving a striped appearance; apical half of corium largely fuscous to black with a large white blotch at apex bordering membrane; membrane black with a round to triangular white spot at middle of apex. Ventral surface black except for white posterior pleural area of.
pronotum, thoracic metanotum, and pro-, meso- and meta-acetabulae. Legs: Coxae black; trochanters brown; swollen profemur black, yellowish brown at base and apex, with one large and two to three smaller spines ventrally on apical third; meso- and metafemora black on apical third to half, yellowish brown basally; tibiae brown to yellowish brown, fuscous at bases; tarsi and claws brown.

Habitat.—Raglias alboacuminatus colonizes open clear areas and borders of woods, and old fields where tall vegetation grows, and seems to prefer sandy, calcareous soils (Wagner 1961, Péricart 1998). In California and Utah, large populations developed in old or fallow fields with mixed vegetation. Late in the season (August to November), adults and late-instar nymphs migrated to irrigated lawns and congregated in and around buildings in enormous numbers, resulting in media attention and concern to businesses and homeowners.

Biological.—According to Péricart (1998), Raglias alboacuminatus overwinters as adults under the bark of trees, often in large groups, sometimes several meters above ground. Its feeds on fallen seeds and, very often, climbs on vegetation to feed on developing seeds. In the Ukraine, it is frequently found near Stachys spp. and other Lamiales, such as Marrubium sp. and Ballota sp., or Scrophulariaceae, such as Verbascum lychnitis (Putshkov 1969). Overwintering adults emerge in early spring as the weather warms. They deposit one or two eggs, one at a time, in ground litter or on the soil in late April or early May and continue until mid August. Populations can have a second generation, with nymphs developing until September. In the southern Ukraine, a third generation can develop. In England, mating begins in early May and first-generation adults appear by late July to begin a second generation. Eggs are deposited singly in leafy or woody litter (Southwood and Leston 1959).

Distribution.—In the Old World, R. alboacuminatus is widespread from Great Britain, throughout much of Europe to the Middle East; into northern Africa, including Algeria, Morocco, Tunisia, and the Canary Islands; and western parts of Asia, including Armenia, Iran, Kazakhstan, Russia, Turkey, Tadjikistan, and Uzbekistan (Péricart 2001).

This species is recorded for the first time in the United States (Fig. 3) from one county in California (Santa Clara), three counties in Oregon (Benton, Multnomah, and Wasco), and three counties in Utah (Box Elder, Cache, and Weber).

Fig. 3. Distribution of *Raglius alboacuminatus* in the United States.

Rhyparochromus vulgaris (Schilling)  
(Figs. 4–6)

*Rhyparochromus vulgaris* Schilling 1829: 65  
(original description).

*Rhyparochromus vulgaris*: Southwood and Leston 1959: 95 (biological notes, illustrations); Wagner 1961: 85; Slater 1964: 1322 (catalog); Slater and O'Donnell...

Diagnosis.—This relatively large species (Figs. 4–5) is distinguished by the black head, antennae, femora, anterior half of the pronotum, scutellum, and membrane (sometimes with a small pale or white mark at apex); and the dark punctured, pale or yellowish-brown hemelytra, with a large quadrato black spot on the inner angle of the corium.

Description.—Male (n = 10): Length 6.48–7.27 mm, width 2.38–2.62 mm. Head: Width 1.40–1.57 mm, vertex 0.75–0.83 mm. Rostrum: Length 2.85–3.01 mm, extending to middle coxae. Antenna: Segment I, length 0.55–0.61 mm; II, 1.40–1.66 mm; III, 1.18–1.31 mm; IV, 1.28–1.47 mm. Pronotum: Length 1.38–1.55 mm, basal width 2.13–2.38 mm.

Female (n = 10): Length 7.62–8.26 mm, width 2.75–2.98 mm. Head: Width 1.45–1.53 mm, vertex 0.85–0.88 mm. Rostrum: Length 3.14–3.22 mm, extending to middle coxae. Antenna: Segment I, length 0.58–0.63 mm; II, 1.43–1.50 mm; III, 1.08–1.28 mm; IV, 1.25–1.38 mm. Pronotum: Length 1.55–1.65 mm, basal width 2.48–2.73 mm.

Large, oval, shiny, dark brown to black with pale or white areas on the pronotum, hemelytra, and sometimes the apex of the hemelytral membrane. Head shiny black, covered with short, dense, silvery setae, except for more glabrous vertex posterior to midline of eyes. Labium uniformly fuscous.

Figs. 4–5. Adult female of Rhyparochromus vulgaris. 4, Dorsal aspect. 5, Lateral aspect.
or black. Antenna uniformly fuscous to black. Pronotum quadrate, basal margin nearly straight, lateral margins explanate and weakly recurved; anterior lobe shiny black including explanate margins, weakly swollen; posterior lobe, including margin pale yellow to white, narrowly fuscous across base, uniformly dark punctured, less so laterally. Scutellum equalateral, shiny black, finely punctate. Hemelytron pale or yellowish brown; clavus black on inner half, with a pale or white blotch at base; corium yellowish brown with rows of dark punctures, apical third with a fuscous or black blotch, area bordering membrane pale or whitish; membrane black, sometimes with a small pale blotch at middle of apex. Ventral surface shiny black, with dorsal third of posterior pleural area of pronotum, posterior half of metanotum, and acutabulae pale yellowish or white. Legs: Coxae and trochanters fuscous to black; femora black, narrowly yellowish brown apically; metatibia black, pro- and mesotibiae yellowish brown, more fuscous basally and apically; tarsi and claws brown to fuscous.

Habitat.—*Raglius vulgaris* frequents clearings, forest edges, mixed forests, parks, woods, borders of gardens, and other shaded biotypes (Péricart 1998), often occurring under loose soil litter and stones (Wagner 1961). This species overwinters as adults and nymphs in sheltered places, often in company with other lygaeoids. Putskhov (1969) found as many as 200 adults and 5th instars under the bark of a beech tree near mid August in Russia. Adults and nymphs may become active on warm days during fall and winter.

Biology.—According to Péricart (1998), females begin ovipositing in early May, depositing eggs one at a time in ground litter. Eggs hatch through July. This species is known to feed on the seeds of numerous plants, including raspberry, nettles, and sage, and on the fallen seeds of elms, poplar, and other plants. The first adults appear in the Ukraine in early July (Putchkov 1969). Most individuals feed until late September before seeking overwintering shelter.

Distribution.—In the Old World, *R. vulgaris* is widespread in Europe; north Africa, including Algeria, Morocco, and the Canary Islands; and Asia from western Russia to China, Mongolia, and Korea (Péricart 2001).

This species is recorded for the first time in the United States (Fig. 6) from two counties in Oregon (Multnomah and Wasco) and one county in Washington (Pierce).


* Xanthochilus saturnius (Rossi)  

*Xanthochilus saturnius* is a widespread Palearctic species, ranging throughout much of Europe, northern Africa, and west-
ern Asia (Péricart 2001). Henry and Adamski (1998) gave the first North American report of this species (as Rhyparochromus saturnius) based on specimens from 17 counties in California.

Since the Henry and Adamski (1998) report, specimens of *X. saturnius* have been intercepted in Japan on produce exported from California. Dr. J. A. Slater (personal communication) identified two specimens sent to him by Goro Takihiro (Yokahama Plant Protection Station, Yokahama, Japan) in September 1999, adding a new twist to the impact invasive insects may have in foreign lands.

The following specimens identified by J. D. Lattin represent the first state record of *X. saturnius* in Oregon.

Specimens examined.— OREGON: 1 ♂, Benton Co., Corvallis, #03-01, SWPM importer, 29-X (Oct) 2002, EWB Survey, ex. funnel traps with exotic *Ips* lure (ODA); 1 ♀, Benton Co., Corvallis, #03-01, SWPM importer, 30-IX (Sept) 2002, EWB Survey, ex. funnel traps with exotic *Ips* lure (ODA).

**DISCUSSION**

As Hoebeke and Page (2002) aptly noted, "Because of dramatic increases in international travel, combined with a boom-
ing world-trade industry, plant and animal species have become globetrotters.” Henry and Adamski (1998) indicated it was not surprising that the Palearctic rhyparochromid *Xanthochilus saturnius* (Rossi) had become established in California, considering that over the previous nine years, it had been intercepted more than 40 times at ports-of-entry in the United States by APHIS/PPQ personnel, almost exclusively on pallets of tile and marble imported from the Mediterranean Region. Since that report (Henry and Adamski 1998), there have been more than 20 additional U.S. interceptions of *X. saturnius*, including new records reported in this paper for Oregon. Similarly, *Raglìus alboacuminatus* has been intercepted 22 times since 1990 and *Rhyparochromus vulgaris*, 67 times during the same period. Lattin and Wetherill (2002) recently documented the establishment of another Old World heteropteran, the oxycarenid *Metopoplistes ditomoides* (Costa), which was found on commercial hazelnut, *Corylus avellana* (L.), and swarming in large numbers around homes in several Oregon counties; and Hoebeke and Carter (2003) reported large numbers of the pentatomid *Halyomorpha halys* (Stål) in eastern Pennsylvania, a potential agricultural pest from eastern Asia. Between 1989 and 2002, *M. ditomoides* was intercepted 73 times at U.S. ports-of-entry, and *H. halys*, 15 times. The frequency of interceptions for the above exotic bugs makes it fairly certain that they arrived in this country as stowaways in international commerce.

While invasive species such as the *Halyomorpha halys* are potential agricultural pests, others, such as *Raglìus alboacuminatus, Rhyparochromus vulgaris*, and *Xanthochilus saturnius* might affect our environment in other ways. Hoebeke and Page (2002) pointed out that nonindigenous insects have the potential to disrupt native environments, threaten fragile ecosystems, and reduce local biodiversity. The environmental effects of the two alien rhyparochromids reported in this paper must await further assessment.

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uscript and offered suggestions for its improvement.

**LITERATURE CITED**


LIFE HISTORY OF MAYATRICHIA PONTA ROSS
(TRICHOPTERA: HYDROPTILIDAE) IN HONEY CREEK, OKLAHOMA

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Abstract.—The life history of Mayatrichia ponta Ross (Trichoptera: Hydroptilidae) was investigated in Honey Creek, Turner Falls Park, Murray Co., Oklahoma, U.S.A. from August 1994 to August 1995. This study provides the first comprehensive life history of a species of Neotrichini. Mayatrichia ponta had an asynchronous multivoltine life history with considerable cohort and generation overlap: five generations were estimated, representing the largest number of annual generations among Trichoptera. The winter generations of M. ponta had wider head capsule widths (136–165 μm) than summer generations (121–145 μm). The growth of M. ponta was slower in the winter than the summer. The sex ratio of adults was 1.43 δ: 1 ♀ and fecundity ranged from 46 to 150 eggs/female. Fifth instars and pupae aggregated on the bottom side of rocks whereas early instars were distributed evenly on all sides of rocks.

Key Words: Mayatrichia ponta, life history, voltinism, fecundity, microhabitat

Trichoptera are a diverse and ecologically important order whose larvae live in a wide range of flowing and standing waters. Hydroptilidae, a species diverse family in the order Trichoptera, account for approximately 19% of all Nearctic trichopteran species. With over 300 species, Hydroptilidae are the second most diverse trichopteran family, surpassed only by Limnephilidae (Morse 1993, 2002). Despite their diversity relatively few detailed studies on the biology of Nearctic hydroptilids have been published. Leucotrichia pictipes Banks was reported to be univoltine with an overwintering final instar in Montana (McAuliffe 1982). Resh and Houp (1986) described a univoltine cycle for Dibusa angata Ross in Kentucky, with an egg diapause through the summer and autumn and emergence in April and May. More recent studies on Nearctic hydroptilids were by Keiper and Walton (1999) and Keiper and Foote (2000). Keiper and Foote (2000) described univoltine populations based on field observations in an Ohio stream for Hydroptila consimilis Mosely, Ochrotrichia spinosa (Ross) and O. wojcickyi Blickle. The biology of Hydroptilidae has been reported in a number of studies in other biogeographical regions of the world. A study of hydroptilids in northeastern Spain, reported univoltine populations for Hydroptila vectis Curtis and Oxyethira frici Klapalek, bivoltine for Hydroptila insubrica Ris, and possibly three generations per year for Hydroptila martini Marshall (Recasens and Puig 1991). Wells (1985) reported univoltine and multivoltine populations life cycles for Australian hydroptilids, but gave no details. The biology of several eastern Palearctic hydroptilids has been described (Ito 1988, 1998; Ito and Kawamura 1980). Palaeagapetus ovatus Ito
and Hattori populations were reported as having approximately three generations per year while *Eubasillissa regina* (McLachlan) were univoltine (Ito 1988). In another study, Ito (1998) reported populations of *Palaeagapetus flexus* Ito as univoltine and *P. ovatus* as having 3–4 generations in 2 years.

The genus *Mayatrichia* Mosely was first established in 1937 (Mosely 1937). The genus is in the tribe Neotrichiini under the subfamily Hydroptilinae. *Mayatrichia* has six species distributed over North and Central America, and northern South America. Honey Creek in Turner Falls Park, Oklahoma is the type locality for *Mayatrichia ponta* Ross (Ross 1944). The species has also been reported in Texas and Wyoming (Moulton and Stewart 1996). The attenuated head of *Mayatrichia* make their larvae easy to identify in all instars (Wiggins 1996a). There have been no published studies on the ecology and life history of any *Mayatrichia* species or any other Neotrichiini. The purpose of this study is to describe the life cycle and aspects of the biology of *M. ponta* through field studies.

**Materials and Methods**

Study site and sampling.—Honey Creek is a second order permanent limestone stream, originating in the Arbuckle Mountains, and flowing northeastward into the Washita River. The geological formation of Honey Creek changes sequentially from cherty limestone and sandstone to ‘Fernvale’ limestone and, eventually, to Washita alluvium (Ham 1969). Honey Creek descends from an elevation of 420 m at its origin to 235 m at Washita River (Ham 1969). The most rapidly descending areas are Bridal Veil Falls and Turner Falls. The pH, raised by photosynthetic activity from aquatic plants and algae, causes precipitation of calcium and magnesium carbonates to form thick layers of travertine in the study area (Minkley 1963).

The study riffles were positioned within a 900 m zone upstream of Bridal Veil Falls in Honey Creek, Turner Falls Park, Oklahoma (34°25.407’N and 97°04.210’W). The upstream riffles were mainly composed of cobbles and pebbles; downstream riffles were mainly composed of travertine substrates with sparse to aggregated stones. The creek width ranged from 15 to 30 m. Riffle depth ranged from 1 to 2 cm in the travertine beds to 20 cm in the cobble substrate under base flow condition. The mean discharge is 1.06 m$^3$/s. The mean pH was 8.0 and the dissolved oxygen was always near saturation. These values were similar to ones reported by Reisen (1975, 1976) suggesting that the water conditions in this stream have been stable over the last 25 years. Water temperature ranged from 9 °C in the winter to 25 °C in the summer during the study period. Air temperature ranged from -6.7 to 41 °C.

Samples of larvae, pupae, and adults were taken from August 1994 until August 1995, weekly from August to September 1994, and biweekly for the remainder of the study.

Adults.—*Mayatrichia ponta* adults were collected with an 8-watt UV light during each field trip. The trap was set approximately one meter from the shoreline near downstream riffles and was operated for one hour after sunset. Flight periodicity was determined from samples taken with aerial nets. Fecundity was studied by dissecting field-collected females, and lab-reared females when no field collected adults were available.

Larvae.—Samples indicated that the majority of *M. ponta* larvae were found on rocks greater than 15 cm across that were resting on the travertine stream substrates. On each sampling date six rocks ranging from 15 to 30 cm in diameter were collected along a randomly chosen transect across the stream. The upper size limit was established based on our ability to handle and process the material in the field. Organisms and debris on the surface of the rock were brushed into a bucket filled with filtered stream water. The contents of the bucket
were then passed through a sieve to concentrate the sample. A 150-μm sieve was initially used for collections in August 1994; for subsequent sampling a 38-μm sieve was used to collect the earliest instars. Collected materials were preserved in Kahle’s solution then stored in 80% ethanol until processed in the laboratory.

Head capsule width and length were measured using an Olympus SZH dissecting microscope coupled with an Olympus CUE-2 image processing system. Instars were separated by a scatter plot of head capsule width against head length. The prominent sclerites of the fifth instar also were used to help distinguish instars. The length of the head capsule (HCL) was measured from the anterior margin of the frons to the posterior margin of head sclerites. The width of the head (HCW) was measured as the distance of the head capsule across the eyes.

Diet examinations of larvae were determined from collections made during July 1996. Freshly collected larvae were relaxed in carbonated water for 5 minutes to reduce regurgitation of the gut contents and then preserved in ethanol. Fore- and midguts were dissected, placed in glycerin on a microscope slide, and scanned under a compound microscope with 800-1,000 magnification. The proportion of each component of the diet was quantified by relative percentage of area.

Larval microhabitat.—The effect of water current on the spatial distributions of *M. ponta* larvae and pupae on each surface (top, bottom, front, back, left, and right) of individual rocks was examined in March 1996. This sampling occurred during a period with high numbers of larvae and pupae present. Prior to each biological sampling, water flows were estimated in front of individual rocks by a Pygmy flow meter and on each rock surface exposed to water current using a modified Gessner current meter (Hynes 1970, Wallace 1975). After measuring currents, each rock surface was brushed, and the contents were concentrated in a sieve (38 μm) and preserved with Kahle’s solution in separate bottles. Larvae were sorted to instar and counted in the lab. The area of each side of each rock was measured using the aluminum foil weight-area method described by Doeg and Lake (1981).

Counts of each instar and pupae on each side of each rock were converted to a standard density, number of individuals/0.01 m². This area was selected because it approximates the mean surface area of all stones collected. Both population size and surface area data were normally distributed (Shapiro-Wilk test for normality, α = 0.05). A one-way ANOVA was used to test if the means of current velocities on six sides were significantly different. A Pearson Correlation Analysis was used to determine the coefficient between the population size of *M. ponta* and surface area of substrates. A one-way ANOVA was also used to examine the mean densities of each instar on the six sides. The Student-Newman-Kuels multiple comparison test was used to determine statistically significant differences between means. All statistical analyses followed Zar (1984) using SAS software (1991).

Rearing.—Live larvae and pupae were transported to the laboratory and placed in aquaria containing natural substrates and aerated stream water for rearing. Pupae were reared individually for association with adults. Behaviors were observed in these aquaria. Larval behaviors were also observed under a dissecting microscope.

The overall behavior, fecundity, life cycle, voltinism, and life history of *M. ponta* were interpreted from information gathered by the field activities described above and laboratory observations. Voucher materials, including representatives of all life stages, are deposited in the University of North Texas Elm Fork Natural Heritage Museum.

**RESULTS AND DISCUSSION**

Eggs.—Despite numerous attempts, we were unable to induce oviposition in females collected in the field or reared in the
lab. However, female *M. ponta* taken in light traps often released egg masses when they became immersed in preservative. These egg masses were contained in a light yellow gelatinous fluid. The diameter of eggs in female abdomens was 52–76 μm (x = 65 μm, n = 8). Eggs of *Agraylea multipunctata* Curtis and *Oxyethira costalis* Curtis, were also reported to be in a gelatinous mass (Nielsen 1948). However, *D. angata* laid eggs singly (Resh and Houp 1986), indicating that oviposition strategies vary among the Hydroptilidae.

Larval distribution.—Instars were separated by a scatter plot of head capsule width against head capsule length (Fig. 1). Five instars were determined for *M. ponta*, which is typical for Hydroptilidae (Nelson 1948).

Nearly all larvae of *M. ponta* were found on or under rocks. However, a few 5th instar larvae were found under moss mats beneath fast flowing water and in abandoned black fly pupal cases. A one-way ANOVA showed significant difference in flows among the six sides of rocks (n = 10, α = 0.05, P = 0.0001). The populations on the bottom side of the rocks were separated as a distinct group from those on other surfaces (Student Newman Keuls test, α = 0.05). The top surface had the highest mean flow of 32.4 cm/s (SD = 10.9 cm/s).

Densities of instar I through IV on the six surfaces of rocks were not significantly different. However, densities of fifth instars and pupae were significantly greater on the bottom of the rocks than other sides (Student Newman Keuls test, α = 0.05). These observations suggest that instars I—IV of *M. ponta* are dispersed evenly on all surfaces, but final instars preferred the bottom surface were low flows occurred. These shifts in microhabitats are similar to those reported for *Hydropsyche pellucidula* Curtis (Boon 1979, Muotka 1990), and *H. angustipennis* Curtis (Muotka 1990).

Diet.—Wiggins (1996b) indicated that *Mayatrichia* species are scrapers. Examination of 13 full larval midguts found that all gut contents were 100% unidentifiable
detritus. However, most larvae collected had bright green abdomens, suggesting that periphytic algae is included in the diet. The attenuated head capsule may be associated with specialized feeding habits (Wiggins 1996a), and it may be that the larvae are piercing individual algal cells, ingesting the contents and discarding the cell walls. This type of feeding has been observed in other hydropsyids (Ito 1998, Keiper and Foote 2000).

Emergence and flight periodicity.—Adults were collected in light traps from April through November (Fig. 2). The sex ratio of 2,482 adults collected during this period was 1.43 ♂: 1 ♀. Adults were not collected in light traps from December through March. However, adults were found in grass along the shoreline throughout the year.

Emergence behavior was observed in the laboratory. During emergence the adult came to the water surface without the pupal exuviae. Upon breaking the surface tension, they rode on the surface for a short distance before climbing onto substrates. Newly emerged adults were soft and white.

Fecundity.—Fecundity was estimated by counting eggs from the dissected abdomens of preserved females. The number of eggs per female was 32–150 (\( \bar{x} = 86, \text{SD} = 31, n = 50 \)). The fecundity of *M. ponta* is slightly lower than that reported for other hydropsyids, such as *Agraylea multipunctata* Curtis, with 120–300 eggs, *Oxyethira costalis* Curtis, with 150–170 eggs, and *Ox-
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1986). Delayed and asynchronus egg hatching probably contributed to the asynchronus life cycles. The fast molt rate in early instars and long duration in the last instar caused last instar larvae and pupae to be represented more often in the population.

A large emergence and high pupal densities were found in the initial samples taken in early August 1994, marking the end of a summer generation. Sampling began too late to define the beginning of this generation (Fig. 2). Decreases in larval and pupal populations were observed at the beginning of September and again in early November. Floods, sufficient to move rocks 20–30 cm in diameter, occurred prior to each of these dates. The travertine stream bed does not provide a hyporeic refuge. It is thought that during floods most organisms are catastrophically swept away. Despite air temperatures suitable for flight activity, reductions in M. ponta emergence were also noted in samples taken following flood events.

A fall generation began in September, developed to last instar in mid-October, and emerged in early November. The winter generation started in mid-November, developed to last instar in January, and began adult emergence in early March. The prolonged occurrence of high densities of early instars and low late instar densities suggested slow development. The asynchronous emergence period of the winter generation was prolonged from early through mid-March, based on high fifth instar and pupal densities in March. The slow development of the winter generation led to larger body size of respective larval instars. Mean head capsule width for winter generations of fifth instar M. ponta was 138 \( \mu m \) (136–165 \( \mu m \)) compared to 131 \( \mu m \) (121–145 \( \mu m \)) for the summer generations. The end of the winter generation was estimated to be in early March, based on the following observations: First, despite the fact that adults were not caught in light traps because of low temperature, aerial net collections indicated emergence of M. ponta occurred in early March; second, a sudden increase of early instars densities in mid-March suggested emergence and oviposition occurred before this date (Fig. 2); and third, degree days accumulation based on air temperature reached 1,100 in early March, which is similar to that observed for a warm season population to complete a life cycle. The relationship between air and Honey Creek water temperature was significantly correlated (Pearson Correlation analysis on ranked data, \( n = 40, r^2 = 0.86, \ P = 0.0001 \)).

The spring generation started from eggs oviposited in early March and emerged in late May. The larval development rate increased with rising water temperature. An early summer generation, developing from May through mid-July, followed the spring generation. Temperature is an important factor regulating growth rates of aquatic insects (Grafius and Anderson 1979, Ward and Stanford 1982, Sweeney 1984), and was probably responsible for the long duration of the M. ponta winter generation and shorter generations in warm seasons. It has been reported that seasonal temperature changes may also synchronize life cycles.
(Williams 1991). However, the life cycles of *M. ponta* remained asynchronous throughout the study.

The five generations a year of *M. ponta* is the highest reported for any trichopteran (Wallace and Anderson 1996). The life histories of other hydroptilids were reported as univoltine in North America (McAuliffe 1982, Resh and Houp 1986, Keiper and Foote 2000). European hydroptilids have been variously reported as univoltine or multivoltine (Nielsen 1948, Recasens and Puig 1991). Ito (1988, 1998) reported univoltine and multivoltine populations for Japanese hydroptilids. Voltinism variations within the same family are well recognized. Species of Glossosomatidae (Anderson and Bourne 1974, Georgian and Wallace 1983) and Hydropsychidae (Mackay 1979, Parker and Voshell 1982) have been reported to have different voltinisms even under the same thermal regime. Additional studies of life histories of Nearctic Hydroptilidae, especially those occurring in warm climates, are needed to understand how the life cycle of *M. ponta* compares to them.

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KYUWIA, A NEW GENUS OF TRICHOGRAMMATIDAE (HYMENOPTERA) FROM AFRICA

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Abstract.—The new genus Kyuwia is described. It includes two new African species, K. doutti and K. zuria. Both species appear to be widespread in subsaharan Africa. Included are a key to species and a discussion of taxonomic placement.

Key Words: Hymenoptera, Trichogrammatidae. Kyuwia, new genus, new species, Africa

Examination of several recent collections of Trichogrammatidae from Africa has revealed the presence of an apparently widespread pair of species of a distinctive new genus, Kyuwia. Although numerous genera of Trichogrammatidae are known from Africa (Doutt and Viggiani 1968, Noyes 2001) Kyuwia is the first that appears to be restricted to that continent. Based on structure of the male genitalia the new genus is tentatively placed in the subfamily Oligositiinae and tribe Chaetostrichini. The two new species, K. doutti and K. zuria, appear to be widespread in subsaharan Africa and are at least partially sympatric. A key to species is included.

Terminology employed in the descriptions for most morphological traits follows Doutt and Viggiani (1968) and Gibson (1997). Terms of antennal sensilla follow, or are modifications of, those utilized for Trichogramma by Olson and Andow (1993) and Pinto (1999). Abbreviations used are as follows: APB = aposeral sensillar trichodea B; PLS = sensilla placodea; BPS = basiconic peg sensilla; FS = flagelliform setae (Pinto 1999) or multiporous pitted sensilla trichodea A (Olson and Andow 1993); APA = aposeral setae A (Olson and Andow 1993) or unsocketed setae (Pin- to 1999). One type of antennal sensillum in Kyuwia not easily fitting standard terminology used for Trichogramma concerns a relatively dense patch of recurved sensilla on the ventral surface of the female antenna (Figs. 4–6). Similar structures were termed multiporous pitted sensilla trichodea C in Trichogramma (Olson and Andow 1993). Although similar in Kyuwia, these sensilla are not associated with a type C base (a shallow socket) but, as with the flagelliform setae (FS), have a type A basal insertion (sensillar surface contiguous with antennal surface). We refer to these structures simply as recurved setae (RS).

Kyuwia Pinto and George, new genus

Type species: Kyuwia doutti Pinto and George, n. sp.; present designation.

Diagnosis.—Flagellum of antenna with only four segments: two anelli and two asymmetrical club segments; funicle absent; club of female with a patch of light-colored, recurved setae (RS) ventrally. Fore wing relatively broad, ca. half as wide as long, densely setose, vein tracks inconspicuous. Male genitalia as in Chaetostrichini (see Description).

Description.—Female. Head: Foramen magnum distant from mouthparts. at level
of dorsum of eyes; malar sulcus absent. Eyes and ocelli red. Toruli at same level as ventral margin of eyes. Antenna (Figs. 2–4) with only four flagellar segments: two anellii and two asymmetrical club segments. Antennal club segment 1 (C1) closely ap- pressed to second segment (C2) and distinctly shorter, longest along dorsal surface; surface densely set with short unsocked setae (APA); venter of C2 with a large light-colored patch of short, digitiform, recurved setae (RS). Mandible with 3 distinct teeth. Maxillary palp one segment. Mesosoma (Figs. 11–12): Pronotum narrowly divided mediolongitudinally. Scutum and scutellum each with two pair of setae, without a mediolongitudinal line; propodeum strap-shaped, only slightly produced posteriorly at middle, medial length ca. 3× that of metanotum; mesophragma notched apically; mesopleuron with pleural sulcus.

Fore wing (Figs. 7, 9) ca 2× as long as wide; disk densely covered with setae, vein tracks not evident or poorly indicated, with a field of minute alar acanthea posterior to premarginal vein on ventral surface; venation extending to ca. 0.5 wing length; marginal vein contacting anterior margin of wing, ca. 1.5× length of premarginal vein; premarginal vein usually distinctly separated from marginal vein, angled away from wing margin resulting in a costal cell; stigma vein distinct, angled toward wing apex, stigma suboval, connected to marginal vein by a constriction; a very short, obsolescent postmarginal vein visible or not. Metasoma: Sterna complete. Ovipositor shorter than hind tibia, often directed dorsally and almost perpendicular to frontal plane when at rest; hypopygium (Figs. 16–17) triangular, extending to apex of metasoma, with a distinct mediolongitudinal line.

Male (known only for type species). Similar to female except club without a ventral patch of recurved setae (RS). Genitalia (Fig. 15) of the Chaetostrichini type (Viggiani 1971): elements fused into a single tubular structure with a distinct and elongate anterodorsal aperture and without ob-

vious parameres or volsellae; genitalia widest at basal third, gradually narrowing to base and to apex.

Etymology.—An arbitrary combination of letters; derived from the letter 'Q', in keeping with 'Genus Q'. The unofficial name originally used in our laboratory for this taxon. Gender feminine.

Host.—Unknown.

Discussion.—Kyuwia is distinguished from all other Trichogrammatidae by its unique antenna consisting of a club with two asymmetrical segments, absence of a funicle, and presence of a large ventral patch of light-colored recurved setae on the second club segment in females. The densely setose fore wing without distinct vein tracks also helps distinguish the genus.

Kyuwia is most likely to be confused with the virtually cosmopolitan Aphelinoidea Girault, which also has a densely setose fore wing, lacks a funicle and often has a two-segmented club (Doutt and Viggiani 1968). In fact, in the key to genera in Doutt and Viggiani (1968) Kyuwia runs to Aphelinoidea at couplet 34. In Aphelinoidea, however, the club segments are symmetrical, and a ventral patch of recurved setae is absent. Also the fore wing is considerably narrower (ca. 2.5× as long as wide), has a short, poorly-defined stigma vein, and the venation does not extend as far toward the wing apex (< 0.5 distance from base to apex). The antennal club of the South American Pseudaxenulfens Yoshimoto, like that in Kyuwia, is composed of two asymmetrical segments, but in that genus a distinct funicle is present (Yoshimoto 1976)

Except for Aphelinoidea, all trichogrammatid genera lacking a funicle have more than two club segments; most are characterized by four or five. Only four of these genera have as few as three club segments. These include Paruscanoeidea Girault, Tumidicelava Girault, Tumididemur Girault, and Uscanella Girault. Paruscanoeidea and Uscanella have virtually glabrous fore wings. Tumidicelava and Tumididemur have densely setose fore wings but are distinguished
from Kyuwia by the same antennal features that separate Aphelinoidae. In addition, Tumidiclava females have a rodlike projection at the apex of the antenna which is lacking in Kyuwia. Of these genera, only Tumidiclava and Aphelinoidae are known from Africa.

The structure of the male genitalia currently places Kyuwia in the Chaetostrichini (Oligositinae) based on the classification of Viggiani (1971). However, it is distinct from all genera placed in the tribe and affinity to any of them is not clear. Other genera of Chaetostrichini include Chaestostrichia Walker, Gnorimogramma DeSantis, Bloodiella Nowicki, Brachista Walker, Lathrogramma DeSantis, Uscana Girault, Lathromeroidea Girault, Lathromeromyia Girault, and Uscanoidea Girault (Viggiani 1971, 1984; Lin 1994; Pinto 1994). The latter six genera lack a funicle but have a 3–5 segmented club. Kyuwia and Brachista are the only genera placed in this tribe that have a patch of recurved setae on the ventral surface of the club in females. In Brachista, this feature only occurs in one species, B. fidiae (Ashmead) (Pinto 1994). This trait also occurs in several genera of Trichogrammatini (e.g., Trichogramma Westwood, Trichogrammatoidea Girault, Trichogrammatomyia Girault).

**Kyuwia doutti** Pinto and George, new species

(Figs. 1, 2, 5, 7, 8, 13, 15, 16)

Quantitative data for females represent means based on three specimens unless indicated; range provided only if noticeable variation detected (observed range for body length, sampled range for all other measurements); n = 1 for male.

Description.—Female (Fig. 1). Body length 0.65 (0.5–0.8) mm (n = 5), relatively robust with metasoma subtruncate apically, ca. twice as long as mesosoma. Color uniformly dark brown except as follows: head with vertex, parascrobal areas, and scrobal depression light brown to almost white, lower face, gena and postgena brown to dark brown; antenna with pedicel and scape very light brown, club noticeably darker; legs with tibiae and tarsi pale brown.
Figs. 2–6. Antennae of Kyawia. 2, *K. douitti* (lateral; arrow near basal-most extension of recurved setal patch). 3, *K. zuria* (as in Fig. 2). 4, *K. zuria* (flagellum, ventral). 5, *K. douitti* (detail of recurved setae). 6, *K. zuria* (as in Fig. 5).

**Head:** ca. 0.8× as long as wide, slightly wider than mesosoma; vertex slightly rounded; scrobes relatively shallow; malar space ca. 0.6× lateral eye length. Antenna (Fig. 2) with scape widest in basal half; second anellus very short, closely appressed to club, expressed medially only; length/width of segments as follows: scape—2.6, pedicel—1.5, club—1.7; club 2.5× and 1.2× as long as pedicle and scape, respectively; C1 0.3× total length of club and closely appressed to C2; C2 0.8× (0.8–0.9) total length of club; C1 with two elongate APB, three PLS dorsally, and four subglobose BPS distributed along apex; C2 with 8 PLS, 3–4 BPS near base, and several relatively narrow and short FS; FS concentrated on lateral surface; ventral patch of RS occupying apical 0.6 (3/5) of segment.

**Mesosoma:** Setation relatively long, setae on mesoscutum and scutellum of subequal length; scutum ca. 1.8× as long as scutellum; dorsum with fine but distinct coriaceous sculpturing, cells generally wider than long anteriorly on scutum, more elongate posteriorly and on scutellum. Fore wing (Figs. 7–8) broad, suboblate, 0.51× as wide as long, with fringe length ca. 0.15 greatest width, venation attaining 0.54 wing length; with a light brown infuscation posterior to marginal vein extending to stigmal vein and ca. half the distance to posterior wing margin; area posterior and basal to premarginal vein very lightly infuscate; the
two infuscate areas separated by a narrow clear zone; disc setation apical to venation dense with relatively few vein tracks indicated: R, RS2 and RS1 tracks distinct, the latter represented by 4–5 setae and separated from adjacent disc setae by a narrow glabrous area; basal vein track of 1–3 setae; costal cell with 2–4 setae in anteroapical corner, setae divided between dorsal and ventral surfaces; marginal vein 1.5× (1.4–1.6) as long as premarginal, both subequal in width; stigmal vein 0.45× length of marginal vein; premarginal vein subrectangular with two long stout setae: marginal vein 4× longer than wide with ca. 12 setae. Hind wing moderately broad, maximum width of disc 0.75× length of longest posterior fringe setae; with three distinct vein tracks, 2–3 additional setae between posterior two tracks in some specimens. Legs relatively slender, relative length of coxa, trochanter, femur, tibia, tarsus and (tarsomeres) as follows: foreleg—34: 14: 48: 51: 41(12): 11: 20), middle leg—25: 16: 47: 66: 49(18): 14: 19), hind leg—50: 22: 61: 70: 55(18: 16: 23); mid tibial spurs (Fig. 13) relatively short, 0.72× (n = 5) as long as first tarsomere.

Metasoma: Hypopygium (Fig. 16) triangular, longer than broad. Ovipositor 0.82× as long as hind tibia.

Male. As in female except as follows: Antennal club similar in shape and segmentation but with fewer PLS (1 on C1, 4 on C2); C2 lacking a ventral patch of RS, with more elongate and conspicuous FS, lacking BPS sensilla near base, and with two elongate APA near middle. Legs more robust with considerably shorter tarsi, e.g. hind tarsus 0.5 hind tibial length (ca. 0.7× hind tibial length in female); midtibial spur 0.9× as long as first tarsomere. Last sternum with a distinct V-shaped emargination. Genitalia (Fig. 15) elongate, 1.1× as long as hind tibia; anterodorsal aperature 0.45 total genital length.


Etymology.—Named after Dr. Richard L. Doutt in recognition of his contributions to trichogrammatid systematics. Dr. Doutt apparently recognized Kyuwia to be distinct, as indicated by the note ‘n. genus’ written on slides of this species found in his collection at UC Berkeley.

Geographic distribution.—Subsaharan Africa from Ivory Coast south to South Africa.


Discussion.—A single female from Perinet, Madagascar (iv–26/v–4–1983; M. Day & J. Noyes, collrs.) is similar to K. doutti but probably represents a new species. Unlike in both K. doutti and K. zuri, the marginal and premarginal veins are contiguous in this specimen. Also, its marginal vein is slightly swollen and noticeably wider than the premarginal vein. This individual is labeled ‘nr. Kyuwia doutti’ in the U.C. Riverside Collection.

Kyuwia zuria Pinto and George, new species
(Figs. 3, 4, 6, 9–12, 14, 17)

Quantitative data represent means based on 5 specimens: range provided only if noticeable variation detected (observed range
for body length, sampled range for all other measurements).

**Description.**—Female. As in *K. douiti* except as follows: Body length 0.67 (0.6–0.8) mm, head somewhat smaller relative to body; color generally lighter ventrally; mesosoma usually slightly lighter than metasoma (see Variation).

**Head:** Slightly narrower, as wide as mesosoma. Antenna (Figs. 3–4) with scape widest at middle; length/width of segments as follows: scape—2.6, pedicel—1.7, club 2.0; club 2.3× and 1.3× as long as pedicle and scape, respectively; C1 0.4× total club length, C2 0.9× total club length; patch of RS larger, occupying 0.8 (0.8–0.9) club length.

**Mesosoma:** Fore wing (Figs. 9–10) appearing somewhat longer; venation attaining 0.47 wing length; infuscations at base of wing darker; disc setation very dense, without distinct vein tracks, RS1 setae not distinguishable from adjacent disc setae; basal vein track of 3–4 setae; costal cell with 9–11 setae, setae divided between dorsal and ventral surfaces. Hind wing with three vein tracks and a partial 4th track at middle between posterior two tracks; setae on disc longer. Legs with relative length of coxa, trochanter, femur, tibia, tarsus and (tarsomeres) as follows: foreleg—37: 18: 57: 56: 44:12: 14: 21, middle leg—27: 25: 54: 74: 55: 17: 16: 24, hind leg—56: 21: 67: 81: 62: 19: 19: 28; midtibial spur (Fig. 14) elongate, 1.36× (1.3–1.5) as long as first tarsomere.

**Metasoma:** Hypopygium (Fig. 17) triangular, broader than long. Ovipositor 0.79 (0.7–0.8) hind tibial length.

**Male.** Unknown.

**Variation.**—The dorsum of the mesosoma may be concolorous with the metasoma or considerably lighter. In most specimens the midlobe of the mesoscutum is only slightly lighter brown with the scutellum considerably more so. In specimens from...
Nelspruit, South Africa, this surface is yellow with two darker longitudinal maculae occupying the anterior \( \frac{2}{3} \) of the midlobe. The limited material available suggests that color variation is continuous.

Types.—Holotype ♀: GHANA, Ashanti Region, Bobiri Forest Reserve; 06° 42'N, 01° 20'W; vii-23/31-2001; flight intercept trap; C. Carlton; deposited in the collection of the PPRI. Paratypes: 3 ♀, same data as holotype except viii-1/16-2001 (2 ♀ UCRC, 1 ♀ Canadian National Collection). All types mounted in Canada balsam on glass slides. Seven additional specimens from type locality card mounted (see below).

Etymology.—From 'zuri', the Swahili term for beautiful.

Geographic distribution.—Subsaharan Africa from Guinea east to Nigeria, south to South Africa.

Material examined.—42 ♀, GHANA. (see Types); 11 ♀; dates and data as for types except 1 specimen from ix-5/10-2001. GUINEA. Mt. Nimba (Gouan River); rainforest: 514 m; 7°42'N, 8°23'W; xi-27/30-1990, xi-29/xii-12-1990; flight intercept trap; 2 ♀; L. LeBlanc. Same as previous except: “514–740 m, 7°41’ to 7°42’N, 8°23’W, xii-1990/i-1991”; 1 ♀. IVORY COAST. Bouaké; i/x-1981; “pan traps in irrigated rice fields”; 10 ♀; P. Cochenerau. Lamto Research Station; 6°13’N, 5°02’W; vii-1988; Malaise trap; 3 ♀. KENYA. Kakamega District; Ischeno (Kakamega Forest, Ischeno Nature Reserve); 1,800 m; 00.24°N, 34.87°E; iv-19/30-2001; “Malaise in forest”; 1 ♀. R. Snelling. NIGERIA. Oyo State; Ibadan (IITA Compound); x-1987; yellow pan trap; 1 ♀; J. Noyes. SOUTH AFRICA. East Transvaal; Pilgrim’s Rest. 11 km SE; xii-11/31-1985; 1 ♀; S./J. Peck. Mpumalanga; Nelspruit Bushveld Lodge; 25°29.53’S, 30°55.91’E; ii-5/6-2002; yellow pan traps; 8 ♀; J. George/J. Kim. Mpumalanga; Nelspruit Lowveld National Botanical Gardens; 25°29.53’S, 30°38.15’E; ii-7-2002; yellow pan trap; 1 ♀; J. George. UGANDA. Fort Portal; 20 km SE Makerere University Biological Field Station (MUBFS) (near Mikana stream); 1,530 m; 0°34.37’N, 30°21.66’E; x-7/21-2001; yellow pan-flight intercept trap; 2 ♀; B.J. Gill. Masindi District; Burungo Forest (near Sonso); 1° 45’N, 31°35’W; vi-19/30-1995; “fogging Trichilia rubescens (Meliaceae)” 1 ♀; T. Wagner.

Discussion.—Kyuwa zuria and K. doutti are similar species but can be distinguished by several characteristics. Differences associated with the fore wing and mesotibial spur length are summarized in the key to species. Also providing separation is the size of the RS patch on the ventral surface of the second club segment in females (Figs. 2–3). In K. zuria this patch of sensilla is more extensive, occupying the apical 0.8 of C2. In K. doutti it is restricted to the apical 0.6 of the segment. In addition to the size of the RS patch, the individual sensilla composing the patch also differ structurally. In K. zuria the sensilla are longitudinally ridged at the base and unevenly narrowed to the apex (Fig. 6), whereas in K. doutti they are relatively smooth basally and are evenly narrowed apically (Fig. 5). Also, the shape of the hypopygium differs (Figs. 16–17). Although triangular in both species, in K. zuria it is distinctly wider than long, whereas in K. doutti it is longer than wide. All differences noted are consistent throughout the range of both species. This includes representatives of each collected together at Bouaké, Ivory Coast.

KEY TO SPECIES OF KYUWA

(based on females)

1. Mesotibia with apical spur elongate, distinctly longer than first mesotarsomere (Fig. 14). Fore wing setation extremely dense, RS1 track setae not distinguishable from adjacent disc setation (Fig. 9); costal cell with more than 8 setae (Fig. 10) .......................... zuria 1' Mesotibia with apical spur shorter than first mesotarsomere (Fig. 13). Fore wing setation less dense, RS1 track setae distinct, separated from adjacent disc setae by a narrow glabrous area (Fig. 7); costal cell with fewer than 5 setae (Fig. 8) .......................... doutti
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LITERATURE CITED


Lin, N. 1994. Systematic Studies of Chinese Trichogrammatidae. Biological Control Research Institute, Fujian Agricultural University, Special Publication No. 4. 363 pp. [in Chinese with summaries and key to genera in English].


Abstract.—*Ophiogomphus smithi*, n. sp., is described and illustrated from 24 males and 15 females (holotype male and allotype female from Wisconsin, Eau Claire County, confluence of South Fork Eau Claire River and Horse Creek, 12 June 1994, K. J. Tennessen). The new species resembles *O. aspersus* Morse; however, the male has shorter proximal lobes on the anterior hamules and the female has occipital horns and a shorter vulvar lamina.

Key Words: Odonata, Gomphidae, new species, Wisconsin, Iowa

Several new taxa of *Ophiogomphus* Selys have been described from North America in the past two decades (Carle 1981, 1982, 1992; Cook and Daigle 1985; Donnelly 1987; Vogt and Smith 1993). The number of species of *Ophiogomphus* in North America is a matter of conjecture, depending on whether several taxa are considered species or subspecies. Based on Needham et al. (2000), the new species described in this paper brings the total to 19. The new species was first discovered in west-central Wisconsin. In the field we independently mistook the specimens for *O. aspersus* Morse, as the male cerci, in lateral view, closely resemble the inflated cerci of that species. Detailed examination of the hamules and several other characters revealed that it was distinct.

*Ophiogomphus smithi* Tennessen and Vogt, new species
(Figs. 1–6, 10)

Types.—Holotype ♀: Wisconsin, Eau Claire County, confluence of South Fork Eau Claire River and Horse Creek, 44°43.3’N, 90°59.2’W, 12 June 1994, K. J. Tennessen (KJT). Deposited in Florida State Collection of Arthropods (FSCA), Gainesville, Florida, USA. Allotype ♀: Same data as holotype; deposited with holotype.

Paratypes (23 ♂, 14 ♀): Wisconsin: Same data as holotype, 3 ♂, 1 ♀, KJT (FSCA); same data, 11 June 1994, 5 ♂, KJT (4 ♂ FSCA, 1 ♂ Coll. National Museum of Natural History, Washington, DC). Eau Claire Co.: Eau Claire River, Co. Rd. D, 44°47.0’N, 91°14.4’W, 12 June 1994, 1 ♂, 4 ♀, 1 pair in cop., KJT (FSCA); same locality, 16 June 1994, 7 ♀, 4 ♀, KJT (5 ♀ in FSCA, 1 ♀ in Coll. J. J. Daigle, 1 ♂, 1 ♀ in Coll. R. W. Garrison); Eau Claire River, Channery Road Boat Landing, 44°43.7’N, 90°59.3’W, 19 June 1990, 1 ♂, 2 ♀, T. E. Vogt (TEV) (Coll. TEV); same locality, 12 June 1994, 1 ♀, TEV (Coll. TEV); Eau Claire River, Co. Rd. K, 44°48.6’N, 91°16.9’W, 12 June 1994, 1 ♂, TEV (Coll. TEV); Horse Creek near Horse Creek Rd., 44°43.3’N, 90°59.2’W, 12 June 1994, 3 ♂, TEV (Coll. TEV). Jackson Co.: Robinson Creek at Dodge Rd., 44°11.6’N, 90°47.8’W, 19 June 1990, 1 ♂, TEV (Coll. TEV).
TEV); Robinson Creek, 1.5 mi. W of Mills- 
ton, 44°11.4'N, 90°41.4'W, 30 July 1994, 1 
♀. J. J. Daigle (Coll. JJD).

Other specimens examined.—W1, Eau 
Claire Co.: confluence S Fork Eau Claire 
River and Horse Creek, 8 June 1993, 3 ♂ 
teneral, KJT; Eau Claire River. Co. Rd. D. 
16 June 1996, 1 ♂. KJT. Rusk Co.: Chip- 
pewa River, Boat Landing Rd. S of Bruce. 
45°23.5'N, 91°17.4'W, 23 May 1994 (larva 
collected and adult ♂ emerged same day). 
T. C. J. Doolittle & C. Dovichin (Coll. W. 
A. Smith). Iowa. Buchanan Co.: unnamed 
stream along Rt. V65, T88N, R10W, Sec-
tion 31, 19 June 1995, 1 ♂. R. Cruden 
(University of Iowa Collection).

Etymology.—Named for our colleague 
and co-discoverer of the species, William 
A. Smith, biologist, Department of Natural 
Resources, State of Wisconsin.

Holotype male.—General color pattern: 
Thorax light green, abdomen patterned in 
black and yellow; eyes in life dull dark 
blue. Head: Labium, maxilla, base of mand- 
dible, labrum and postclypeus light gray 
brown; postclypeus green yellow; ante- 
frons green, except basal fourth of horizon-
tal surface dark brown; postfrons (vertex) 
black around ocelli, tan posterior to postocellar 
ridge; occiput markedly tumid medially, 
yellow green, with long, black setae on 
crest; crest convex in frontal view (Fig. 1), 
evenly swollen across posterior vertical sur-
faced in dorsal view; rear of head black dor-
sally, mottled with light brown and tan to-
ward cervix and mouthparts.

Thorax: Prothoracic notum mostly 
brown, middle lobe with a pair of medial 
yellow green spots, yellow-green laterally; 
epimeron light brown. Pterothorax mostly 
light green, with narrow brown stripes as 
follows: middorsal stripe along dorsal car-
ina, although dorsal edge of carina yellow; 
episternum 2 (anterior) stripe wide an-
teriorly, extending 0.8 distance to posterior 
margin of episternum 2, connected at ¾ its 
length to mesopleural (humeral) stripe 
which extends length of suture but nar-
rowed anteriorly; faint, narrow brown stripe 
on inter- and meta-pleural sutures (first and 
second laterals); metapostepimeron light 
tan. Legs: Coxae tan basally, tan-gray dist-
tally; femora mostly yellow tan proximally, 
black distally; tibiae black except outer sur-
face and lower edge of lateral surface yel-
low tan; tarsi black except outer surface of 
first and second segments of hind tarsus 
yellow tan. Wings: Costa yellow, vena-
tion dark brown, pterostigma dark brown 
on dorsal surface, tan on ventral surface; 14 
antenodal crossveins in fore wing (fw), 10 
in hind wing (hw); 11 postnodal crosses 
veins in fw, 10 in hw.

Abdomen: Segments (S) 1–10 each with 
dorsolateral, longitudinal dark stripes wid-
ened posteriorly and with a broad green yel-
low middorsal stripe; pale middorsal stripe 
on S3–9 triangular, tapering posteriorly, 
extending nearly full length, on S10 oval; S2 
with narrow, dark brown stripe ventral to 
auricle, wider light brown marking poste-
rior to auricle connected to dorsolateral 
abdomen stripe; S7–9 with dorsolateral dark 
stripes slightly paler than on preceding seg-
ments, on S10 even paler; all segments tan-
gray ventrolaterally; S8–9 each with pos-
terior third of lateroventral flange black; 
septa of S3–6 black, 7 brown, 8–10 tan. 
Anterior hamule dark brown, bifurcate dis-
tally, proximal lobe slightly longer than 
posterior lobe, also more slender and hook-
like; space between lobes oval (Figs. 2, 10); 
posterior hamule green gray proximally, 
distal slender portion dark brown, recurved 
and spatulate. Cercus yellow tan, epiproct 
tan to tan gray; cercus in lateral view thick, 
dorsal margin convex at midlength, apex 
sharply acuminata (Fig. 3); cercus in dorsal 
view separated at midlength by a distance 
equal to its width (Fig. 4); epiproct in lat-
eral view with high dorsolateral protuber-
ance beyond midlength (Fig. 3); epiproct in 
dorsal view narrow, dorsolateral protuber-
ances hidden by cerci, base of cleft convex, 
posterior arms slightly convergent (Fig. 4).

Measurements (mm): Total length 44.5; 
abdomen length 32.0; hw length 26.2; hw

pterostigma 2.9; cercus length 1.60; epiproct length 1.23.

Allotype female.—Color pattern similar to male, except eyes dull gray blue in life. **Head**: Color pattern of mouthparts and rest of head as in male; crest of occiput with a slender horn 0.22 mm long at each corner, spaced 1.37 mm apart, apical third of horns black (Fig. 5); postoccipital horns (on rear of head) shorter (about 0.20 mm), stouter, dark brown; horn on left side with a single acuminate tip, horn on right side more blunt with two small sharp tips.

**Thorax**: Color pattern of sternites, legs
and wings similar to male; 12 antenodal crossveins in fw, 9 in hw; 10 postnodal crossveins in fw, 11 in hw.

**Abdomen:** Color pattern similar to male, except dorsolateral brown stripe of segment 3 not extending ventrally to vestigial auricle; also, ventrolateral flange of segment 9 black along entire length, and dorsal yellow marking of segment 10 occupying nearly entire dorsum of segment; cercus in lateral view more sharply acuminate than in male. Vulvar lamina mostly yellow tan, tips dark brown; cleft between lobes elongate oval, tips approximated at basal constriction but apices divergent (Fig. 6); tips deflected, visible in lateral view; length of vulvar lamina 0.6 times length of sternum 9.

**Measurements (mm):** Total length 44.0; abdomen length 31.2; hind wing length 27.6; pterostigma (hw) 3.36; vulvar lamina length 1.27.

Variation in paratypes.—Color pattern was remarkably uniform in the paratypes. In one male and two females, the dark antehumeral stripe was not connected to the dark humeral stripe at its upper end. In several males, the outer surface of the first and second tarsal segments was nearly all black. The abdomen ranged from slightly darker to slightly lighter than in the holotype. **Wing venation:** Males had 11 to 14 antenodal crossveins in fw, 9–10 in hw and 10–12 postnodals in fw, 10–13 in hw (one male had only 8 postnodals in one hw); females had 12 to 14 antenodal crossveins in fw, 9–11 in hw and 10–12 postnodals in fw, 9–13 in hw. The female occipital horns ranged from 0.16–0.30 mm long (in one female the horns were only 0.08 mm long, but the tips appear to be broken off), and the distance between them ranged from 1.28–1.47 mm. In one female, the left occipital horn had a
small sharp black tipped point on its outer side. The postoccipital horns ranged from 0.10–0.24 mm long.

Range in measurements (mm; means in parentheses include holotype and allotype): Males—total length 44.0–47.5 (45.5); abdomen length 31.5–34.5 (32.7); hw length 25.5–27.5 (26.6); hw pterostigma length 2.9–3.3 (3.1). Cercus length 1.56–1.78 (1.69); epiproct length 1.19–1.35 (1.26). Females—total length 43.5–46.5 (45.0); abdomen length 31.0–33.5 (32.1); hw length 27.5–29.5 (28.5); hw pterostigma length 3.3–3.9 (3.6); vulvar lamina length 1.15–1.39 (1.31).

Diagnosis.—TEV examined Morse’s type series of O. aspersus (1895) in the Museum of Comparative Zoology, Cambridge, in March 2001. The syntype series consists of 5 specimens (2 ♂, 3 ♀); 1 ♂ and 1 ♀ each bear a label with the word “Type” in red ink. All are from Wellesley, and probably all are from Massachusetts, but the collectors, S. W. Denton and S. F. Denton, wrote “MA” on only some of the data labels. Examination of these specimens confirmed that O. aspersus is correctly diagnosed in recent taxonomic works. Males of Ophiogomphus smithi key to O. aspersus in couplet 7 of Needham et al. (2000) based on the inflated male cerci. However, the second character in that couplet (“apical processes of anterior hamuli nearly twice as long as apical processes of posterior hamuli”) does not fit O. smithi (note that it is the proximal process, or lobe, of the anterior hamule that is longer than the apical process of the posterior hamule in O. aspersus, not the apical process as stated in couplet 7). In Walker (1958), males of O. smithi key to couplet 6 where they conflict in the two characters given (postocellar ridge is not sinuate but apices of cerci are acute). In Walker (1958), females key to O. occidentis Hagen, except for the designation of “western.” Several structural characters serve to separate males of O. smithi from O. aspersus: 1) In lateral view, the cerci of O. aspersus have a markedly convex ventral margin (Fig. 7) compared to the slightly convex margin of O. smithi (Fig. 3); 2) The superexosternal tooth of the O. aspersus epiproct is only slightly produced and the deflected tip is elongate (Fig. 7), whereas in O. smithi the superexosternal tooth is greatly produced and the deflected tip is shorter (Fig. 3). In O. aspersus, the proximal lobe of each anterior hamule is as long as the slender apical lobe of the posterior hamule (Fig. 8). In O. smithi, this lobe is about half as long as the apical lobe of the posterior hamule (Fig. 2).

The gap separating the apical lobes of the epiproct in dorsal (or ventral) view is variable in O. aspersus, the lobes themselves being parallel to slightly convergent and their inner margins straight to slightly curved. We have not found any reliable character for separating the two species based on a dorsal or ventral view of the epiproct. The abdomen of male O. aspersus (n = 7) was slightly longer (34.6–35.1 mm) than in O. smithi (31.5–34.5 mm), and the epiproct was slightly longer (1.39–1.52 mm vs. 1.19–1.35 mm).

The most striking difference between O. smithi and O. aspersus exists in the anterior hamules. In O. aspersus, the proximal lobe of the anterior hamule is slendr for its whole length and terminates in a curved hook in ventrolateral view (Fig. 9), whereas in O. smithi it is short and wide and terminates in a straight abrupt point (Fig. 10). The anterior hamules of O. smithi are similar to those of two other species within its range, O. rupinsulensis (Walsh) and O. colubrius Selys. These species are easily separated from O. smithi as follows: O. rupinsulensis lacks a definite brown middorsal thoracic stripe and the cerci in lateral view are parallel-sided and blunt; in O. colubrius, the cerci are not inflated, and the epiproct is as long as the cerci (see Needham et al. 2000).

In females, the vulvar lamina of O. aspersus extends about 0.75 the length of sternum 9 versus 0.6–0.66 in O. smithi (one of the shortest in the genus in eastern North
America). In *O. aspersus* females, occipital horns vary from absent to very small and widely spaced; postoccipital horns (0.25–0.43 mm long) were present in the few specimens we examined.

Two color pattern differences that appear to hold for both sexes are: 1) The dorsal yellow spots on abdominal segments 7–9 are full length in *O. smithi* whereas they do not extend to the apex of the segment in *O. aspersus*; 2) the external surfaces of the tibiae are usually yellow in *O. smithi* versus black in *O. aspersus*.

**Distribution and habitat.**—We examined specimens of *Ophiogomphus smithi* from three counties in Wisconsin (Eau Claire, Jackson, and Rusk) and one county in Iowa (Buchanan). The streams from which these specimens were collected are medium sized with predominantly sandy substrates. With this in mind, Dunkle (2000) gave it the common name “Sand Snaketail.” Since we made our collections, W. A. Smith (personal communication) has found additional localities where the habitat is more variable than purely sand-bottomed streams. He will be describing the larva with more information on habitat in an upcoming paper.

Flight dates we recorded are May 23 to July 30; most adults were collected in June.

The record for *O. aspersus* in Wisconsin (Ries 1969) was based on a single specimen collected by P. D. Harwood in Siren, Burnett Co. Before his death, Dr. Harwood told us that he loaned the specimen to a colleague in Canada, but he could not remember his name. We have been unable to find the Harwood specimen, and can only assume that it was *O. smithi*. W. A. Smith has examined larvae of *O. smithi* from the Clam River approximately 7 km N of Siren (personal communication). *Ophiogomphus aspersus* was reported for Michigan based on a single female from Gogebic Co. (Kormondy 1958). KJT examined this specimen (housed in the University of Michigan Collection) and determined it to be *O. carolus* Needham. These findings indicate that the range of *O. aspersus* is Appalachian, and includes NB, NS and QC in Canada and CT, KY, ME, MA, NH, NJ, NC, NY, RI, VA, and VT in the United States. The known western limit in the northern part of the *O. aspersus* range is at Nominingue, Canada, 75°W longitude (Walker 1958), whereas in the midsouth region it is Green Co., KY (Cook 1951) at approximately 85.7°W longitude.

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**Literature Cited**


A NEW SPECIES OF BRUGGMANNIELLA (DIPTERA: CECIDOMYIIDAE) ABORTING YOUNG FRUIT OF AVOCADO, PERSEA AMERICANA (LAURACEAE), IN COLOMBIA AND COSTA RICA

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Abstract.—A species new to science, Bruggmanniella perseae Gagné (Cecidomyiidae: Diptera), is reported from avocado, Persea americana, from Colombia and Costa Rica. The insect is a severe pest of avocado. Infested fruit drop to the soil when less than 2 cm in length. The new species is described, illustrated, and compared with the five previously described species of Bruggmanniella, and its biology is outlined. A key to the six species of Bruggmanniella is provided.

Key Words: Persea americana, avocado, Lauraceae, Neotropical, gall midges.

Avocados, Persea americana Miller (Lauraceae), are grown throughout the American tropics and in many places constitute an important part of the agricultural economy. A gall midge (Diptera: Cecidomyiidae) new to science was recently discovered in a coffee growing area in Caldas, Colombia during a survey of insects attacking avocado and also in Carrizal, Costa Rica. Larvae live in ovaries of young fruit and pupate in situ. Infested young fruit, less than 2 cm long (Figs. 1–4), die and dehisce shortly after adult emergence. The new species belongs to the genus Bruggmanniella Tavares and is the first record of a gall midge from avocado. It is the sixth species known for the genus. Bruggmanniella is Neotropical except for one species that occurs also in southern USA. All six species are specific to a particular plant host, each of a different plant family, as summarized in the key presented in this paper.

Materials and Methods

Recently fallen young avocado fruit of abnormal shape found in an avocado plantation, Finca Guamal, in Villamaria, near Caldas, Colombia were collected and brought to the laboratory for dissection and observation of contents and life history of the cecidomyiid. To obtain adults, fruit with pupae were placed in glass containers with paper tissues inside to collect excess moisture and prevent the fruit from spoiling. Damaged fruit were also collected in Carrizal, Costa Rica and specimens were obtained in a similar way. Specimens of immature stages and adults were preserved in 70% isopropyl alcohol and sent to the Systematic Entomology Laboratory for identi-
fication. Some samples were mounted on microscope slides using the method outlined in Gagné (1989, 1994). Some pupae and larvae were dried and placed on stubs for scanning electron microscope study. Terminology for adult morphology follows usage in McAlpine et al. (1981) and for larval morphology that in Gagné (1989). Most of the specimens and information on biology were obtained by FP and ZNG. The taxonomic investigation in this paper was the responsibility of RJG.

**Diagnosis of Bruggmanniella**

*Bruggmanniella* species are easily separated from those of the generally similar *Asphondylia* Loew by characters found in males and pupae (Gagné 1994). The male genitalia of *Asphondylia* have a wide, apical gonostylar tooth and lack parameres, while the genitalia of *Bruggmanniella* have two small, separate gonostylar teeth and parameres. Pupae of the two genera differ substantially: the integument is unpigmented in *Bruggmanniella*, except for the brown antennal horns and prothoracic spiracles, but is entirely brown to black in *Asphondylia*; the frons of *Bruggmanniella* lacks the prominent horns found in *Asphondylia*; the abdomen of *Bruggmanniella* has tiny, closely-set abdominal tergal spicules and some spinelike abdominal spiracles instead of large, discrete tergal spines and entirely sessile spiracles found in *Asphondylia*.

Several characters not used in the key that follows may be diagnostic for separating *Bruggmanniella* species but have not been described for some or all previously described species. Two such characters are the length of the needlelike part of the ovipositor in relation to that of the seventh sternite and the number of spiniform spiracles of the pupal abdomen. In the new species, the needlelike part of the ovipositor is 2.9–3.2 times the length of the seventh sternite, while in *B. bunneliae* (Felt), the only other *Bruggmanniella* species we have seen, the needlelike part is only about 2.0 times as long as the seventh sternite. In *B.
maytenuse (Maia and Couri) the ratio has been reported as 2.7 and in B. byrsonimeae (Maia and Couri) as 4.0 (Maia et al. 1992). The pupa of the new species has five pairs of spiniform abdominal spiracles while B. buneliae has six. In the key to species that follows, we have supplied host, distribution, and helpful references.

**KEY TO PUPAE AND THIRD INSTAR LARVAE OF BRUGGMANNIELLA SPECIES**

1. Larval spatula with 4 apical teeth (as in Fig. 12); pupal antennal horn in ventral view acutely triangular, narrowed gradually from base to pointed apex (as in Fig. 14) ............ 2
   - Larval spatula with 3 apical teeth (as in Fig. 13); pupal antennal horn in ventral view narrowed abruptly at midlength (as in Fig. 11) ............ 5
2. Pupal antennal horn minutely serrate laterally (as in Fig. 14) ............ 3
   - Pupal antennal horn coarsely serrate laterally ............ 4
3. Pupal antennal horn concave laterally (Fig. 14); ex young fruit of Persea americana (Lauraceae), Colombia and Costa Rica ............ B. perseae, new species
   - Pupal antennal horn convex laterally; ex fruit of Maytenus obtusifolia (Celastraceae), Brazil ............ B. maytenuse (Maia & Couri) (Maia 1999, Maia et al. 1992)
4. Pupal antennal horn straight laterally except for serrations; ex multichambered, swollen stem apices of Soroece ilicicola (Moraceae), Brazil ............ B. brasilensis Tavares (Möh 1963)
   - Pupal antennal horn convex laterally; ex single or multichambered, swollen buds of Byrsomima sericea (Malpighiaceae), Brazil . . . B. byrsominae (Maia & Couri) (Maia et al. 1992, Maia 2001)
5. Pupal antennal horns twice as long as widest diameter (Fig. 11); ex multichambered twig galls of Bunelia lanuginosa (Sapotaceae), USA (southern), Mexico ............ B. buneliae (Felt) (Gagné 1994)
   - Pupal antennal horns approximately as long as widest diameter; ex multichambered galls on stems of Schinus sp. (Anacardiaceae) Brazil ............ B. oblitia Tavares (Möh 1961)

**Bruggmanniella perseae Gagné, new species**

(Figs. 5–10, 12, 14–18)

Adult. **Head** (Fig. 5): Eye connate, 8–9 facets long at vertex; facets hexagonal, all closely approximated. Frons with 8–15 setae per side. Clypeus with apicodorsal row of 4–5 short setae. Labellum with 5–7 setae laterally and patch of short setae mesally. Palpus 3 segmented, first segment about as long as wide, second segment broadest, about twice as long as wide, third segment 2–3 times as long as wide, all with scattered setae and covered with setulae. Antenna: Scape cylindrical, ca. 1.5 times length of pedicel; pedicel globular, slightly wider than long; first and second flagellomeres partially connate; male flagellomeres (Fig. 6) each with four wavy circumfila running along flagellomere length and connected near base and near apex of flagellomere; female flagellomeres (Fig. 7) with two circumfila running along length and connected to one another at base and apex.

**Thorax:** Wing length, male 2.4–3.1 mm (n = 5), female 2.5–3.0 (n = 7). Dorsocentral setal row at midlength 3 rows broad, rows continuing onto scutellum to posterior margin, scutellum otherwise bare. Anepisternum with several setae clustered in middle. Aneupimeron covered with setae. Katepimeron bare. Acropods (Fig. 8): Tarsal claws subequal in size and similar in shape on all legs; empodia as long as bend in claws; pulvilli about ¼ length of empodia.

**Male abdomen:** First through seventh tergites: rectangular with mostly single row of posterior setae, except seventh tergite with mostly 3 rows of posterior setae; several lateral setae present, more numerous on seventh tergite; elsewhere covered with scales; with anterior pair of trichoid sensilla, not easily seen because not much larger than and situated among anteriormost scales. Eighth tergite unsclerotized, without vestiture except for anterior pair of trichoid sensilla. Sternites covered with setae and scales, without anterior pair of trichoid sensilla, male eighth sternite greatly reduced in size, twice as wide as long. Genitalia as in Figs. 9–10.

**Female abdomen:** First through seventh tergites as for male. Eighth tergite diminutive, bare, the only vestiture the anterior pair of trichoid sensilla. A pair of large lobes present immediately posterior to...
Figs. 5–13. 5–10, Bruggmaniella perseae. 5. Head, frontal. 6. Male third flagellomere. 7. Female third flagellomere. 8. Tarsal claw, empodium, and pulvillus. 9. Male genitalia, one gonopod removed, dorsal. 10. Same, lateral. 11, Bruggmaniella bumeliae, antennal horns and prothoracic spiracle, ventral. 12, B. perseae, larval spatula and associated papillae. 13, B. bumeliae, same.
eighth tergite, entirely covered with large, spiny, mostly recurved setulae. Sternites covered with setae and scales, without anterior pair of trichoid sensilla, seventh sternite about 2.3 length of preceding sternite. Basal half of ovipositor evenly cylindrical, with longitudinal rows of setulae, distal half of ovipositor rigid, needlelike, 2.9–3.2 (n = 5) times as long as seventh sternite.

Pupa (Figs. 14–16).—Integument unpigmented except for dark brown antennal horns and prothoracic spiracle. Antennal horns elongate, dorsoventrally flattened, in dorsal view widest and parallel-sided at base, distal two-thirds scalloped laterally and gradually narrowing to acute apex, entire length covered with shallow striae, and scalloped edge minutely serrate. Frons convex, without prominences, with 0–2 palpalae near each palpal base, each with short seta. Clypeus with 0–2 palpalae, each with seta. Pair of vertexal palpalae with elongate setae. Prothoracic spiracles elongate. Abdominal spiracles of first and eighth segments sessile, those of second through sixth segments elongate-spiniform. Abdominal tergites with anterior pair of palpalae, each with short seta, second through seventh tergites with several rows of many, closely spaced spicules, four dorsal palpalae with setae, two each situated at lateral third of posteriormost spicule row. Eighth tergite with field of spicules nearly divided medially into two groups and much less numerous, shorter, and more robust than on seventh tergite. Abdominal segments otherwise uniformly minutely spiculose.

Third instar larva (Figs. 12, 17–18).—Yellow. Spatula with 4 prominent anterior teeth, lateral teeth more acute and usually slightly shorter than mesal teeth. Three lateral palpalae present on each side of spatula, all setose. Sternal palpalae setose. Dorsal and pleural palpalae with short setae. Terminal segment papillose, blunt, palpalae not distinguishable from spicules.

Holotype.—Male, from fruit of Persea americana. Villamaria, Caldas, Colombia. III-1999, F. Posada & Z. Gil, deposited in Cenicafé Insect Collection, Chinchiná, Caldas, Colombia.

Other material examined.—2 ♂, 4 ♀, 11 pupae, 7 larvae, same data as holotype: 1 ♂, 3 ♀, 2 pupae, 5 larvae, same data as holotype except III-2002: 1 ♂, 2 larvae. Carrizal, Alajuela, Costa Rica, 11-IV-2002. A. Gonzalez & P. Hanson. All deposited in National Museum of Natural History, Washington, DC.

Etymology.—The specific name means “of Persea.” We suggest for a common name, the avocado ovary gall midge.

Remarks.—This species differs from all other known species of Bruggmanniella by the unique shape of the pupal antennal horns. It also differs from other species by the other characters used in the key, and presumably in other characters as well but which have not yet been described for all other species. The only other species known from fruit is B. maytenuse and, interestingly, it and the new species exit at the same coupled in the key to species. The needlelike half of the ovipositor of B. perseae is 2.9–3.2 times the length of the seventh sternite, while in B. maytenuse, as mentioned earlier, it is only 2.7 times as long (Maia et al. 1992). This ratio appears to be useful to distinguish Bruggmanniella species, but users should be cautioned that slide mounted specimens are not always properly displayed, with the ovipositor not always completely flat or straight. The terminal palpalae of B. perseae larvae are indistinguishable from surrounding tissue but in B. maytenuse they each bear a very noticable seta (Maia 1999).

Biological notes.—The female of B. perseae inserts a single egg in the ovary of each flower it attacks. Upon hatching the larva feeds with its head towards the peduncle end of the ovary, while the fruit extends beyond the larva into a cucumber-shaped cylinder with an elongate chamber that during the course of larval feeding becomes partially filled with white hyphae of a presumably symbiotic fungus. An infested fruit can be recognized in the field by its shape when only about 1 cm long (Fig. 1). Nor-
Figs. 14–18. *Bruggemannia perseae* pupae and larvae. 14, Anterior half of pupa, ventral. 15, Same, lateral. 16, Pupa, dorsal, with arrow pointing to spiniform spiracle. 17, Larval head to second thoracic segment showing spatula in center, ventral. 18, Larval eighth and terminal abdominal segments, dorsal.
nal fruit are pyriform at that length, but infested fruit instead become elongate and slender, cucumber-like. When the larva is full grown (Fig. 2), it turns head to tail and migrates towards the apical end of the fruit. By means of its spatula (Fig. 17), armature present in the third instar larva of most gall midges, the larva scrapes away an exit tunnel partway through one side just anterior to the apex and extending only to the thin exocarp wall (Fig. 3). The larva retreats to the main chamber and pupates immediately, nestled in the particulate matter from the scraping mixed with the fungus, which turns black and brittle after cessation of larval feeding. A short time later when the adult is fully formed inside the pupa and by which time the uncit circle of exocarp has turned brown, the pupa advances head first through the exit chamber and cuts a circular opening to the outside by gaining purchase inside the tunnel with the help of its abdominal tergal spicules and applying its pupal horns to the uncut end of the tunnel while rotating its body around the longitudinal axis (Fig. 4). The pupa then exits partway and the adult emerges from the end of the pupal body. Shortly afterwards, still less than 2 cm in length, the aborted fruit drops to the soil.

Many galls contained a parasitoid belonging to the Eulophidae (Hymenoptera). The parasitoid kills the cecidomyiid before the latter pupates, so must form its own escape hole, usually through the very apex of the fruit. The hymenopteran is the subject of a separate paper in preparation by Paul E. Hansen and Alan Gonzalez of the Escuela de Biología, Universidad de Costa Rica. Infested fruit could be found throughout the year. In 1999 in varieties such as Pinchochet and Edranal in Finca Guamal near Caldas, Colombia, the insect appeared responsible for 100% fruit drop. No evaluation was carried out to determine if the lack of fruit set was a result of fly attack or other factors also. In Costa Rica, the infestation is more seasonal and there appears to be only one generation of the gall midge per year.

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EXGUIANA, A NEW GENUS OF NEOTROPICAL PHYCITINES
(LEPIDOPTERA: PYRALIDAE)

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Abstract.—The new genus Exguiana is proposed to receive Euzophera postflavida Dyar, n. comb, and three new species, E. beckeri, E. limonensis, and E. pitillana. Euzophera postflavida has been known only from female specimens, and its generic placement was uncertain until the recent discovery of males. A key separating the four species, habitus photographs of males, and fine drawings of the wing venation, labial palpus, antenna of the male, and male and female genitalia are included.

Resumen.—El genero Exguiana es propuesto para ubicar la especie Euzophera postflavida Dyar, además de tres especies no descritas, E. beckeri, E. limonensis, y E. pitillana. La especie Euzophera postflavida ha sido identificada solo de hembras y su posición generic generica incierta hasta la recolección de machos recientemente. Una clave para las cuatro especies, fotos de los machos, así como dibujos de la venación de alas, palpus labial, antenna del macho, y genitalia del macho y la hembra son incluidos.

Key Words: Phycitinae, taxonomy, Brazil, Costa Rica, French Guiana, Guyana

Heinrich (1956), in his bulletin dealing with the American phycitines, included a section entitled “Genera and species unplaced, unrecognized, or referred from the Phycitinae.” Many of the unplaced species consisted of a female type, or female types, lacking associated males. One of these was Dyar’s Euzophera postflavida described from French Guiana, an easily recognized species with very distinctive orange coloration and readily identifiable genitalia. Based on an examination of the genitalia, Heinrich rightly concluded “It is not a Euzophera.” Despite its uniqueness, it has been only recently that additional females, as well as males, of postflavida have been collected. These were found in Costa Rica as a result of the biological inventory undertaken by the Instituto Nacional de Biodiversidad of that country, and in Brazil because of the collecting efforts of Vitor Becker. Interestingly, two more species, obviously congeneric with postflavida, have been found to occur in Costa Rica, and a fourth species, also belonging to the genus, has been collected in Brazil. In the present paper we place postflavida and the other species in a new genus, Exguiana.

Abbreviations used for depositories of types and other specimens are as follows: Cornell University, Ithaca, New York, U.S.A. [CU]; Instituto Nacional de Biodiversidad, Santo Domingo, Costa Rica [IN-Bio]; North Carolina State University, Raleigh, North Carolina, U.S.A. [NCSU]; National Museum of Natural History, Wash-
Exguiana Neunzig and Solis new genus

Type species.—*Euzophera postflavida* Dyar, 1923, by present designation.

Diagnosis.—The male genitalia (Figs. 5–6, 8–9, 11–12, 16–17) have the valva short (not reaching posteriorly to the apex of the uncus), weakly sclerotized and with few setae, and the vinculum abbreviated with the sacculus broad and with its anterior margin straight to concave.

Description.—Antenna (Fig. 14) simple in both sexes; sensilla trichodea (seta) of shaft abundant and about ½ to ⅓ as long as basal diameter of shaft. Frons convex, smoothly scaled. Labial palpus (Fig. 15) of both sexes upcurved, reaching slightly above vertex. Maxillary palpus simple, short-scaled in both sexes. Haustellum well developed. Ocelli present. Basal half of costa of forewing of male slightly concave to slightly convex (Fig. 13), and smooth above (*postflavida* with raised scale cluster at base of wing); underside of male forewing simple (*pitillana* with contrastingly colored streaks of scales); forewing with 11 veins; R₃ from cell; R₃+₄ and R₅ fused at base with R₂ and stalked for more than ¼ distance beyond cell; M₁ straight; M₂ and M₃ stalked for about ½ distance beyond cell; Cuₐ₁ and Cu₂ separate at base; Cu₂ from before lower angle of cell. Hindwing (Fig. 13) simple above (*limonensis* and *beckeri* with small patch of dark brown to black scales near base); hindwing below simple, or with patches or streaks of colored scales; hindwing with seven veins (1A, 2A and 3A together treated as one vein); Sc + Rs fused for less than ¼ distance beyond cell; M₂+₃ and Cuₐ₁ stalked for ½ to ½ distance beyond cell; Cu₂ from before lower outer angle of cell; cell about ½ length of wing; hindwing of most species of usual shape (hindwing of *limonensis* with outer margin lobed just below apex). Male abdominal segment 8 with bushy tufts of ventral scales. Male genitalia (Figs. 5–6, 8–9, 11–12, 16–17) compact (with short valva, vinculum, and saccus); uncus untapered to triangularly shaped; gnathos distally a slender, well-sclerotized element with its apex entire to shallowly forked; transtilla with medial pair of posteriorly projecting arms and with or without anteriorly projecting arms; juxta V-shaped, its distal arms setiferous; valva stubby, with few setae; sacculus with well-developed tuft(s) of weakly attached scales; aedeagus short, well-sclerotized, slightly angled; ductus ejaculatorius annulated, with pair of well sclerotized, approximate rods; vesica simple, or with patches of microspines; vinculum about as long as tegumen plus uncus; saccus with anterior margin straight or concave. Female genitalia (Figs. 7, 10, 18) with ostium bursae simple or microspined; ductus bursae about ⅓ as long as corpus bursae, ribbed in basal half, and scrobinate over most of its length or in its distal half; corpus bursae membranous, elongate-oval with signum a well-developed patch of concentrically arranged scobinations (centrally located scobinations in some species, forming a short, inwardly-projecting, spinelike process); ductus seminalis attached to lobe of corpus bursae near junction of ductus bursae and corpus bursae.

Etymology.—The generic name is a combination of the Latin *ex* (from) and the type locality (Guiana) of the type species. The gender is feminine.

**Key to Species of Exguiana**

1. Hindwing with many orange scales; transtilla with posteriorly projecting arms as long as length of uncus (Fig. 5) . . . . . *postflavida* (Dyar) — Hindwing without many orange scales; transtilla with posteriorly projecting arms shorter than length of uncus (Figs. 8, 11, 16) . . . . . . 2

2. Forewing with well-developed dark spot immediately following antemedial line; underside of male forewing and hindwing with red streaks; transtilla with short, strongly-divergent, posterolaterally directed arms (Fig. 8) . . . . . . . . . . . . . . . . . . . . . . . . *pitillana* Neunzig and Solis, n.sp. — Forewing without well-developed dark spot and without antemedial line; underside of male fore-
The orange scales covering most of the hindwings of both the male and female, in association with the appearance of the genitalia (Figs. 5–7) will identify this species. In addition to the orange scales, the male hindwing has many slightly-curled, pale ocherus scales. These specialized scales are mostly concentrated into two, pale, oval spots in the anal region, and a less obvious, subapical reniform spot.

The male genitalia of Exguiana postflavida have the uncus broadly rounded distally (not gradually tapered towards the apex), a gnathos with its distal, medial element slightly sinuous, with a clearly forked apex, a transtilla with long, medial, posteriorly projecting arms (longer than length of uncus), a valva rounded apically, a vinculum short, and a saccus with its anterior margin concave. The female genitalia have a long obovate corpus bursae with a signum com-

Exguiana postflavida (Dyar),
new combination
(Figs. 1, 5–7, 13–15)
Euzophera postflavida Dyar 1923:29.
posed of very small concentrically-arranged scobinations. The central scobinations of the signum form a shallow, inwardly projecting process.

_Exguiana postflavida_ was reported by Heinrich (1956), under the name _Euzaephra postflavida_, as occurring in British Guiana (Guyana), at Tumatamari, near the Potaro River, as well as in French Guiana, at Nouveau Chantier, and at St. Laurent Maroni. All specimens mentioned by Heinrich were females, and collected in June and September. The holotype, in the USNM, from French Guiana has been examined. In Costa Rica two males and one female have been collected as follows: 1 ♂, Rancho Quemado, Peninsula de Osa, 200 m., Provincia Puntarenas, October, 1991, F. Quesada, INBio CR 1000507105 [INBio]; 1 ♂, Sector Cerro Cocori, Finca de E. Rojas, 150 m., Provincia Limon. May, 1992, E. Rojas, INBio CR 1000438406, genitalia slide 4756 HHN [INBio]; 1 ♀, Fila Esquinas, 35 km. S. Palmar Norte, Provincia Puntarenas, January, 1983, D. H. Janzen & W. Hallwachs, INBio CR 1002043324 [INBio]. In Brazil one male and two females have been collected at Maricá, Minas Gerais, 5 m. 12–15. January, 1985, V. O. Becker No. 54577 [VOB, NCSU].

_Exguiana pitillana_ Neunzig and Solis new species
(Figs. 2, 8–10)

Diagnosis.—The transtilla of the male (Fig. 8) has short, strongly divergent, posterolaterally directed arms, and the well developed streaks of red scales on the underside of the wings of the male will help identify this species.

Description.—Forewing length 9.0–10.0 mm. Head: Frons and vertex brownish white to brown; labial palpus upturned, reaching above vertex, outwardly entirely brownish white or brownish white with basal segment dark brown; maxillary palpus simple, with brownish white scales; antenna of male simple, with sensilla trichodea (cilia) about ½ as long as basal diameter of shaft. _Dorsum of thorax_: Pale brown and dark brown, washed with brownish red in some specimens. Forewing: Mostly a mixture of pale brown and brownish red scales; antemedial line weakly developed, consisting of an incomplete, angled line of white scales in the costal half of the wing; postmedial line faint, formed of very small, isolated patches of white scales; several patches of black scales, most noticeably at posterior base of wing, immediately following antemedial line in costal half of wing, and preceding postmedial line; a few scattered, white scales on costal half of wing and in terminal area of wing; discal spots black, partially suffused with red; underside of wing of male with strongly developed streaks of red scales on base of veins. Hindwing: Brown above in both sexes; male with streaks of red scales on base of veins on underside of wing. _Male genitalia_ (Figs. 8–9): Uncus strongly tapered towards apex (triangular); gnathos with apical process slender, long (about as long as length of uncus) with shallowly forked apex; transtilla with medial pair of distinctly diverging, posterolaterally projecting arms (arms about 1/3 as long as length of uncus) and with pair of, about the same size, anteriorly projecting arms; juxta narrowly V-shaped; valva short, truncate distally; sacculus with tuft of long, slightly curved, simple scales; aedeagus with ductus ejaculatoris annulated and with pair of sclerotized rods; vesica simple; vinculum as long as tegumen plus uncus; saccus with anterior margin almost straight. _Female genitalia_ (Fig. 10): With ductus bursae about ½ as long as corpus bursae, slightly ribbed in basal half and densely scobinate over most of its distal half; corpus bursae membranous elongate oval, with numerous, minute scobinations; some scobinations slightly enlarged, densely grouped, strongly sclerotized and concentrically arranged to form a signum; scobinations in center of signum forming a shallow, inwardly projecting process; ductus seminalis attached

to lobe of corpus bursae near junction of ductus bursae and corpus bursae.


Exguiana limonensis Neunzig and Solis
new species
(Figs. 3, 11, 12)

Diagnosis.—The hindwing of the male has its outer margin distinctly lobed just posterior to its apex, and has basally a unique dorsal pocket that contains a cluster of tiny, black scales.

Description.—Forewing length 10.5–11.0 mm. Head: Frons brownish white; vertex pale brown; labial palpus upturned reaching above vertex; mostly brownish white on outer surface with a few white scales on basal segment; maxillary palpus simple, with brownish white scales; antenna of male simple, with sensilla trichodea (cil- lia) about ½ as long as basal diameter of shaft. Dorsum of thorax: Pale brown and dark brown or reddish brown. Forewing: Ground color a mixture of pale brown and brown; antemedial and postmedial lines absent; with costal dusting of white on distal third of wing, and patches or streaks of dark brown elsewhere on wing (most obvious dark streak extends from base of wing to just posterior of whitish costal patch); also, streaks or patches of red scales, particularly noticeable in median fold; discal spots dark brown. Hindwing: Of male pale brownish white with outer margin lobed just posterior to its apex, and with basal pocket with short white scales partially concealing dense cluster of very small black scales. Male genitalia (Figs. 11–12): Uncus subtriangular, slightly tapered toward apex; gnathos with apical process moderately elongate with very shallowly forked apex; transtilla with medial pair of posteriorly projecting arms (arms about ½ as long as length of uncus and weakly sclerotized over most of their lengths), and with slightly shorter, more slender, more laterally positioned, pair of anteriorly projecting arms: juxta narrowly V-shaped; valva short with distal end truncate; sacculus with tuft of long, slightly curved, simple scales; aedoeagus with ductus ejaculatoris annulated and with pair of sclerotized rods: vesica with patch of small spines; vinculum only slightly longer than tegumen plus uncus; saccus with anterior margin very shallowly concave. Female genitalia: Probably similar to those illustrated in Figs. 7, 10, 18 (no females of Exguiana limonensis have thus far been collected).


Etymology.—The specific epithet is derived from the province in Costa Rica where the holotype and paratype were collected (Limon) and the Latin adjectival suffix -ensis (belonging to).

Exguiana beckeri Neunzig and Solis
new species
(Figs. 4, 16–18)

Diagnosis.—Males of Exguiana beckeri have a well exposed, dark brown to black tuft of scales near the dorsal base of the hindwing (Fig. 4) and pilous, hooked scales attached to the sacculus of the genitalia (Fig. 16).

Description.—Forewing length 9.0–10.0 mm. Head: Frons whitish brown; vertex pale reddish brown; labial palpus upturned, reaching above vertex, outwardly clothed in mixture of white, reddish brown, pale
brown and dark brown scales (most dark brown scales at basal half of palpus); maxillary palpus simple, with white to brownish white scales; antenna of male simple, with sensilla trichodea (cilia) about $\frac{1}{3}$ as long as basal diameter of shaft. 

*Dorsum of thorax:* Pale brown. *Forewing:* Ground color dark brown; antemedial and postmedial lines ab-
sent (a few pale scales present where these lines usually occur, but no organized lines discernible); a weak dusting of white scales over most of wing, and streaks and patches of brownish red and red scales: discal spots dark brown, indistinct, blending with dark brown ground color of wing. Hindwing: Mostly pale brownish white, in part transparent, brown along anterior and outer edges of wing; male with linear, dark brown to black basomesial scale tuft (? cubital pecten) that strongly contrasts with inner part of wing. Male genitalia (Figs. 16–17): Uncus strongly tapered towards apex (triangularly shaped); gnathos with apical process short (about ½ as long as length of uncus) with apex entire; transtilla with medial pair of narrow, posteriorly projecting arms (arms about ½ as long as length of uncus, and weakly sclerotized for most of their lengths), and with pair of about as long, but more robust, anteriorly projecting arms; juxta narrowly V-shaped; valva short, rounded distally; sacculus with two tufts of scales (a tuft of long, slightly curved, simple scales, and a more posteriorly located unusual tuft of short, hooked, pilous scales); scale-bearing part of sacculus bulbous, strongly projecting laterally; aedeagus with ductus ejaculatoris annulated and with pair of sclerotized rods; vesica with patch of small spines; vinculum slightly longer than tegumen plus uncus; saccus with anterior margin shallowly concave. Female genitalia (Fig. 18): With ductus bursae about ½ as long as corpus bursae, slightly ribbed in basal half, and scobinate over most of its length (particularly near corpus bursae); corpus bursae membranous, elongate oval with many very small, weakly formed scobinations; signum a rosette of much larger, strongly sclerotized scobinations; center of signum only slightly indented; ductus seminalis attached to lobe of corpus bursae near junction of ductus bursae and corpus bursae.

Holotype.—♂. Sete Lagoas, Minas Gerais, 720 m., Brazil, 24-VII-1969, V. O. Becker, genitalia slide 4631 HHN [VOB].

Paratypes.—3 ♂, 2 ♀. Same collection data as holotype, genitalia slide 5714 HHN [USNM, NCSU]: 1 ♂. Same collection data as for holotype except collected 21-VII-1969, genitalia slide 4632 HHN, [VOB]: 2 ♂, 1 ♀. Ilha do Bananal, Goiás, Brasil, 4-8-IX-1977, V. O. Becker, genitalia slide 5716 HHN [USNM]: 1 ♂, 1 ♀. Planatina, Distrito Federal, 1,000 m., Brasil, 3-V-1983, V. O. Becker, genitalia slide 5715 HHN [USNM].

Etymology.—This species is named after Vitor Osmar Becker who collected the type series, and who has assiduously collected many other Neotropical Lepidoptera.

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LITERATURE CITED


Abstract.—The phyline plant bugs *Keltonia rubrofemorata* Knight and *K. wheeleri* Henry are specialist herbivores on *Polygonella* species (Polygonaceae); the former mirid has been known only from *P. myriophylla* (Small) Horton in the Lake Wales Ridge of central peninsular Florida and the latter only from *P. americana* (Fisch. & C.A. Mey.) Small in portions of the Georgia and South Carolina Sandhills. Sampling of *P. americana, P. myriophylla,* and several other species of *Polygonella* in the Southeast from 1998 to 2003 provided further evidence for the restricted host and distributional ranges of both mirids. Whereas the range of *K. rubrofemorata* coincided with that of *P. myriophylla,* which essentially is a Lake Wales Ridge endemic, that of *K. wheeleri* on *P. americana* did not: the bug was not found in northern areas of the Fall-line Sandhills of South Carolina or in disjunct populations of *P. americana* in Georgia. Both mirids are multivoltine, the overwintered eggs of *K. wheeleri* hatching about mid-March and those of *K. rubrofemorata* in January. Adults of both species persisted until late November or early December.

Key Words: Heteroptera, Miridae, Phylinae, *Keltonia, Polygonella, Fall-line Sandhills,* endemism, Lake Wales Ridge, *Prepops rubrovittatus*

Phytophages, which account for about one-fourth of all described species of insects, generally are host restricted. Host specialists can include strict monophages that develop only on one plant species throughout their geographic ranges (e.g., Mitter et al. 1988; Bernays and Chapman 1994; Thompson 1994, 1998; Janz et al. 2001). The little-known mirid *Keltonia rubrofemorata* Knight and a recently described congener, *K. wheeleri* Henry, not only are each thought to be limited to one host species but also to exhibit restricted geographic ranges (Henry 2002). Here I provide additional evidence supporting the limited host and geographic ranges of both plant bugs, characterize the habitats in which they are found, and give notes on their seasonal histories.

**Methods**

American jointweed, *Polygonella americana* (Fisch. & C.A. Mey.) Small, the only known host of *K. wheeleri,* was sampled at irregular intervals from 1998 to 2003 by tapping the main stem, ascending secondary branches, and prostrate basal branches over a white enamel pan to detect nymphs and adults. To further delimit this plant bug’s range, *P. americana* was sampled nearly throughout its range in South Carolina; at numerous sites in Georgia, includ-
ing several disjunct populations; and in the Sandhills of North Carolina. Adults from each locality were deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Information on the seasonality of *K. wheeleri* was obtained principally from two disturbed sandhills in South Carolina, one in Barnwell County southwest of Williston and the other in Edgefield County southwest of Eureka, and from a similar plant community in McDuffie County, Georgia, southwest of Dearing. Emphasis was placed on determining the approximate time that eggs hatch in early season, when adults of the first generation begin to appear, and how long the last-generation adults persist in the fall. Nymphs (*n* = 1–10, depending on abundance) of all instars were collected live or placed in 70% ethanol and the instars determined in the laboratory. *Polygonella polygama* (Vent.) Engelm. & Gray in the Fall-line Sandhills from south-central North Carolina to eastern Georgia was sampled to determine whether it serves as a host for *K. wheeleri*, and *P. fimbriata* (Ell.) Horton was sampled similarly in southeastern Georgia.

Biological information on *K. rubrofemorata* was obtained by sampling *P. myriophylla* (Small) Horton at irregular intervals from 1998 to 2003 in the Lake Wales Ridge of peninsular Florida. Mats of this more prostrate *Polygonella*, known as sandlace or Small’s jointweed, were shaken over an enamel pan or shallow beating net. Sampling and sorting of nymphs otherwise was the same as that used to study *K. wheeleri* on *P. americana*. The main study sites were in Highlands County north and northwest of Lake Placid, southwestern Orange County, and Polk County south of Frostproof. Co-occurring species of *Polygonella* that were sampled as possible hosts of the mirid included *P. basiramia* (Small) Nesom & Bates, *P. ciliata* Meisn., and *P. gracilis* Meisn.

**Keltonia rubrofemorata** Knight

Knight (1966) described *Keltonia* and *K. rubrofemorata* from 8 males and 13 females collected from *P. myriophylla* by the miridologist L.A. Kelton at Sebring (Highlands Co.), Florida, on 30 April 1961. The only other published record of this plant bug is north of Frostproof (Polk Co., Florida), where nymphs and adults (27 ♀, 19 ♂) were taken on the same host on 25 April 1984 (Henry 1991).

Distribution.—The following new records of *K. rubrofemorata*, except one in Highlands County in 1998, are based on my collecting from *P. myriophylla*. Roman numerals indicate the nymphal instars present.


Host plant and habitat.—My collections of *K. rubrofemorata*, as well as the two previously published records, were from *P. myriophylla*. Syntopic populations of *P. basirania*, *P. ciliata*, and *P. gracilis* in the Lake Wales Ridge did not yield specimens of the plant bug.

The host plant is endemic or precintive (*sensu* Frank and McCoy 1990) to scrub communities on relict beach ridges and dune fields of peninsular Florida (Huck et al. 1989, Menges 1999). Essentially restricted to the Lake Wales Ridge (ca. 160 km long), *P. myriophylla* is found mostly in Highlands and Polk counties (Christman and Judd 1990, Lewis and Crawford 1995). This rare, state and federally endangered plant (McCoy and Mushinsky 1992, Coile 2000, Stout 2001) also is known from small portions of Orange and Osceola counties (Christman and Judd 1990).

A woody, prostrate perennial (flowering branches are erect) with persistent needle-like leaves, sandlace forms dark-green mats on pure white sands of peninsular scrubs. The tree layer of scrubs, often including sand pine (*Pinus clausa* (Chapm.) ex Engelm. Vasey ex Sarg.), and sparse ground or herb layer are secondary to a layer of xeromorphic shrubs dominated by oaks, ericas, palmettos, and sometimes Florida rosemary (*Ceratiola ericoides* Michaux) (*e.g.*, Abrahamson et al. 1984, Myers 1990, Stout and Marion 1993, Menges 1999, Stout 2001). Sandlace grows in the more open sites or gaps between shrubs and in vacant lots and on highway slopes among adventive plants such as bahiagrass (*Paspalum notatum* Flügge) and natalgrass (*Rhynchelytrum repens* (Willd.) C.E. Hubbard. Bare zones associated with mature colonies of sandlace are not only the result of infrequent, intense fires but also are due to this plant’s allelopathy (Weidenheimer and Romeo 1989).

Seasonal history.—Collections of late instars and adults in early February suggest that eggs began to hatch about mid-January. Nymphs of all instars that were found in late February and early March likely represented those of a second generation; a fifth instar collected on 3 March eclosed later that same day. Adults were not collected from late February to late March. A fifth instar collected on 20 March eclosed a week later. Early instars observed in late March might have been those of a third generation. Adults, probably representing the third generation, have been collected from mid-April to early May (Knight 1966, Henry 1991). Populations of the mirid were not sampled again until early August when adults and instars I–V were observed. In 2002, nymphs of all instars were present in early and late November; only one adult was taken (a female on the 20th) during November. In 2001, a male and a female were found on 1 December in southern Highlands County, but no nymphs were observed.

*Keltonia wheeleri* Henry

Henry (2002) described *K. wheeleri* from six counties in Georgia and five counties in South Carolina. Type material was based on my collections from *Polygononella americana* in the Fall-line Sandhills of those states. On the basis of a previous phylogenetic analysis of *Keltonia* (Henry 1991), Henry (2002) was able to state that *K. wheeleri* is most closely related to *K. rubrofemorata*.

Distribution.—Nearly all my localities for *K. wheeleri* were cited in the original description of the species (Henry 2002). Only the three main sites used for seasonal-history observations are cited here. For South Carolina, the site in Barnwell County was listed by Henry (2002), as was the one in Edgefield County (as “4.5 mi. SSW of Trenton”): the sample site in McDuffie County, Georgia, was not given in the original description. Adults observed on *P. americana*, but not collected, are indicated.
as "adults"; roman numerals denote the nympha instars present.


Host plant and habitat.—All collections of K. wheeleri have been from American jointweed, P. americana. My sampling of P. polygama from the Fall-line Sandhills of North Carolina and South Carolina and P. jimbiata in Georgia failed to produce specimens of this mirid.

Polygonella americana is a suffrutescent (somewhat woody) perennial that in early season appears as depressed, matted leaves and shoots. It is closest in appearance to P. myriophylla but has a more upright growth habit (Horton 1963, Kral 1983).

American jointweed is weedy and often found along sandy roadsides and hillsides and in other ruderal sites (Horton 1963). In South Carolina, it is a plant of disturbed sandhills along the fall line (Radford et al. 1968, Porcher and Rayner 2001). The range is from the North Carolina Sandhills, where populations apparently are adventive (Sorrie et al. 1997), to South Carolina, Georgia, and Alabama, west to Texas and New Mexico, and north up the Mississippi Valley to southern Missouri. Although P. americana is one of the more widespread species of the genus, the range is discontinuous. Only small, isolated populations along river banks and on rocky outcrops in rivers are found in the middle of its range (Horton 1963, Lewis and Crawford 1995).

Seasonal history.—Overwintered eggs of K. wheeleri hatched during March in the Fall-line Sandhills of Georgia and South Carolina. First instars were found as early as 11 March in 2001. Based on the presence of fifth instars in the last half of April, first-generation adults probably appear from late April to early May. First instars of the second generation were observed by late May in 2000. Reproduction probably continues throughout spring and summer. Fifth instars were present in early November, and adults were taken as late as 28 November.

DISCUSSION

Keltonia wheeleri was found only on P. americana in Georgia and South Carolina, but in the areas sampled in the Southeast, its range was not coincident with that of its host. Although populations of P. americana are nearly continuous in South Carolina along Interstate Highway 20 from North Augusta to Columbia, K. wheeleri was not found in Richland or Kershaw counties in the Columbia area. The plant bug also was not found in disjunct populations of P. americana in Houston and Jasper counties in Georgia or in disjunct but apparently adventive populations of the plant in the North Carolina Sandhills. Because nymphs and adults of K. wheeleri can be easily collected from American jointweed, the likelihood of detecting the mirid is high; the failure to find it in certain areas, therefore, seems informative.

Keltonia rubrofemorata also was found only on a single species of Polygonella, P. myriophylla. Unlike K. wheeleri, its distribution nearly coincided with that of its host; mainly Highlands and Polk counties in Florida’s Lake Wales Ridge. This plant bug can be added to the list of insects consid-
cred endemic or precinctive to Florida scrub (Deyrup 1989, 1990). Deyrup (1989) pointed out that insects dependent on plants restricted to scrub habitats are less known than those that depend directly on aspects of the physical environment, such as the deep, sterile, excessively well-drained sands, and further noted that herbivores restricted to scrub-endemic hosts remain unstudied.

Florida is considered the center of distribution for Polygonella (Horton 1963). Plants ancestral to present species of the genus presumably were forced southward during the Pleistocene glaciations, eventually reaching Florida and spreading into sandy habitats. The Lake Wales Ridge might have provided refuge for plants during periods of higher sea levels (e.g., Delaney et al. 1989, Huck et al. 1989). Through range fragmentation or short-distance dispersal, followed by genetic differentiation, the present species are thought to have arisen. With retreat of the ice sheets, the genus probably radiated northward and westward (Horton 1963, Huck et al. 1989).

Phylogenetic analysis based on morphological data suggests that P. americana and P. myriophylla represent sister taxa. The latter species, even though its range is narrow, shows greater allozyme diversity than the widespread P. americana, which underwent mass migrations corresponding to advances and retreats of ice sheets. The greater gene diversity of P. myriophylla apparently is the result of population stability during glacial cycles (Lewis and Crawford 1995).

The plant bugs K. wheeleri and K. rubrofemorata, which apparently are monophagous on P. americana and P. myriophylla respectively, are themselves considered sister species (Henry 2002). A host shifting or transfer—colonization of novel host plants—perhaps has been involved in speciation within Keltonia. In the case of K. wheeleri and K. rubrofemorata, whether populations on the new and original host plants diverged genetically in allopatry or sympathy is unknown.

The only other mirids collected on Polygonella species during the present study were mirines of the tribe Restheniini. Host relationships in this tribe remain little known (Wheeler 2001). Nymphs and adults of Prepops rubrovittatus Stål were found infrequently on P. americana in South Carolina and on P. myriophylla in Florida. Overwintered eggs hatched by mid-March in disturbed sandhills of South Carolina. Nymphs also were observed during April and early June; an adult was taken in mid-May. In Florida, fifth instars were found in early and late February and late March; adults were observed in late March and late November. Nymphs of P. rubrovittatus, in addition to being larger than those of the Keltonia species, are reddish, whereas nymphs of Keltonia are green. In South Carolina, an adult of another resthenine, Oncerometopus nitens Knight, was collected on P. americana in early October at each of two sites in Kershaw and Richland counties.

Acknowledgments

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Washington, DC) for describing _K. wheeleri_ and confirming identifications of _K. rubrofemorata_ and _Prepops rubrivittatus_; and Peter Adler (Department of Entomology, Soils, and Plant Sciences, Clemson University) for comments that improved an earlier draft of the manuscript.

**LITERATURE CITED**


ILLUSTRATED KEYS TO GENERA OF THE MALE WASPS IN THE
SUBFAMILY THYNNINAE (HYMENOPTERA: TIPHIIDAE)

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Abstract.—Extensively illustrated keys to the genera of the tiphiid subfamily Thynninae are provided for males, with separate keys for Australasian and South American taxa, and a table is included giving generic composition and synonymies in the Thynninae over the past century.

Key Words: Tiphiidae, Thynninae, generic keys

The tiphiid subfamily Thynninae has never been any easy group to study. Changes in the taxonomy in the past century have made identification of genera nearly impossible. There are no up-to-date keys, and a number of recently described genera are so poorly characterized that generic identification is impossible without identified specimens on hand. There have been many changes in the taxonomy of the subfamily since Turner (1910) published the most recent key to the genera in the Genera Insectorum. The number of described genera has increased from 53 as of Turner (1910) to 71 today (Table 1). Numerous changes in the status of the genera have also taken place. The genus Diamma Westwood was placed in a separate subfamily (Kimsey 1991). Eight genera have been synonymized and a ninth, Glyptometopa Ashmead, was found to belong to a different subfamily, the Brachycistidinae, by Mickel and Krombein (1942). Seventeen new genera have been described since 1910. Finally, the subfamily Thynninae has been rearranged and the tribal classification has also changed in the last century.

To further confuse matters male female associations are incomplete and females are unknown for some genera. This is exacerbated by the frequency of miscoupling. Thynnine females are wingless, antlike and largely subterranean. Males are winged, fossorial and very different looking than the females. Pairs fly in copula and are frequently collected in tandem. Sadly, although this should give us clear sex associations, male-female pairs are, on occasion, miscoupled (Brown 1993)—pairs consisting of two different species, genera or even tribes have been observed. Personal observations suggest that this rate of miscoupling may be as frequent as 10% of the pairs observed. Therefore species and generic characterization of females cannot be done reliably unless multiple pairs have been collected of a particular species. Thus, the taxonomy of this group is based on male features. While this is not an optimal situation it will be some time before females are sufficiently well known to be included in generic keys.

Because of these major taxonomic changes it seems appropriate and necessary to produce illustrated keys to the genera of Australia and South America to facilitate biological and systematic research in this group. The genera in the two continental
Table 1. Changes in the generic and tribal taxonomy of the tiphiid subfamily Thynninae in the past century.

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<td>11. <em>Ainmodromius</em> Guérin Méneville</td>
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<td>12. <em>Ariphron</em> Erichson</td>
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<td>17. <em>Campylothynnus</em> Turner</td>
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<td>19. <em>Chrysothynnus</em> Turner</td>
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<td>22. <em>Guerinius</em> Ashmead</td>
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<td>53. <em>Zeleboria</em> Saussure</td>
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$^1$ Names followed by parentheses in the 1910 column are synonyms, and the currently accepted valid name for the genus is given in parentheses.

$^2$ Names in parentheses in the 2003 column are recently synonymized junior synonyms.

$^3$ The genus is unknown and the type species is apparently lost.

regions are keyed separately to simplify the identification process.

There are several features of these keys that should be explained. I have tried not to use difficult to observe characteristics, such as genitalia. However, there is no way to avoid some of these. Characteristics of the underside of the head and the tongue are critical features to distinguish a number of genera. In most specimens it is possible to see enough of the underside of the head to determine the shape and extent of the hypostomal plate, positions of the occipital and hypostomal carinae, and setation of the stipes and prementum. If not, in some cases it will be necessary to relax the specimen and tilt the head up to see the underside. Critical features on the underside of the head are illustrated in Fig. 1. Other structures important in identifying thynnine genera are illustrated in Figs. 2–3.

**KEY TO MALES OF THE AUSTRALASIAN GENERA OF THYNNINAE**

1 Hypopygium apically evenly curved and apical margin spinose or apicomically with long curved apicominal spine (unciform) (Figs. 6–11); hindcoxal cavities continuous with petiolar socket, not enclosed by extension of metasternal and metapleural lobes (Fig. 5); metastomal sternum I basally with single longitudinal ridge or carina (Raghigasterini) . . . . 2

- Hypopygium apically dentate, lobate, or narrowly rounded without marginal spines and not apicomically unciniform or spinose (as in Figs. 45–62); hindcoxal cavities-enclosed, separated from petiolar socket by extension of metasternal and metapleural lobes (Fig. 4);
Figs. 1–3. 1, Diagram of underside of head. 2, Front view of face. 3, Side view of body with legs and antennae removed. Species illustrated: 1, 2, mitifasciatus (Smith); 3, fiscocostalis Turner. Abbreviations used include: M = marginal cell, SM1 etc. = submarginal cells. 1m-cu = first marginal-cubital crossvein, 2m-cu = second marginal-cubital crossvein.

metasomal sternum I basally without longitudinal ridge or carina

2 Hypopygium evenly rounded and unmodified, or with narrow platform margined with stout broad setae (Fig. 8); metasomal sternum VII evenly rounded, or slightly indented apicomedially, otherwise unmodified

Eirone Westwood

Hypopygium unciniform without stout broad setae (as in Figs. 6–7); metasomal sternum VII broad and shovellike or narrowed and sublaterally carinate (as in Figs. 6–7, 9, 11)

3

Eirone Westwood

4 Metasomal sternum VI with small, acute lateral tooth (as in Figs. 20, 32)

Dimorphothynnus Turner

- Metasomal sternum VII strongly narrowed or almost trilobe apically, often with accompanying sublateral carinae (Figs. 7, 11); hypopygium with dorsal tooth or narrow rim above uncus (Figs. 7, 11)

Rheigaster Guérin Méneville

5 Metasomal sternum V with small, acute lateral tooth or elongate prong (Fig. 32)

- Metasomal sternum V simple, without lateral tooth or large prong
6 Mesopleuron evenly convex, without scrobal groove and scrobe obsolescent (Fig. 20); metastoma appearing flattened on top, terga flat to concave dorsally; terga II–VI or III–VI terminating in apicolateral tooth (Fig. 20)  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
16 Antennal lobe carinæ forming narrow V between antennal sockets (as in Fig. 25); apical flagellomeres parallel-sided (as in Fig. 29) ... 17
- Antennal lobes broadly rounded and well-separated without topical carina, or continuous or narrowly separated with topical carinæ forming broad U-shaped platform (as in Fig. 2); apical flagellomeres usually arcuate (as in Fig. 75) or lobulate (as in Fig. 30) ... 19

17 Hypopygium apical triangle strongly concave, almost cuplike in dorsal view (Fig. 51) ... 
- Hypopygium apical triangle flat and carinate in dorsal view (as in Figs. 48–49) ... 18

18 Epipygium strongly elevated medially and shelflike, overhanging broad polished posterior declivity (as in Fig. 42); propodeum strongly flattened between metanotum and petiolar socket in lateral view; metasomal sternum 1 strongly angulate medially ... Guerinus Ashmead
- Epipygium only slightly elevated adjacent to posterior transparent lip, without elevated middle; propodeum convex, at least dorsally between metanotum and petiolar socket in lateral view; metasomal sternum 1 flattened or rounded medially ... Campylotythus Turner

19 Prementum with discrete row of long apical setae, setae as long or longer than prementum (as in Fig. 1); stipes without fringe of long marginal setae; submental sclerite with medially longitudinal ridge or carina obsolescent ... Lophocheilus Guérin Méneville
- Prementum without long apical setae; stipes with dense fringe of long marginal setae (as in Fig. 1); submental sclerite usually medially carinate (weak in Catocheilus) ... 20

20 Metasomal sternum 1 gently convex or nearly flat; antennal lobes rounded, topical carina weakly indicated and not joining medially to make U-shaped structure ... Catocheilus Guérin Méneville
- Metasomal sternum 1 strongly angled or convex ventrally, particularly near posterior margin, often nearly forming right angle posteriorly in side view; antennal lobes undeveloped or angulate, with well-developed topical carinae; carinae often merged forming broad U-shaped platform (as in Fig. 2) ... 21

21 Epipygium with lip posterior to elevated medial surface coarsely cross-ridged and transparent to opaque (Fig. 43); hypopygium with lateral lobes obtuse or broadly rounded ... 
- Epipygium with lip posterior to elevated medial surface smooth and nearly transparent; hypopygium with lateral lobes clearly defined and acute (as in Fig. 48) ... 22

22 Hindcoxal dorsal carina strongly angled, allmost toothlike near base (Fig. 12); hypopygium with impunctate ventral longitudinal carina extending from base to apex of medial spine or tooth ... Thaumoides Guérin Méneville
- Hindcoxal dorsal carina low, without basal angle; hypopygium without impunctate ventral longitudinal carina, if carina or ridge present then punctate and extending only part way posterior to medial spine or tooth ... Lestricothynnus Turner

23 Occipital and hypostomal carinæ widely separated by semitransparent genal plate covering tongue base (Fig. 21); epipygium with flat smooth wedge-shaped or subovoid apicomeral area; hypopygium often quadrilobate (Fig. 60) ... Zeleboria Saussure
- Occipital and hypostomal carinæ touching to broadly separated, but without semitransparent expansion covering most of tongue base; epipygium variable, usually without flat, smooth apicomeral area; hypopygium with 1 or 3 apical teeth or spines, or ligulate (as in Figs. 45–46, 50, 53) ... 24

24 Prementum with long apical setae, setae as long or longer than prementum (as in Fig. 1); occipital and hypostomal carinæ broadly separated; hypopygium ventrally with distinctive parallel-sided or crescentic medial indentation (Fig. 45) ... Aeolothynnus Ashmead
- Prementum without long apical setae, setae if present shorter than width of prementum; occipital and hypostomal carinæ touching to broadly separated medially; hypopygium ventrally without medial indentation ... 25

25 Epipygium with discrete transverse subapical welt or ridge extending all or part way across epipygium, with narrow transparent apical rim (as in Figs. 37, 39), or epipygium with apical margin thickened and appearing rolled under (as in Fig. 41) ... 26
- Epipygium without subapical welt or ridge, gradually tapering to translucent rim or flattened apicomeral area (as in Figs. 40, 44) ... 29

26 Stipes with discrete marginal fringe of long setae; flagellomeres V–XII with (as in Figs. 29–30) or without tyloids ... Timesothythus Turner
- Stipes with well-developed marginal fringe of long setae; flagellomeres V–XI without tyloids (as in Fig. 33) ... 27

27 Hypopygium strongly apically bidentate (similar to Fig. 55); epipygium with polished medial knob and without transverse subapical ridge or welt, appearing rolled under apically, without thin transparent apical rim (Fig. 41); metasomal terga III–V without subspiracular sulci ... Psammothythus Turner
- Hypopygium strongly tridentate (as in Figs. 44, 52); epipygium without polished medial
35. *Lestricothynnus*

36. *Ariphron*

37. *Timesothynnus*

38. *Beithynnus*

39. *Iswaroides*

40. *Zythynnus*

41. *Psammothynnus*

42. *Thynnus*

43. *Macrothynnus*

44. *Ariphron*

45. *Aeolothynnus*

46. *Beithynnus*

47. *Bifidothynnus*

48. *Campylothynnus*

49. *Catocheilus*

50. *Doratithynnus*

51. *Elidothynnus*

52. *Iswaroides*

53. *Leiothynnus*

knob and with transverse subapical ridge or
welt at least laterally, with thin transparent
apical rim; metasomal terga III–V with sub-
spiracular sulcus .......................... 28

28 Mesopleuron without scrobial sulcus or
groove; propodeum boxlike with distinctly
flattened dorsal and posterior surfaces; flagel-
lomeres V–XI less than twice as long as broad
and cylindrical (as in Fig. 33) ................

.................... Gynothymus Turner

– Mesopleuron with scrobial groove (as in Fig.
3); propodeum evenly rounded; flagellomeres
V–XI more than twice as long as broad and
somewhat lobulate (as in Fig. 30) ........

.................... Epactiothymus Turner

29 Head posteriorly cupped, genal margins
strongly narrowed and sharp-edged, with
marginal fringe of long setae; occipital foramen
with elevated necklike collar (as in Figs. 16,
18–19) ........................................ 30

– Head not posteriorly cupped, genal margins
broadly rounded, without marginal fringe of
setae; occipital foramen without elevated col-
lar .................................................. 32

30 Propodeum somewhat flattened medially, with
clearly indicated petiolar grooves (as in Fig.
35); hypopygium with multidentate apical plat-
form or rounded with one apicomedial tooth
(Fig. 58); basal maxillary palpomere with elon-
gate fringe (Fig. 19); posterior malar articula-
tion subtended by toothlike genal projection
(Fig. 19) .................. Tachydonia Guérin Méneville

– Propodeum strongly rounded, without petiolar
grooves (as in Fig. 36); hypopygium broadly
tridentate to trilobate, without discrete poste-
rior platform (as in Fig. 44); basal maxillary
palpomere without fringe; posterior malar ar-
ticulation simple or subtended by broadly
rounded genal lobe (as in Figs. 16, 18) ..... 31

31 Oral fossa narrow, only extending to inner base
of mandible; maxillary brush absent (Fig. 16);
occipital collar usually protruding posteriorly be-
hind head in lateral view (Fig. 16); head narrow
in profile, not large and cuboidal, with gena be-
hind eye less than half as wide as eye in side
view (Fig. 16) .................... Tachypiron Brown

– Oral fossa wide, extending as far as mandib-
ular insertion; maxillary brush well developed
(Fig. 18); occipital collar not visible posterior-
ly behind head in lateral view (Fig. 18); head
large and cuboidal, with gena behind eye
more than half as wide as eye in side view
(Fig. 18) .................... Tachyphoinos Kimsey

32 Propodeum evenly convex, without longitu-
dinal grooves on either side of petiolar (Fig.
36) and clypeus with median carina; epipy-
giun thin, evenly rounded and unmodified
(Fig. 44); hypopygium broadly tridentate, with
three more or less equally developed apical
Teeth (Fig. 44) .................... Aripthorh Erichson

– Propodeum ovoid and somewhat flattened,
with longitudinal grooves on either side of pet-
iole (as in Fig. 35) (minimal in Dythyinus and
Leiothymus) and clypeus usually without me-
dinal carina; hypopygium not broadly triden-
tate, usually with one medial tooth and later-
ally rounded or truncate, ligulate or penta-
dentate ........................................ 33

33 Prementum with long apical setae, setae as long
or longer than premiment (as in Fig. 1) .... 34

– Prementum asetose or setae considerably
shorter than premiment ........................ 35

34 Hypopygium notched laterally before apical
platform, apically trilobate to hooklike (as in
Figs. 57, 62); antenntal lobes strongly elevated
above and between antennal sockets ....

.................... Phymatothymus Turner

– Hypopygium unnotched laterally before apical
platform, apically pentadentate (Fig. 56); an-
tenntal lobes separated by medial depression
.................... Pentacleberobia Brown

35 Hypostomal plate with each side narrower than
stipes; occipital and hypostomal carinae con-
vergent medially; stipes nearly asetose, without
marginal or apical fringes of hair ............ 36

– Hypostomal plate with each side as wide or
wider than stipes (as in Fig. 1); occipital and
hypostomal carinae widely to narrowly (Bie-
thymus species) separated medially; stipes
usually with well-developed long marginal
fringe of long setae .......................... 37

36 Metasoma not polished, covered with dense
erect short setae, appearing velvety; flagello-
meres V–XI less than twice as long as broad
and cylindrical in cross-section (as in Fig. 33)
or slightly bulging on one side; metasomal
sternum I flattened or gently convex ....

– Metasoma polished with sparse short decum-
bent setae; flagellomeres V–XI 2X or more
longer than broad, somewhat arcuate; me-
etasomal sternum I with well-developed ventral
prong in most species (Fig. 31) ............

.................... Agrioniya Guérin Méneville

37 Hypopygium ligulate, apex rounded (similar
to Fig. 53, but without apical tooth); vertex
without red spot posterolateral of hindocellus;
flagellomeres V–XI without tyloids ........

.................... Hathyimus Kimsey

– Hypopygium apically dentate, with acute me-
dial tooth and sometimes lateral tooth as well
(appearing tridentate) (as in Figs. 46, 53); ver-
tex usually with red spot posterolateral hind-
ocellus; flagellomeres V–XI usually with one
or two tyloids ............................... 38

38 Clypeus and subantennal sclerite with medial
Figs. 54–68. 54–62, Dorsal view of hypopygium. 63–68, Front view of face, with antennae removed. Species illustrated: 54, friedrichi (Dalla Torre); 55, sauthophilus (Shuckard); 56, agnata Brown; 57, atratus (Cameron); 58, abdominalis (Guérin Ménéville); 59, zelebori (Saussure); 60, xanthorrhoei (Smith); 61, vespoidea Kimsey; 62, monilicornis (Smith); 63, frontalis Guérin Ménéville; 64, impressus (Bréthes); 65, ulidens Kimsey; 66, inferius (Turner); 67, inca (Turner); 68, pastoris (Dalla Torre).
longitudinal carina; stipes with marginal fringe extending outward; hypopygium apically tridentate; propodeum covered with fine, dense, cross-ridging .......................... *Chilothymus* Brown

- Clypeus and subbental sclerite carinate; sti-

pal fringe extending ventrally or inward; hy-

popygium apically unidentate, less commonly 

tridentate; propodeum polished or with fine, 

dense rugae or shagreening, rarely cross-

ridged ........................................... 39

39 Flagellomeres V–X 3X as long as broad or 

longer, with one or no tyloids; antennal lobes 

strongly projecting above subbental sclerite 

and clypeus (as in Fig. 17) ................. 40

- Flagellomeres V–X less than 3X or more lon-

ger than broad, with two tyloids; antennal 

lobes planar with clypeus and subbental 

sclerite, with lobes obsolescent or lobes slight-

ly elevated and obtusely rounded down to 

subbental sclerite ............................ 41

40 Epipygium smooth to coarsely punctate with 

short longitudinal lateral ridge and smooth im-

punctate apical lip; hindcoxlal dorsal carina ob-

solescent .................. *Neozeleboria* Rohwer

- Epipygium coarsely punctate basally, tapering 

toward apex to somewhat flared, smooth, im-

punctate apical rim, without longitudinal lat-

eral ridge; hindcoxlal dorsal carina well-devel-

oped .................. *Dithynmus* Kimsey

41 Head with posterior margin strongly concave 

dorsal view; vertex without red spot pos-

terolateral hindocellus; mid- and hindtrochan-

thers usually angulate ventrally (Fig. 38) . 

.............................................. *Beithynus* Kimsey

- Head with posterior margin straight or slightly 

convex in dorsal view; vertex with red spot 

posterolateral hindocellus; mid and hindtro-

chanters rounded ventrally .......................... 42

42 Antennal lobes forming apically carinate shelf 

above clypeus (Fig. 17); midfemur simple, not 

basally angulate or dentate; apical flagel-

lomeres V–X with 1 vaguely defined tyloid or 

none .................. *Arthrothymus* Brown

- Antennal lobes at most slightly developed 

above clypeus, carinate; midfemur basally 

angulate or dentate; flagellomeres V–X with 1 

or 2 tyloids ........................... *Leiothymus* Turner

**KEY TO MALES OF THE SOUTH AMERICAN 
GENERA OF THYNNINAE**

1 Hypopygium apically evenly curved and api-

cal margin spinose (Fig. 78); hindcoxlal cavi-

ties continuous with petiolar socket, not en-

closed by extension of metasternal and meta-

pleural lobes (Fig. 5); metasternal sternum 1 

basally with longitudinal ridge or carina (*Rha-

gigasterini) .......................... *Aechias* Klug

- Hypopygium apically dentate or narrowly 

rounded without marginal spines (as in Figs. 

82, 83); hindcoxlal cavities enclosed, separated 

from petiolar socket by extension of metasta-

ernal and metapleural lobes (as in Fig. 4); me-

tasomal sternum 1 basally without longitudinal 

ridge or carina ........................ 2

2 Epipygium rounded and constricted toward 

apex with apical rim flared, usually carinate 

(as in Fig. 81); aedeagus with rounded medial 

lobe and lateral membranous winglike lobes 

(Fig. 92); *Scotaenini* .......................... 3

- Epipygium somewhat truncate apically, not 

constricted, with clearly indicated lateral ca-

rina (as in Fig. 79); aedeagus with elongate 

straplike apex, without membranous lateral 

lobes (as in Fig. 91); *Elaphropterini* ........ 9

3 Forewing second recurrent vein originating at 

or nearly at second transcutal vein (Fig. 80); hy-

popygium tridentate with elongate, acute medial 

tooth or prong .......................... *Parelaphroptera* Turner

- Forewing second recurrent vein originating 

near middle of third submarginal cell; hypopy-

gium apically rounded, angulate, unidenta-

te, tridentate or bidentate, but without elongate 

medial tooth or prong .......................... 4

4 Pronotum without anterior transverse carina, 

evenly rounded anteriorly; clypeal apex broadly 

truncate; hypopygium either medi-

dally or broadly truncate (as in Fig. 84) . 

5 Pronotum with anterior transverse carina or 

welt; clypeal apex narrowly elongate and 

truncate (as in Fig. 71), or shallowly or deeply 

notched (as in Fig. 72); hypopygium either 

apically trilobate, ligulate or with small api-

comedial angle .......................... 6

5 Hypopygium apicomedially or broadly truncate 

(Fig. 84); tongue rarely protruding from beneath 

head at rest; galea and lacinae short and weakly sclerotized, 

without dorsoapical lobe (as in Fig. 90) .......................... *Anodontyra* Westwood

- Hypopygium apically rounded and hooflike; 

tongue usually protruding from beneath head 

at rest; galea and lacinae elongate and heav-

ily sclerotized, galea with sharp, elongate dor-

soapical lobe (Fig. 88) .................. *Glottymus* Genise

6 Hypopygium apicomedially or trilobate 

(Fig. 85) .................. *Pseudelaphroptera* Ashmead

- Hypopygium apically rounded or with small api-

comedial angle in *Ornepes* (as in Fig. 86) 7

7 Clypeal apex drawn out into elongate, narrow 

and apically truncate medial lobe (Fig. 71) . 

.............................................. *Kostyimus* Genise

- Clypeal apex not drawn out into narrow tunc-

ation, short and apicomedially broadly trunc-

ate or medially notched (as in Fig. 72) . 8

8 Hypopygium with small apicomedial angle or 

tooth (Fig. 86); hindtibia without distinct row
Figs. 69–83. 69–74. Front view of face, with antennae removed. 75. Antenna. 76. Dorsal view of head. 77. Oblique view of hind femorotibial joint. 78. Dorsal view of hypopygium. 79. Oblique view of epypygium. 80. Forewing. 81. Side view of epypygium and hypopygium. 82–83. Dorsal view of hypopygium. Species illustrated: 69. vulpina (Klug); 70, unidentified species; 71. tarsatus (Klug); 72. polistoides Turner; 73. laetus (Klug); 74. impressiceps (Turner); 75, pastoris (Dalla Torre); 76, frontalis Guérin Ménville; 77, aethiops (Klug); 78, nigrofasciatus (Smith); 79, pastoris (Dalla Torre); 80, santacruciana (Brethes); 81, tarsatus (Klug); 82, pastoris (Dalla Torre); 83, gratiosus (Smith).
of small projections or teeth along posterior margin (viewed in profile) .................. Ornepetes Guérin Ménville

- Hypopygium without medial angle or tooth; hindtibia with distinct row of projections or serrations along posterior margin (viewed in profile) (Fig. 87) .................. Scotaena Klug

9 Posterior margin of head strongly concave in dorsal view (Fig. 76); clypeus irregularly sculptured between punctures, and strongly bulging dorsomedially, with broad, shallow subtriangular apical emargination (Fig. 63) ........... Ammodromus Guérin Ménville

- Posterior margin of head flat or only slightly concave in dorsal view; clypeus relatively smooth between punctures, not bulging dorsomedially, apex variously modified (as in Figs. 63-70, 73-74) .................. 10

10 Hypopygium apex trilobate, tridentate or sharply triangular or unidentate (as in Fig. 83) ........... 11

- Hypopygium apex rounded (as in Fig. 82), truncate or bilobate .................. 12

11 Mandibles distinctly bent and angulate medially, somewhat elbowed, usually with small subbasal tooth or angle (Fig. 69); clypeus broadly, but usually, shallowly emarginate apically; body without pale markings .................. Elaphroptera Guérin Ménville

- Mandibles at most gently curved medially, not angulate or elbowed, with or without small subbasal angle or tooth; clypeus slightly indented apico-medially (similar to Fig. 66); body with yellow or white markings .................. Mesolithynnis Kimsey

12 Pronotum without discrete, delimited dorsal surface; clypeus bulging somewhat around apico-medial depression, apex narrow and at most slightly indented (Fig. 64) ....... Argenthynnis Genise

- Pronotum with discrete, dorsal surface, delimited by transverse carina or welt; clypeus evenly convex, without apico-medial depression, apex various but generally emarginate (as in Figs. 68, 73) .................. 13

13 Hypopygium apically bidentate or bilobate, if apparently rounded apically then mandibles tridentate .................. 14

- Hypopygium apically rounded, unidentate or truncate (as in Fig. 82), and mandibles always bidentate (as in Figs. 67-68) .................. 16

14 Mandibles apically tridentate; clypeus apico-medially emarginate, with polished bevel above emargination, usually overhung by
ridge or projection (similar to Fig. 73) .

- Mandibles apically bidentate; clypeus apico-
  medially trilobate, with two small lobes or
  projections above (Fig. 74) .

15 Clypeus elongate, with projecting and truncate
  apex (Fig. 67); mandibles slender and elongate,
  with single small subapical tooth (Fig.
  67); labrum with elongate basal “neck” .

- Clypeus not elongate with truncate apex, apex
  shallowly emarginate to deeply notched (as in
  Figs. 68, 70), or with small medial lobe (as in
  Fig. 65); mandibles robust with large subapical
  tooth; labrum without long basal “neck” .

16 Clypeus projecting apicomically into small
  rounded lobe (Fig. 65) .

- Clypeus apicomically truncate or emarginate,
  not produced into small rounded lobe (as in
  Figs. 66, 68, 70, 73)

17 Hindfemoral apex ventrally lobate on either
  side of femoral-tibial joint, lobes asymmetrical
  when viewed posteriorly, with flattened pos-
  terior surface, inner lobe longest (Fig. 77);
  clypeus medially emarginate (as in Figs. 66,
  68, 73)

- Hindfemoral apex generally not expanded into
  obvious lobes on either side of femoral-tibial
  joint, or if lobate then lobes symmetrical in size
  when viewed posteriorly, usually without flat-
  tened posterior surface; clypeus various .

18 Clypeal apex medially emarginate, with polished
  subtriangular bevel above notch .

- Clypeal apex truncate, shallowly convex or
  emarginate but without polished subtriangular
  bevel above apex .

19 Clypeus subapically transversely depressed,
  apex projecting somewhat anteriorly, either
  truncate or shallowly emarginate medially and
  mandible with sharp subbasal tooth or angle
  (Fig. 66) .

- Clypeus not transversely depressed, apex
  broadly and shallowly or deeply and narrowly
  emarginate and mandible without subbasal
  tooth or angle (Figs. 68, 70, 73), except Spi-
  lothyinmis exsectus (Turner).

20 Clypeus broadly truncate apically, very shallow-
  lowly concave medially, mandibles slender,
  becoming much broader at subapical tooth
  (Fig. 70) .

- Clypeus narrow apically, shallowly or deeply
  emarginate (as in Figs. 68, 73); mandibles ei-
  ther broadened submedially or about as broad
  submedially as through subapical tooth .

21 Clypeus with sharp medial tooth (Fig. 73); scu-
  tellum with transverse carina before pos-
  terior margin, posterior margin sharply decli-
  nous .

- Clypeus without medial tooth (Fig. 68); scu-
  tellum without transverse carina, smoothly
  flattened to sharp posterior margin .

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PUBLICATIONS OF THOMAS KENNETH WOOD (1942–2002)

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Abstract.—This annotated bibliography lists the publications to date of Thomas K. Wood, late Professor of Entomology at the University of Delaware, Newark. Of 52 published works, 50 are on Tom’s beloved treehoppers (Insecta: Hemiptera: Membracidae). Wood’s dissertation and three other unpublished works are also listed. Additionally, future publications based on collaborative efforts in progress will likely bear his name. A chronological index to Wood’s contributions is included.

Key Words: Thomas K. Wood, publications, bibliography, treehoppers, Membracidae, Enchenopa

The life and scientific achievements of Professor Tom Wood (Fig. 1) were fittingly documented by Kelley Tilmon (2002). Although strongly focused on the family Membracidae (treehoppers), Tom’s “research spanned an amazing range of biological disciplines” (Tilmon 2002), including anatomy, physiology, molecular and morphological systematics, ecology, genetics, evolution, biogeography, behavioral and social biology, and life history patterns.

Dr. Tilmon also organized a symposium entitled “Populations, Species, and Phylogenies: Evolution in Insect-Plant Systems (in Memory of Thomas K. Wood)” for the 2003 National Meeting of the Entomological Society of America in Cincinnati, Ohio.

As a further tribute to the significance and lasting value of Tom’s contributions, we here present a comprehensive listing of his works arranged alphabetically by author (Table 1 gives an index by year). At the time of his death, Tom had several collaborative research projects in progress and thus a number of future papers will also likely bear his name, notably an ongoing field experiment on sympatric speciation (initiated in 1995) and an extensive molecular phylogeny of the Membracidae. A copy of each of the 52 publications and 4 unpublished manuscripts listed is held in Deitz’s collection of literature on treehoppers (Deitz and Kopp 1987, Deitz 1989)—54 works are on membracids and 2 early papers are on pesticide residues in forage crops. Wood’s dissertation and many subsequent papers treated “Enchenopa binotata,” which he ultimately demonstrated to be a complex of at least nine biologically distinct sibling species. Based on this profusion of work, the Enchenopa binotata species complex has become a model system for the study of evolution and sympatric speciation (Futuyma 1999).

Tom’s was a life cut short, but lived to the fullest. He jumped at every chance to collect or talk about treehoppers, whether in the U.S. or abroad (Fig. 1 [Cardiff, Wales]). In 1993, Tom initiated a small informal gathering of membracid workers in
the Eastern United States. We were fortunate to be among those invited to join the group at the University of Delaware (Fig. 2). In subsequent years, the aggregation of "Membraskateers" moved to Little Orleans, Allegany County, Maryland, where it grew larger and became an annual tradition. Tom's colleagues and students, including all who gathered at Little Orleans, will long be inspired by his enthusiasm for science and for everything related to treehoppers.

BIBLIOGRAPHY OF T. K. WOOD


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Fig. 1. Treehopper workers Tom Wood and Imtiaz Ahmad (of Karachi, Pakistan) at the 10th International Auchenorrhyncha Congress, September 1999, Cardiff, Wales.
Fig. 2. First annual gathering of Eastern U.S. treehopper workers organized by T. K. Wood, at his home in Newark, Delaware, 14 May 1993. Top row (left to right): Tom Greene, Tom Wood, Rex Cocroft, Stuart McKamey, Chris Dietrich; bottom row: Lewis Deitz, Kelley Tilmon, Jason Cryan, Charles Bartlett, Diana McPherson [later McPherson Bartlett].

...using the same individuals of the different host races of Enchenopa binotata, pp. [75]. In Abstracts: Combined Meetings of the 7th International Auchenorrhyncha Congress and the 3rd International Workshop on Leafhoppers and Plant-hoppers of Economic Importance. August 13–17, 1990, Wooster, Ohio, USA [97 unnumbered pages; abstract; disclaimer on first page indicates this work is not to be considered published].


on the alfalfa weevil. *Hydra postica* (Coleoptera: Curculionidae).

Wood, T. K. and S. Datz. 1990 [unpublished]. The *Enchenopa binotata* Say complex: experimentally induced host plants shifts, pp. [95]. In Abstracts: Combined Meetings of the 7th International Auchenorrhyncha Congress and the 3rd International Workshop on Leafhoppers and Planthoppers of Economic Importance, August 13–17, 1990, Wooster, Ohio, USA. [97 unnumbered pages; abstract; disclaimer on first page indicates this work is not to be considered published].


**Chronological Index to Wood's Publications**

**Year Author(s)**

1966 Wood, Armbrust, Gyrisco, Guten-
mann & Lisk; Wood, Gyrisco, Guttenmann & Edmonds
1968 Wood [unpublished dissertation]
1969 Wood
1971 Wood & Patton
1974 Nault, Wood & Goff; Wood: Wood & Morris
1975 Wood, a-b
1976 Wood, a-b
1977 Wood, a-b
1978 Wood
1979 Wood
1980 Guttman, Wood & Karlin; Wood: Wood & Guttman
1981 Guttman, Wood & Karlin; Wood & Guttman
1982 Wood, a-b; Wood & Guttman
1983 Wood, a-b; Wood & Guttman
1984 Wood; Wood & Dowell; Wood, Guttman & Taylor; Wood & Olmstead
1985 Wood & Dowell; Wood & Guttman
1986 Tallamy & Wood
1987 Wood, a-c
1988 Wood
1990 Olmstead & Wood, a-b; Pratt, Datz & Wood [unpublished abstract]; Wood & Datz [unpublished abstract]; Wood & Keese; Wood & Kruluts [unpublished manuscript]: Wood, Olmstead & Guttman
1991 Keese & Wood
1992 Pratt & Wood; Wood & Pesek
1993 Pratt & Wood; Wood, a-b; Wood & Tilmon
1997 Wood
1998 Tilmon, Wood & Pesek
1999 Wood, Tilmon, Shantz, Harris & Pesek
2002 Lin & Wood

ACKNOWLEDGMENTS

We especially appreciate the comments of Tom’s wife, Barbara Wood, and Christopher J. DeHeer, Christopher H. Dietrich, Kevin V. Donohue, Judy Hough-Goldstein, Herbert H. Neunzig, Mark J. Rothschild, Douglas W. Tallamy, K. J. Tilmon, and Matthew S. Wallace, who reviewed this tribute. Additionally, M. S. Wallace and K. V. Donohue assisted in verifying references, and K. J. Tilmon kindly provided valuable clues that allowed us to retrieve two early works on pesticide residues and a copy of Tom’s curriculum vitae that listed many of his treehopper publications. This work was supported by the National Science Foundation (under Grant Nos. DEB-9815867 and DEB-9978026), the North Carolina Agricultural Research Service, and the University of Delaware (Department of Entomology and Applied Ecology).

LITERATURE CITED


ADDENDUM

The authors learned of the following work too late for inclusion above:

PROC. ENTOMOL. SOC. WASH.

592-597

THE NEMATUS MAGUS GROUP" (HYMENOPTERA: TENTHREDINIDAE)
IN NORTH AMERICA
David R. Smith
Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Depart-

ment of Agriculture, % National Museum of Natural History, Smithsonian Institution,
RO. Box 37012, MRC 168, Washington, DC 20013-7012, U.S.A. (e-mail: dsmith@sel.
barc.usda.gov)

—Two species

Nematus ''magus group" in North America, Nematiis magus (Marlatt) on Salix sp. from eastern Canada and northeastern United
States west to Northwest Territories and British Columbia and Nematus appalachia, new
species, from the Appalachians of West Virginia, Tennessee, and North Carolina. The
species are described, keyed, and compared to Palearctic species.
Abstract.

Key Words:

are recognized in the

Nematinae, sawflies

The species groups of Nematus Panzer
were designated by Ross (1951) and Smith
(1979) in Nearctic catalogs and were never
formally defined. They were based solely

With the discovery of the new species from the central and southern Appalachians, and, as part of an ongoing study to

on the Nearctic fauna. One species, Nema-

characterize the sawfly fauna of this area,

tus

magus

'"''magus

was included

in

the

group," a group characterized

pri-

(Marlatt).

National Park in Tennessee and North Carolina.

here review the

"magus group"

I

for North

America.

marily by the long, well-sclerotized lancet

Correlation of the species groups desig-

with curved annuli and lacking hairs or oth-

nated for Nearctic Nematus with the Eur-

lancets

asian fauna has not been studied. However,

of other species of Nematus usually have

have compared Nearctic specimens of the
"magus group" with the Palearctic Nematus miliaris (Panzer) which is very similar,
and this species, N. fagi (Zaddach) of Europe, and the two Nearctic species treated
here may be grouped together.

er lateral armature (Figs. 5-6).

The

straighter annuli with annular hairs or
spines, or are very short

and

triangular. In

the male, the procidentia (central projection

of the eighth tergum. Fig. 10)

is

unusually

long and slender, more than one and onehalf times longer than the breadth of

I

its

Key to Nearctic

truncate apex.

Very few specimens have been available
for study of the "'magus group" in North
America, and those that were known were
from eastern Canada and Maine. A number
of specimens have now been taken as far
west as Northwest Territories and British
Columbia and south in the Appalachians to
West Virginia and Great Smoky Mountains

1

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Species

Dark orange with black between and surrounding ocelli and sometimes on postocellar area;
abdomen usually with mesal black marks on
terga; head sculpturation irregularly wrinkled
(Figs.

1-2); lancet (Fig. 5) with

first

annulus

abruptly curved dorsally, serrulae narrower and

deeper

-

imii^iis

(Marlatt)

Mostly whitish with frontal area and dorsum of
thorax and abdomen pale orange, interocellar
area black; abdomen with paired black marks


on each terga; head shining, without sculptura-
ton each terga; head shining, without sculpture (Figs. 3–4); lancet (Fig. 6) with first annulus evenly curved, serrulae broader and shallower.

*Nematus magus* (Marlatt) (Figs. 1, 2, 5, 7, 10, 11)


*Nematus magus*: Ross 1951: 44 ("East. Canada").—Smith 1979: 68 (Que., Maine: *Salix* sp.: as "magnus" [error]).

Female.—Length. 7.1–7.5 mm. Antenna black above, dark orange beneath. Head (Figs. 1, 2) dark orange with area enclosing and surrounding ocelli and sometimes posterior third of postocellar black, black area not reaching eyes or antennae. Thorax dark orange with mesoprescutum except lateral margins and large longitudinal spot on each lateral lobe black; mesosternum sometimes with black spots. Legs dark orange. Abdomen orange with basal plates except laterally and center of 2nd tergum black, and various sized mesal black spots on remaining terga; sheath black. Wings hyaline; costa and stigma amber; remaining veins dark brown.

Antenna 2.7× head width; segment 3 shorter than 4 and subequal in length to segment 5; ratio of segments 1–5 as 10:8:45:50:45. Head shining, but with irregular wrinkled sculpture (Figs. 1–2). Malar space broader than diameter of front ocel-

between second and third annuli: serrulae narrow and deep, with 5–6 fine posterior subbasal teeth.

Male.—Length, 6.8 mm. Color similar to that of female. Procidentia 1.8× longer than breadth of truncated apex. (Fig. 10). Penis valve in Fig. 11, elongate, with stout apical spine and with short, stout spines on dorso-lateral surface.

Holotype.—Female from “Can.” Type No. 10243 in the Academy of Natural Sciences, Philadelphia, PA. Marlatt (1896) stated “One female. Canada.”


Food plant.—Salix sp. According to label data, bred from willow in Quebec and Maine.

Discussion.—This species is very close to Nematus miliaris, which is recorded from Europe, Asia Minor, Central Asia, Siberia, and Korea and is known to feed on Salix and possibly Populus, and N. fagi from central and southeastern Europe which feeds on Fagus (Benson 1958, Zhelochovtsev 1988, Lacourt 1999). Benson (1958) and Zhelochovtsev (1988) separated the two Palearctic species by slight differences in color of the hind tibiae and the larvae of N. miliaris feeding gregariously on Salix and the larvae of N. fagi feeding solitarily on Fagus. They could not differentiate them by genitalic structures. The coloration, female lancets (N. miliaris illustrated by Benson 1958, Fig. 724, and Zhelochovtsev 1988, fig. 66-4, the latter as N. capreæ L.), and male penis valves (N. miliaris illustrated by Zhelochovtsev 1988, fig. 68-1, as N. ca-

preæ) of N. miliaris and N. magus are also practically indistinguishable. With limited material, especially of males, I prefer to keep the species separate since there are slight differences such as more extensive black coloration on the head and mesonotum in N. miliaris, the slightly broader sheath in dorsal view in N. miliaris (Fig. 8), and the slightly longer and more slender procidentia in the male of N. magus (Fig. 10). The two species treated here and the two Palearctic species are, however, counterparts, and can be considered in the same group.

The single specimens from Northwest Territories and British Columbia are disjunct from the eastern records; however, and I cannot differentiate them from the eastern specimens.

Nematus appalachia Smith, new species

(Figs. 3, 4, 6, 9)

Female.—Length, 7.8–8.0 mm. Antenna black above, undersurface pale brown. Head (Figs. 3–4) whitish with frontal area and postocular area orange and interocellar area, postocular lateral furrows, and median posterior spot of postocellar area black. Thorax with pronotum and entire under-thorax whitish; dorsum orange; small mesal spot and central longitudinal stripe on each mesonotal lateral lobe, small spot on downturned area of each lateral lobe, area immediately surrounding cenchrus, and posterior spot on metanotum black. Legs with coxae, trochanters, and femora and fore and midtibiae white; hind tibia brownish; tarsi brownish. Abdomen white below, orange above with paired black spots mesally on terga, black separated by fine pale lines; cercus black with white at extreme base; sheath orange, black apically. Wings hyaline, costa, stigma, and apical half to two-thirds of subcosta whitish; remaining veins dark brown.

Antenna 2.9× head width; third segment shorter than fourth and subequal in length to fifth segment; ratio of segments 1–5 as 10:7:55:70:63. Head shining, impunctate
and without sculpturation (Figs. 3–4); malar space broader than diameter of front ocellus. Hind basitarsus 0.9× length of remaining tarsal segments combined. Sheath short, rounded at apex in lateral view; in dorsal view slender, tapering to acute apex (Fig. 9). Lancet (Fig. 6) long, without hairs or other armature on annuli; first annulus evenly curved (not abruptly curved dorsally); distance between first and second annuli greater than distance between second and third annuli; serrulae low, broad, each with 5–6 coarse posterior subbasal teeth.

Male.—Unknown.
Figs. 7–11. 7–9, Female sheaths. 7. Nematus magus, lateral view and dorsal view. 8. N. miliaris, dorsal view. 9. N. appalachia, dorsal view. 10–11, N. magus, male. 10, Procidentia of 8th tergum. 11, Penis valve.


Etymology.—The name is based on the Appalachian Mountains where this species occurs.

Discussion.—This species is separated from both N. magus and N. miliaris by its much paler whitish and orange coloration with very few black marks, smooth shining head, and slight but significant difference in the lancet and sheath (see key and Figs. 5–7, 9).

Specimens from Great Smoky Mountains National Park were taken in Malaise traps set in a grassy bald (southern grass type), 5,670' (Andrews Bald), and a high elevation beech forest, 5,600' (Indian Gap). Those from West Virginia were from Malaise traps in a mixed broadleaf forest, about 3,500'.

Acknowledgments

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mens from Great Smoky Mountains National Park. Collections made in the Fernow Experimental Forest, Tucker Co., West Virginia, were with permission of the U.S. Forest Service and part of a broad study on the effects of Dimilin® against Gypsy moth on non-target insects by Edward M. Barrows, Georgetown University, Washington, DC. Examination of the type of *N. magus* was through the courtesy of D. Azuma, Academy of Natural Sciences of Philadelphia. Cathy Apgar, Systematic Entomology Laboratory (SEL), USDA, Washington, DC, prepared the photographs and arranged the plates. I appreciate the following for review of the manuscript: N. M. Schiff, U.S. Forest Service, Stoneville, MS, H. Goulet, Agriculture and Agri-Food Canada, Ottawa, and M. A. Solis and E. E. Grissell, SEL, Washington, DC.

**LITERATURE CITED**


PALAEOMYIA BURMITIS (DIPTERA: PHLEBOTOMIDAE), A NEW GENUS AND SPECIES OF CRETACEOUS SAND FLIES WITH EVIDENCE OF BLOOD-SUCKING HABITS

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Abstract.—Palaeomyia burmitis Poinar (Phlebotomidae: Diptera), a new genus and new species of sand flies, is described from Cretaceous Burmese amber. This genus and species differs from extinct and extant members of the family by the following combination of characters: small size (under 1 mm); 18—segmented antennae; Rs shorter than R_2+4; R_1 longer than R_2+3, R_2+4 longer than R_2+5; discal cell open basally; vein R_2 shorter than R_2+3 obliquely reaching costal margin; basal part of M_3 separated by a short crossvein from M_{1+2}; vein CuA_2 short; and anal vein absent. The presence of a well-developed proboscis with piercing type mandibles and maxillae and a blood meal in its midgut indicates that this specimen was a blood feeder. Palaeomyia burmitis is considered a progenitor of the Sergentomyia clade, an Old World genus that feeds on reptiles.

Key Words: Palaeomyia, Palaeomyia burmitis, Phlebotomidae, Burmese amber, Cretaceous

The moth flies (Psychodidae) and sand flies (Phlebotomidae) are closely related primitive Diptera that are often treated as subfamilies in the family Psychodidae (Quate and Vockeroth 1981). The fossil record of sand flies has been summarized by Evenhuis (1994) and consists mostly of Tertiary forms (Meunier 1905, Stuckenbarg 1975). The oldest sand flies, comprising several extinct genera, have been described from Lower Cretaceous Lebanese amber (Hennig 1972, Azar et al. 1999).

A female sand fly from Lower Cretaceous Burmese amber is described below in a new genus and compared with extinct and extant phlebotomids. Based on the structure of the mouthparts and remains of a blood meal in its gut, the fossil fly apparently fed on vertebrate blood shortly before its entombment in resin.

Materials and Methods

The amber was recut and polished in order to better view the specimen. The amber piece containing the fossil is square in outline, measuring 5 mm along all sides and 2 mm in width. The specimen is well preserved and nearly complete. The middle left leg and the tips of the tarsi on both hind legs are missing, and there is a small circular opening in the pleura of the sixth abdominal segment, possibly made by a predator, since the gonads are missing. Observations, drawings and photographs were made with a Nikon SMZ-10 R stereoscopic microscope and Nikon Optiphot compound microscope (with magnifications up to 650×). Amber from Burma (Myanmar) occurs in lignitic seams in sandstone-limestone deposits in the Hukawng Valley. These lignitic seams extend from the valley...
up the sides of a mountain where the mine that contained this specimen is located (Jim Davis, personal communication). Nuclear magnetic resonance (NMR) spectra of amber samples taken from the same locality as the fossil indicated an araucarian (possibly Agathis) plant source (Lambert and Wu, personal communication). Palynomorphs obtained from the amber beds where the fossil piece originated have been assigned to the Upper Albian (~110–100 mya) (Cruickshank and Ko 2003). While an Eocene age was originally provided for these deposits (Chhibber 1934), Cockerell (1922) was the first to suggest they were Cretaceous based on primitive insect types found in the amber, and others have concurred (Zherikhin and Ross 2000). Terminology in the description follows that presented in the "Manual of Nearctic Diptera" (McAlpine 1981).

Family Phlebotomidae Kertész 1903
Subfamily Phlebotominae Kertész 1903

**Palaeomyia Poinar, new genus**

Description.—Small size (under 1 mm); eye bridge absent; 18—segmented antennae; flagellomeres fusiform (Fig. 1); palp with five palpomeres, terminal one longest, second segment shorter than fourth (Fig. 3); wing (Fig. 2) with Sc not reaching costa; Rs shorter than R_2; R_1 longer than R_2; R_1 meeting costa at middle of wing; R_2 longer than R_3; discal cell open basally; vein R_2 shorter than R_2; obliquely reaching costal margin; basal part of M_1 separated by a short cross vein from M_1; so that CuA; and medial veins appear to arise from CuA; vein CuA_2 short; anal vein absent.

Etymology.—“Palaeo” is from the Greek “palaios” for ancient or old (masculine); “myia” is from the Greek “myia” for fly (neuter).

Diagnosis.—The absence of an eye bridge, fusiform flagellomeres, Rs four branched, 2 longitudinal veins present between the radial and medial forks, and A_1 absent, place the fossil in the Phlebotomidae (Lewis 1973; Quate and Vockeroth 1981).

Type species.—**Palaeomyia burmitis**, n. sp.

**Palaeomyia burmitis** Poinar, new species (Figs. 1–6)

Description.—Characters as listed under generic description. Very small species with a body length of only 0.887 mm; body light brown; legs and antenna dark brown. Head length, 0.146 mm; length of proboscis, 0.144 mm; length of maxillary palp, 0.236 mm (Fig. 3), extending beyond tip of proboscis. fifth palpal segment longest, first shortest, closely associated with second; relative lengths of palpal segments, 1, 0.04; 2, 0.12; 3, 0.27; 4, 0.19; 5, 0.37; antenna (Fig. 1) with scape short, stout, pedicel globular, 16 fusiform flagellomeres, becoming shorter at apex, flagellomeres bearing scales and variously sized setae; ascods absent or obscured by setae and scales.

Thorax with well-developed mesoscutum; mesoscutellum greatly reduced; postscutellum large, convex; wing length, 0.945 mm; membrane hyaline, covered with minute granules, microtrichiae absent; humeral vein perpendicular to costa, wing (Fig. 2) with Rs four-branched, with all branches extending to wing margin; R_4 and R_4 curved anteriorly at costa; R_4 straight; veins M_1 and M_2 straight, nearly same length; basal part of M_3 separated by a short cross vein from M_1; vein CuA_2 short; main veins and wing margin with macrotrichiae; longer setae occur along posterior wing margin, especially in anal area; length of halter, 0.117 mm; legs long, bearing numerous setae and scales; femora longer than corresponding tibiae, tarsi 5-segmented with first segment longest, nearly equal to remaining segments, terminal segment shortest; tarsal claws simple, small, paired, surrounded by hairs, some with apparent secretions at tips (Fig. 5); spermatheca and associated reproductive structures missing; cibarium not visible.

Abdomen extended, seven segments
Fig. 1. *Palaeomyia burnitis* in Burmese amber. Dark stippled area in gut represents blood meal. Bar = 140 μm.
clearly visible (Fig. 1); length, 0.548 mm; with remains of blood meal in midgut.

Male.—Unknown.

Material examined.—Holotype female in Burmese amber deposited in the Poinar amber collection (accession # B-D-16) maintained at Oregon State University. From lignitic seams in sandstone-limestone deposits in the Hukawng Valley, Burma (Myanmar).

Etymology.—From “Burma” referring to the country where the fossil originated.

Comments.—The cluster of hairs, many of which bear apparent terminal secretion drops, at the tips of the terminal tarsal segments is curious. These might be considered retinerae (hollow hairs through which a viscous substance is secreted) (McAlpine 1981) and could have played a role in anchoring the sand fly to the substrate or host during a blood meal. The long fifth palpal segment is a character found in Old World sand flies and separates them from New World forms (Lewis 1973).

Diagnosis.—The only previous description of a phlebotomid from Burmese amber is Eophlebotomus connectens Cockerell (1920), which was recently redescribed and re-evaluated by Duckhouse (2000). The presence of only 13 flagellomeres, palpal segments 4 and 5 short and subequal, Sc with a costal branch and M$_1$ and CuA$_1$ fused at the base to form a pedicel, separate E. connectens from P. burmitis.

*Palaeomyia burmitis* has some features of the early Cretaceous Lebanese *Phlebotomites brevifilis* Hennig and *P. longifilis* Hennig (Hennig 1972). However, in both of these species, the termination of R$_1$ is distal.
to the fork of R_{2+3} and R_4 while the termination of R_1 is proximal to this fork in *P. burmitis*. Also, both *Phlebotomites* species have branch R_{2+3} longer than R_{2-4} while R_{2+3} is shorter than R_{2-4} in *P. burmitis*. In addition, in *P. brevifilis*, the third palpal segment is the longest, not the terminal one as in *P. burmitis*.

Some similarities also exist between *P. burmitis* and the Lebanese amber *Mesophaebotomites hennigi* Azar et al. (1999). However, in that taxon, Sc has a costal branch. Rs is longer than R_{2-4}, R_{2-4} is shorter than R_{2+3}, and R_1 meets the costa in the distal half of the wing. The Lebanese amber *Libanophlebotomus lutfallahi*, Azar et al. (1999) has R_2 perpendicular to the costa, M and CuA_1 joined at the base, and an A_1 vein, all characters which differ from the condition in *P. burmitis*. One similarity between *L. lutfallahi* and *P. burmitis* is the curious venation of Sc/R_1. It is likely that the distal portion of Sc originally made contact with the costa, but then became separated and remained in that condition in some lineages, all of which apparently became extinct during the Cretaceous.

There are also some similarities between *P. burmitis* and the Jurassic *Liassopsychodina pommerana* Ansorge (1994). While the wing venation of *L. pommerana* is unique, especially with the presence of an anal vein, some similarities with *P. burmitis* are a very reduced R_2 in comparison to R_{2+3}, a fairly long R_1, and M_3 and CuA_1 with a similar basal configuration.

**DISCUSSION**

There are two major extant genera of Old World sand flies, *Phlebotomus* Rondani & Berté and *Sergentomyia* Franza & Parrot (Lewis 1973). The fossil sand fly possesses some characteristics of members of the genus *Sergentomyia*. One such character is the position of the hairs on the distal ends of abdominal tergites 2 to 6 (Perifilev 1966, Fairchild 1955, Lewis 1973). These are mostly erect in *Phlebotomus* but decumbent in *Sergentomyia*. Only one of these hairs is present in the fossil and it is decumbent. Erect hairs have round sockets while decumbent hairs have elongate sockets (Lewis 1973). In the fossil, the sockets, which are visible, are slightly elongate (Fig. 6). Another *Sergentomyia* character is the short R_2 vein. Early Cretaceous phlebotomids have the R_2 vein shorter than R_{2+3} (Azar et al. 1999), which can be portrayed by the ratio R_2/R_{2+3}, and is under 1.0 in Cretaceous forms. The R_2 vein tends to elongate over time, reaching a ratio of almost 2.0 in modern *Phlebotomus* species (Lewis 1973).

Most *Sergentomyia* have retained a relatively short R_2/R_{2+3} ratio (under 1.0), similar to the early Cretaceous forms. A third character linking *P. burmitis* to the genus *Sergentomyia* is the size of the palpal segments. While the fourth palpal segment is usually the shortest in members of the genus *Phlebotomus*, most species of *Sergentomyia* have the second palpal segment smaller (Fairchild 1955), which is the condition in the fossil fly. These morphological characters suggest that *P. burmitis* is a progenitor of the reptile feeding *Sergentomyia* clade. By the Eocene, modern appearing *Sergentomyia* were present (Stuckenber 1975).

The mouthparts on the fossil are similar to the piercing and sucking forms of extant sand flies (Croset 1969). The presence of elongated stylet-shaped mandibles and maxillae enclosed in an elongate proboscis is an indication that *P. burmitis* possessed the ability to penetrate the skin and take up blood or semi-fluid tissues. However, as stated by Lukashevich and Mostovski (2003) in their review of hematophagous insects in the fossil record, feeding structures are insufficient to determine a definite hematophagous habit without further analysis of gut contents, etc. However, a dark area in the anterior portion of the gut of *P. burmitis* appears to be a recently acquired blood meal. This blood meal extends through the first three abdominal segments and into a small portion of the fourth. According to the stages of blood digestion in
Figs. 4–6. *Palaeomyia hurmitis* in Burmese amber. 4. Habitus of fly in amber. Dark area in gut (arrow) shows blood meal. Bar = 0.148 mm. 5. Detail of terminal tarsal segment, showing secretions at tips of some of the setae (arrowheads). Bar = 52 μm. 6. Terminal abdominal tergites showing single decumbent hair and elongate hair sockets (arrows). Bar = 52 μm.
Phlebotomus papatasi Scopoli. Dolmatova (1942) found that just after feeding, vertebrate blood filled the anterior portion of the abdomen up to the last two to three abdominal segments. As digestion proceeded, the blood volume was reduced and after 3–4 hours, the last three to four abdominal segments were cleared of blood. Assuming a similar pattern in P. burnitidis, it would imply that the ancient sand fly was in the early stages of blood digestion when it became entrapped. While present-day host records of Asian sand flies include both mammals and reptiles (Lewis 1978), since P. burnitidis was probably a progenitor of the Sergentomyia clade, the blood could have come from a reptile. In the midgut of P. burnitidis are also some microorganisms, which will be the subject of a separate study.

While biting mouthparts can be traced back to the early history of the Diptera and are considered a basic feature in most of the major lineages of that group, actual evidence of blood acquisition in fossil flies has not been previously reported. Downs (1970) speculated that Phlebotomus-like flies might have represented the earliest forms of Diptera adapted to cut through vertebrate skin and imbibe fluid. The present study confirms blood sucking in early Cretaceous phlebotomids.

ACKNOWLEDGMENTS

I thank Alex Brown for his assistance in obtaining the present specimen, Joseph Lambert and Yuyang Lu for providing unpublished research on the plant source of Burmese amber and Roberta Poinar for comments on an earlier draft of this paper.

LITERATURE CITED


THE TRIBE COLPURINI (HEMIPTERA: HETEROPTERA: COREIDAE) OF THE PHILIPPINE REPUBLIC, WITH DESCRIPTIONS OF FOUR NEW SPECIES, AND A SYNONYMICAL NOTE

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Abstract.—A checklist of the known genera, subgenera, and species of the coreine tribe Colpurini (Hemiptera: Heteroptera) from the Philippine Republic is given. Four new species, Hygía (Eucolpura) cassisi, Hygía (Sphinctocolpura) alvarezii, Hygía (Sphinctocolpura) oligotricha, and Kekihygía culiona, are described. Dorsal habitus illustrations and drawings of the pronotum and male genital capsule are provided to distinguished these species. Hygía (Colpura) obscuricornis (Stål) is synonymized with Hygía (Colpura) pallidicornis (Stål).

Key Words: Insecta, Heteroptera, Coreidae, Colpurini, new species, Philippine Republic

The Colpurini of the Philippine Republic are still incompletely known, due the lack of recent through collecting on most of the very many islands (over 7,100, with only 11 larger than 2,500 km), which constitute the Philippine archipelago (Cassola 2000).

The Philippine Colpurini fauna has been described or reviewed by Stål (1870), Walker (1871), Bergroth (1916, 1918), Bloe-te (1936), and more recently by Braïlovsky (1994a, b, 1995, 1996, 1997, 1998) and Braïlovsky and Barrera (1997, 2002).

The Philippine members of the tribe are usually black or dark, with striking structural differences in the hemelytra, as well as a great diversity in the male genital capsule and in the female genital plates. This contribution brings the known Philippine fauna to 7 genera, 4 subgenera, and 27 species. Of that total, 4 species are described here as new.

The following abbreviations are used for the institutions cited in this paper: AMS (Australian Museum, Sydney, Australia); BMNH (The Natural History Museum, London, England); BPBM (Bernice P. Bishop Museum, Honolulu, Hawaii); FMNH (Field Museum Natural History, Chicago, Illinois); NRE (Naturhistoriska Riksmuseet, Stockholm); UNAM (Instituto de Biología, Universidad Nacional Autónoma de México).

All measurements are given in millimeters.

CHECKLIST OF THE PHILIPPINE COLPURINI

Baumannhygia insulata Braïlovsky, 1996
Carvalhygia carvalhoi Braïlovsky, 1995
Carvalhygia milzae Braïlovsky, 1995
Carvalhygia nigra Braïlovsky, 1995
Carvalhygia camarinesa Braïlovsky and Barrera, 2002
Homalocolpura aploa Braïlovsky, 1994b
Homalocolpura leyteana Braïlovsky, 1994b
Homalocolpura parrilloi Braïlovsky, 1994b
Homalocolpura sorbas Bergroth, 1918
Hygía (Colpura) pallidicornis (Stål, 1870)
Hygía (Colpura) obscuricornis (Stål, 1870) new synonym
Hygia (Eucolpura) cassisi Brailovsky, new species

Hygia (Microcolpura) denticollis (Bergroth, 1918)

Hygia (Sphinctocolpura) alvarezi Brailovsky, new species

Hygia (Sphinctocolpura) dentifer (Stål, 1870)

Hygia (Sphinctocolpura) maculipes (Stål, 1870)

Hygia (Sphinctocolpura) obscureipes (Stål, 1870)

Hygia (Sphinctocolpura) oligotricha Brailovsky, new species

Hygia (Sphinctocolpura) pictipes (Stål, 1870)

Hygia (Sphinctocolpura) punctipes (Stål, 1870)

Kekihygia culionia Brailovsky, new species

Kekihygia luzonica Brailovsky. 1994a

Kekihygia vasarhelyi Brailovsky, 1994a

Sibuyanhygia atrap Brailovsky, 1997

Sibuyanhygia callejai Brailovsky, 1997

Sibuyanhygia sibulana Brailovsky, 1997

Typhlocolpura discoïdalis Brailovsky, 1998

Typhlocolpura vulcanalis Bergroth, 1916

Hygia (Colpura) pallidicornis (Stål)

Lybas pallidicornis Stål 1870: 654. Type ♀, deposited in NRE.

Lybas obscuricornis Stål 1870: 654. Type ♂, ♀, deposited in NRE. New synonym.

Stål (1870) described Lybas pallidicornis based on a single female, and Lybas obscuricornis based on one male and one female. Types of both are at NRE.

Stål separated these two taxa by the different coloration of antennae, length of rostrum, shape of pronotal humeral angles, and presence or absence of a yellow marking on the apical margin of the endocorium.

Even after examining the respective types, as well as a large set of specimens that belong to this species complex, I was unable to separate these two species. The characters mentioned above overlap. That is, the coloration of the antennal segments varied from yellowish ochre to pale yellow to chestnut yellow; the rostrum reached the posterior border of abdominal sternite III or the anterior border of segment V; the humeral angles display vague differences; and the yellow marking on the endocorium is either well defined, diffuse, or in some specimens not visible.

Differences in body length, relative size of antennal and rostral segments, proportional measurements of the scutellum, wing development, and general body color are not significant. The female genital plates are the same in both taxa. For that reason both species are here synonymized.

Hygia (Eucolpura) cassisi Brailovsky, new species

(Figs. 2, 15, 17, 21)

Description.—Measurements: Male: Head length 1.96; width across eyes 2.06; interocular space 1.12; interocellar space 0.50; preocular distance 1.22; length antennal segments: I, 3.40; II, 4.40; III, 3.36; IV, 1.96. Pronotum: Length 2.96; maximum width of anterior lobe 2.66; maximum width of posterior lobe 4.40. Scutellar length 2.20; width 1.72. Body length 15.03. Female: Head length 2.24; width across eyes 2.26; interocular space 1.20; interocellar space 0.52; preocular distance 1.34; length antennal segments: I, 3.44; II, 4.92; III, 3.72; IV, 2.08. Pronotum: Length 3.32; maximum width of anterior lobe 2.88; maximum width of posterior lobe 4.60. Scutellar length 2.40; width 2.00. Body length 17.18.

Male (holotype). Dorsal coloration: Head reddish brown with following areas ochre to pale yellow: longitudinal band adjacent to eyes, dorsal aspect of postocular tubercle, apex of tylus, and antenniferous tubercle; antennal segments I to III dark chestnut orange, basal joint of II and III yellow, IV dark chestnut orange with subbasal yellow ring; anterior lobe of pronotum reddish brown, posterior lobe and anterolateral margins entirely dark orange; scutellum dark orange brown with apex yellow; clavus and corium dark orange brown with
creamy yellow discoidal spot on inner third of apical margin of corium; costal margin bright orange yellow; hemelytral membrane dark yellow with veins brown; connexivum with anterior third dark brown, and posterior third yellow; dorsal abdominal segments black with reddish-brown reflections. **Ventral coloration:** Black with reddish-brown reflections; buccula, rostral segments 1 to IV, legs, anterior and posterior lobe of metathoracic peritreme, and posterior third of pleural abdominal sterna III to VII bright orange yellow to yellow; femora and tibia with reddish brown granules. **Structure:** Rostrum reaching anterior third of abdominal sternite IV; genae with obtuse teeth directed laterally; frontal angles rounded, not raised; humeral angles rounded, and not exposed (Fig. 2).

**Genital capsule:** Posteroventral edge projected on a medium-sized plate, deeply concave, with the lateral lobes short and robust (Figs. 15, 17).

**Integument:** Body surface rather dull, and densely covered with circular grayish-white farinose punctures, and with short decumbent silvery bristlulike setae, intermixed with a few long erect hairs on abdominal sterna.

**Female.—**Coloration similar to male ho-
lotype. Connexival segments VIII and IX dark brown, with upper margin dirty yellow; dorsal abdominal segments VIII and IX black with reddish-brown reflections; genital plates black with reddish-brown reflections, and with upper angle of gonocoxae I, upper and external margin of paratergite VIII and upper margin of paratergite IX yellow.

Genitalia: Abdominal sternite VII with a plica and fissura; plica triangular almost reaching middle third of sternite VII; gonocoxae I enlarged dorsoventrally, in lateral view with the external face entire, weakly
convex; paratergite VIII quadrate with spiral visible; paratergite IX square, medium size, extending beyond external face of gonocoxae I, and with external margin folded.


Discussion.—The species included in the subgenus *Hygia* (*Eucolpura*) appear to be very similar, especially the color pattern, and general external morphology. The differences noted in the posteroventral edge of the male genital capsule indicate the limits of each taxa. In *H. (E.) cassisi*, the posteroventral edge is projected on a medium-sized plate, deeply concave, and with lateral lobes short and stout (Figs. 15, 17). In *H. (E.) lugubris* (Walker 1871), a closely related species, the posteroventral edge is projected on a medium-sized plate with pronounced U-shaped concavity, not deep, and enclosed by two short arms having a sharp inwardly curving spine apically on each side (Figs. 14, 16).

This is the first record of the subgenus *Eucolpura* for the Philippine Republic. Previously the subgenus was known from Malaysia, Borneo, Sumatra, Singapore, New Guinea, Timor, and Java (Blote 1936, and Brailovsky and Barrera 1997).

Etymology.—Named for Dr. Gerasimos Cassis, distinguished Australian entomologist.

*Hygia* (*Sphinctocolpura*) _alvarezi_
Brailovsky, new species
(Figs. 1, 9, 19–20)

Description.—*Measurements:* Male: Head length 1.80; width across eyes 1.84; interocular space 1.00; intercellar space 0.42; preocular distance 1.18; length antennal segments: I. 2.20; II. 3.20; III. 2.08; IV. 1.72. Pronotum: Length 2.20; maximum width of anterior lobe 2.24; maximum width of posterior lobe 3.84. Scutellar length 1.60; width 1.48. Body length 12.20. Female: Head length 1.88; width across eyes 1.92; interocular space 1.04; intercellar space 0.49; preocular distance 1.28; length antennal segments: I. 2.20; II. 3.32; III. 2.20; IV. 1.84. Pronotum: Length 2.40; maximum width of anterior lobe 2.84; maximum width of posterior lobe 4.24. Scutellar length 1.80; width 1.76. Body length 13.17.

Male (holotype). *Dorsal coloration:* Head black, the space adjacent to eyes dirty yellow; antennal segments I to III dark reddish brown, IV dark chestnut brown with subbasal yellow ring; pronotum black to dark reddish brown, with two chestnut orange discoidal spots lateral to middle line and covering most of posterior lobe; scutellum dark reddish brown with apex dark chestnut orange; clavus and corium dark reddish brown with black discoidal spot on inner third of apical margin of corium; hemelytral membrane dark yellow with veins brown; connexival segments dark reddish brown with posterior border of segments III to VI dark chestnut orange; dorsal abdominal segments bright orange. *Ventral coloration:* Including rostral segments I to IV, and legs black to dark reddish brown; trochanter, squarish spot at propleure, posterior border of pleural margin of abdominal sterna III to VI, and anterior and posterior lobes of metathoracic pretreme dark chestnut orange. *Structure:* Head dorsally flat; rostrum reaching posterior border of abdominal sternite V; genae without sharp teeth projecting laterally; collar wide; frontal angles projecting forward as medium-sized conical lobes; humeral angles projected into rounded lobes, raised, directed outward, and conspicuously higher than posterior pronotal disc (Fig. 1); femora armed ventrally with two or three small subdistal spines.

*Genital capsule:* Posteroventral edge with pronounced U-shaped concavity, not deep, and enclosed by two medium-sized and robust arms, apically rounded (Fig. 9).
Fig. 18. Dorsal view of *Kekihygia culiona*, male.
**Integument:** Body surface rather dull, with short decumbent silvery bristletlike setae, intermixed with a few long erect hairs, located on the abdominal sternum.

Female. Coloration similar to male holotype. Trochanter dark reddish brown to dark chestnut orange; femora dark reddish brown with or without yellow mark on anterior third; posterior lobe of metathoracic peritreme dark chestnut orange to black; connexival segments VIII and IX dark reddish brown; dorsal abdominal segment VIII bright orange, and IX dark reddish brown; genital plates dark reddish brown, with upper margin of gonocoxae I, and apical angle of paratergite VIII and IX dark chestnut orange.

**Type material.—Holotype ♂, Philippine Republic: Mindanao, Zamboanga del Norte, Masawan Trail to Mt. Malindang (in jungle), 1.290 m, 2-VII-1958, H. E. Milliron (BPBM). Paratypes: 3 ♀, same data as holotype (BPBM, UNAM).

**Discussion.—**This new species resembles *H. (S.) dentifer* (Stål 1870), and *H. (S.) pictipes* (Stål 1870) in having the humeral angles projected into rounded lobes, raised, directed outward, and conspicuously higher than the posterior pronotal disc.

In *H. (S.) dentifer* and *H. (S.) pictipes*, the femora are yellow with brown rings or spots scattered through the segment, the trochanters are pale yellow, the tibiae reddish brown with two or three yellow rings, and connexival segments III to VI have the anterior and posterior margins yellow. In *H. (S.) alvarezi*, the femora and tibiae are entirely black to reddish brown, the trochanters are dark chestnut orange to dark reddish brown, and connexival segments III to VI are reddish brown and only the posterior border is dark chestnut orange.

An additional character is the shape of the posteroventral edge of the male genital capsule (Figs. 9–10, 13).

**Etymology.—**Named for Dr. Fernando Alvarez Noguera, distinguished Mexican carcinologist.

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**Hygia (Sphinctocolpura) oligotricha**

Brailovsky, new species

(Figs. 4, 12)

**Description.—**Measurements: Male: Head length 1.74; width across eyes 1.86; interocular space 1.10; interocellar space 0.42; preocular distance 1.12; length antennal segments: I, 2.24; II, 2.96; III, 2.04; IV, 1.64. Pronotum: Length 2.28; maximum width of anterior lobe 2.20; maximum width of posterior lobe 3.28. Scutellar length 1.40; width 1.26. Body length 10.90. Female: Head length 1.84; width across eyes 2.00; interocular space 1.22; interocellar space 0.51; preocular distance 1.28; length antennal segments: I, 2.28; II, 3.20; III, 2.24; IV, 1.76. Pronotum: Length 2.64; maximum width of anterior lobe 2.48; maximum width of posterior lobe 3.72. Scutellar length 1.72; width 1.52. Body length 12.18.

Male (holotype). **Dorsal coloration:** Head black, space adjacent to eyes yellow; antennal segments I to III reddish brown, IV yellow with basal third reddish brown; pronotum dark reddish orange, calli and punctures reddish brown; scutellum dark reddish orange with punctures reddish brown, and apex yellow; clavus and corium reddish orange with punctures reddish brown, and black discoidal spot on inner third of apical margin of corium; hemelytral membrane creamy white with veins brown; connexivum reddish brown; dorsal abdominal segments bright reddish orange. **Ventral coloration:** Head black; buccula dark chestnut brown; rostral segment I yellow with lateral margins and apical third chestnut brown, and segments II to IV chestnut brown with apical joints of II and III yellow; thorax and abdominal sterna reddish brown to black with propleuron, posterior margin of mesopleuron and metapleuron, and pleural sterna margin dark reddish orange; coxae, fore and middle femora, tibiae and tarsi dark reddish orange; trochanters creamy yellow; hind femur dark reddish orange, with inner anterior third creamy yel-
Fig. 19. Dorsal view of *Hygia (Sphinctoculpura) alvarezi*, female.
low; anterior and posterior lobe of metathoracic peritreme creamy yellow. **Structure:** Head dorsally slightly convex; genae without sharp teeth projecting laterally; postocular tubercle protuberant; rostrum reaching posterior border of abdominal sternite III or anterior third of IV; collar wide; frontal angles rounded, weakly raised; humeral angles rounded, not exposed, and not higher than posterior pronotal disc (Fig. 4); femora armed ventrally with two or three small subdistal spines.

**Genital capsule:** Posteroventral edge with small U-shaped concavity, enclosed by two shorter arms (Fig. 12).

**Integument:** Body surface rather dull, with short decumbent silvery bristle-like setae, intermixed with a few long erect hairs on abdominal sterna; circular grayish-white farinose punctures not visible.

Female. Coloration similar to male holotype. Connexival segments III to VI reddish brown, with posterior margin yellow and VII to IX reddish brown; dorsal abdominal segments VIII and IX reddish brown; genital plates reddish brown to black, with upper angle of gonocoxae I, and apical angle of paratergite VIII and IX dirty yellow; pleural margin of abdominal sterna dark reddish orange, with posterior border of III to VI dirty yellow.

**Integument:** Body surface rather dull, with short decumbent silvery bristle-like setae, intermixed with few long erect hairs on abdominal sterna; posterior lobe of pronotal disc, scutellum, clavus, corium, and thorax, covered with circular grayish-white farinose punctures.


Discussion.—**Hygia** (*Sphinctocolpura*) oligotricha, is similar to **H.** (S.) obscuripes (Stål 1870) in having the femora almost unicolorous, relatively short rostrum, not extending beyond the abdominal sternite IV, a black head with the area adjacent to each eye yellow, and the humeral angles rounded, not exposed, and not higher than posterior pronotal disc (Figs. 3–4).

This new species is easily recognized by the shape of the posteroventral edge of male genital capsule which has a small U-shaped concavity at the middle third, enclosed by two shorter arms, in contrast with the closely related species (Figs. 8, 11–12). Additional characters are the head dorsally slightly convex, and the hemelytral membrane creamy yellow with veins brown. In the other two species the hemelytral membrane is pale brown with darker veins, and the head is dorsally flat.

**Etymology.**—From the Latin, oligotricha, meaning sparse hairs.

**Kekihygia culiona** Brailovsky, new species

(Figs. 5, 18)

**Description.**—**Measurements:** Male: Head length 1.96; width across eyes 1.66; interocular space 1.00; preocular distance 1.42; length antennal segments: I. 1.40; II. 2.56; III. 1.32; IV, missing. Pronotum: Length 1.34; maximum width of anterior lobe 1.52; maximum width of posterior lobe 2.28. Scutellar length 0.80; width 1.20. Body length 9.80.

Male (holotype). **Dorsal coloration:** Head reddish brown, postocular tubercle dark yellow; antennal segment I pale reddish brown, II and III chestnut orange (segment IV missing); pronotum pale reddish brown, collar and posterior margin chestnut orange; scutellum, hemelytron, connexivum, and abdominal segments pale reddish brown, posterior margin of connexival segments V and VI yellow. **Ventral coloration:** Pale reddish brown, buccula, and anterior and posterior lobes of metathoracic peritreme dark to pale yellow; acetabulae, and rostral segments I to IV chestnut orange; legs dark chestnut yellow. **Structure:** Head lon-
Fig. 20. Dorsal view of Hygia (Sphinctocolpura) alvarezi, female.
Fig. 21. Dorsal view of *Hygia* (Eucolpura) casisi, female.
ger than wide; tylus unarmed, apically globose; antenniferous tubercle armed with wide lobes diverging anteriorly, and apically rounded; ocelli absent; postocular tubercle protuberant; rostrum reaching posterior border of abdominal sternite V. Thorax. 

**Pronotum:** Collar weakly apparent; anterior lobe longer than posterior lobe; frontal and humeral angles rounded; legs unarmed.

**Scutellum:** Wider than long, apically rounded. **Hemelytra:** Micropterous; wings reduced to small pads, widely separated, with corium and clavus fused, abdomen exposed mesially, and membrane absent. **Abdomen:** Spherical.

**Genital capsule.** Posteroventral edge with deep V-concavity; lateral arms large and robust (Fig. 5).

**Female.** Unknown.

**Type material.**—Holotype ♂. Philippine Republic: Culion Is., 6 km W Culion, 6-VI-1962, H. Holtmann (BPBM).

**Discussion.**—*Kekihygia* Brailovsky 1994, endemic to the Philippine Republic, previously included two species *K. luzonica* Brailovsky and *K. vasarhelyi* Brailovsky. The third species *K. culiona*, is easily distinguished by the shape of posteroventral edge of male genital capsule, which has a deep V-shaped concavity with lateral arms large and robust (Fig. 5). In *K. vasarhelyi* the posteroventral edge has two small arms with tiny U-shaped concavity (Fig. 7), and the apex of scutellum has the bright yellow spot absent in the new species. In *K. luzonica* the posteroventral edge has two short acute lobes laterally delimited by two rounded lobes (Fig. 6), and the apex of scutellum has a dark yellow spot. The male genital capsule in *K. culiona* is pale reddish brown, and those of *K. luzonica* and *K. vasarhelyi* are black.

**Etymology.**—Named for the Philippine Island of Culion.

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**Literature Cited**


Stål, C. 1870. Hemiptera Insularum Philippinarum
CONTRIBUTIONS TO THE KNOWLEDGE OF OLLA CASEY (COLEOPTERA: COCCINELLIDAE: COCCINELLINI): NEW SPECIES FROM THE GALAPAGOS ISLANDS, UPDATES ON THE DISTRIBUTION OF O. V-NIGRUM (MULSANT)

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Abstract.—Olla lacrimosa, n. sp., is described from Isabela Island of the Galapagos Archipelago. Earlier, the single known example of this species was mistaken for Olla hageni Vandenberg, a closely related species which occurs on the neighboring island of Santa Cruz. A diagnosis, habitus drawing, and key details of the anatomy and morphology of the new species are provided and compared to related members of the genus. The habits and distribution of the genus are reviewed, and updated distributional data are provided for O. v-nigrum Mulsant, a widespread species of temperate and tropical America which has been released in a number of countries for biological control purposes.

Key Words: Olla, Coccinellini, new species, taxonomy, biological control, distribution, Galapagos

With the addition of the single new species described herein, the New World genus Olla Casey (Coleoptera; Coccinellidae: Coccinellini) contains five known species, two of which are endemic to islands of the Galapagos Archipelago (Santa Cruz Island, Isabela Island). Olla was last revised by Vandenberg (1992) who described three new species, reviewed the taxonomic and nomenclatural history, and provided prey/habitat associations and distributional data, along with hypotheses of specific and higher affinities. In that work, the name Olla hageni Vandenberg was assigned to a species collected on Santa Cruz Island, but also incorrectly applied to a single specimen collected from Isabela Island, recognized here as a distinct, but closely related species. The present contribution to the genus was undertaken in order to make the new species name available for a book on the Coleoptera of the Galapagos Islands being prepared by Stewart Peck, Carleton University, Ottawa, and to provide updated information on the distribution of the genus and its use in natural and biological control.

Olla is endemic to the New World, with a natural range extending from southeastern Canada to Argentina, the West Indies, and Galapagos Archipelago. These lady beetles are primarily arboreal or bush-inhabiting and feed on a variety of soft-bodied insects, including aphids, psyllids, whiteflies, and thrips. As such, they have been considered a major component in the natural control of pest insects in commercial nut groves and fruit orchards (Bugg and Dutcher 1989, 1993; Goonewardene et al. 1989; Carroll and Hoyt 1984; Horsburgh and Asquith 1968; Putman 1964).
The present distribution of the genus has been altered drastically due to the activities of man. Early biological control efforts resulted in the establishment of *Olla v-nigrum* (Mulsant) in Hawaii and Guam (Timberlake 1943, Chapin 1965, Gordon 1985). According to internet resources (Sarailh et al. 1996, Centre de Coopération Internationale en Recherche Agronomique pour le Développement—Département des productions fruitières et horticoles (CIRAD-Flhor), Stations de la Réunion 1995), recent attempts to control the Leucaena psyllid, *Heteropsylla cubana*, have led to the introduction of *O. v-nigrum* in a number of Asian and Pacific countries, with recent redistribution and establishment in New Caledonia and Reunion Island. Sasaji (1992) records the presence of *O. v-nigrum* in Japan (particularly Okinawa Prefecture), with the earliest collection date in 1987. Kreiter and Iperi (1984) propose the release of this species in southeastern France for control of aphids on peach trees, and further document releases in Israel and former Czechoslovakia: the current status of *O. v-nigrum* in these countries is unknown.

The introduction of other exotic species into North America has apparently had both positive and negative impacts on the presence of *O. v-nigrum*. This predator, once relatively rare in Florida, became common following the invasion of the Asian citrus psyllid, *Diaphorina citri* Kuwayama, in citrus groves throughout the state (Michaud 2001, 2002). In contrast, *O. v-nigrum* has apparently become less prominent in certain fruit and nut crops in North America following the introduction of the multicolored Asian lady beetle, *Harmonia axyridis* (Pallas) (Brown and Miller 1998, Rice et al. 1998), which also has a broad prey range and predilection for arboreal habitats. The recent spread of *H. axyridis* into Argentina and Brazil (Saini in press, Almeida and Silva 2002) may further impact population levels of *O. v-nigrum* where the two species compete for similar resources in the southernmost part of *Olla*’s range.

Acronyms for collections mentioned in the text are:

CAS California Academy of Sciences, San Francisco.
CMNC Canadian Museum of Nature Collection, Ottawa.
USNM National Museum of Natural History, Washington, D.C.

**Olla lacrimosa** Vandenberg, new species

(Figs. 1-5, 7, 9, 11)

*Olla hageni*: Vandenberg 1992 (misidentification of single specimen from type series of *Adalia galapagoensis* Van Dyke).

*Adalia galapagoensis* Van Dyke 1953 (in part).

Diagnosis.—Distinguished from other species in the genus by the form of the siphon of the male genitalia which has the apical flagellum distinctly longer (~1.4×) than the declinate subapical projection, but much less than three times as long (Fig. 7), and by the tendency for the elytral maculae to form dark brown streaks against a yellow background (Figs. 1, 3-4). It can be further distinguished from *Olla hageni*, the only other species of *Olla* known from the Galapagos Islands, by the pair of median carinae on the intercoxal process of the prosternum (Figs. 13-14). *Olla lacrimosa* is most likely to be confused with *Cycloneda galapagoensis* (formerly in *Adalia*), which may exhibit a similar streaked elytral pattern. *Cycloneda galapagoensis* differs in having the metepisternum black and mese-pimeron white (both cream colored in *O. lacrimosa*), and the head entirely black, or pale with a basal transverse to triangular black mark (yellow with a pair of brown to black basal spots in *O. lacrimosa*). The genitalia of *C. galapagoensis* are of an entirely different form (Vandenberg 1992, 2002), with an undivided apex to the male basal lobe, and a well developed infundibulum of the female sperm duct. Although *C. galapagoensis* is listed as occurring on both Floreana and Isabela Islands (Van Dyke 1953) the latter record is the result of a misiden-

**Description of holotype (male).**—Length 5.0 mm; width 4.0 mm. Form subovate, moderately convex with elytral and pronotal margins feebly explanate. Surface between elytral punctures highly polished to weakly shagreened, between head and pronotal punctures distinctly shagreened. Dorsal color pattern (Figs. 1, 4) consisting of dark brown spots and streaks on light yellow background. Head with pair of rounded dark brown spots near base and faint stippled row extending anteriorly from each: clypeus and labrum light golden brown. Pronotum with five dark brown marks forming a broken M rooted at pronotal base and occupying median three-fifths; pair of well-developed rounded dark brown spots centered one within each lateral third; additional pair of minute, more ruddy dots faintly indicated at base just in front of scutellum. Elytral suture and scutellar margins dark brown. Each elytron with four discrete irregular dark brown marks in staggered row across basal one-fourth, sutural and lateral spots closely approaching but not touching respective margins; single discrete spot near lateral margin centered just in front of middle; remaining marks forming a dendrogram rooted at elytral apex, with tapered sutural branch, abbreviated lateral branch and two medium length inner branches as shown (Fig. 4). Elytral punctures each marked with pinpoint of brown. Ground color of ventral surface including appendages light golden brown; mesepisternum slightly darkened at middle; mesepimeron, metepisternum, metepimeron cream colored; metasternum except intercoxal process and outermost margins dark brown; abdominal ventrites 1–5 dappled with dark brown; pronotal hypomeron and elytral epipleuron same color as elytron.

Eyes with inner orbits roughly parallel, separated by about twice diameter of eye. Intercoxal process of prosternum with pair of carinae converging just beyond midlength of prosternum (Fig. 13). Elytral epipleuron concave, descending externally, with maximum width approximately 1/6 width of body at base of abdomen. Abdo-
men arcuate, pointed posteriorly, with six ventrites, widest at middle of first ventrite; postcoxal line of first ventrite curved posteriad and laterad closely paralleling posterior margin for most of length, fading before attaining lateral margin; oblique line present, separated from main postcoxal arc by short break; posterior margins of ventrites 1–3 linear, of ventrites 4–5 weakly bowed anteriorly, apex of ventrite 6 exposed, obtriangular. Male genitalia with basal lobe long and slender (Figs. 9, 11), with apex consisting of two triangular denticles separated by weakly convex border; parameres simple in shape, not curving over sides of basal lobe at apex; sipho (Fig. 7) with sinuous apex (bearing median orifice) approximately 1.4x longer than declinate subapical projection; tube forming main body of sipho slender, oval in cross-section, with membranous area visible in lateral view.

Female.—Differs from male in being slightly more elongate and possessing rounder abdominal apex; ventrite 5 bowed posteriorly, covering ventrite 6. Spermatheca with curved, tapered cornu; straight, distally swollen ramus bearing small accessory gland; with minute, nipplelike nodulus communicating with sperm duct. Sperm duct flexible, attached middorsally to tubular bursa. Base of common oviduct swollen with thick rugose walls.

Variation (based on allotype and 14 para-types).—Length 4.0–6.5 mm; width 3.2–4.2 mm. Prosternal carinae joined anteriorly

(Fig. 13) or not (Fig. 14). Elytral ground color varying from more ashen color (these appear to be terenal specimens) to light or medium yellow. Elytral maculation variable (Figs. 2–5), some specimens with apical dendritic mark as in holotype (Figs. 1, 4), but others with mark broken into detached spots and abbreviated dashlike markings (Fig. 3), or of intermediate configuration; one lightly marked individual with discrete elytral spots arranged in rows of 4–3–1 as in common form of most Olla species (Fig. 2); one specimen with large irregular mark formed from discal spots of all three levels (Fig. 5). Pronotum with some spots lacking or coalescent. Venter with more or less extensive areas of dark brown.


Other material examined.—Paratype (♀)= of Adalia galapagoensis Van Dyke (1953): “Albemarle, Galapagos Is./500 ft, VIII-1906/ coll. by J. R. Slevin/ PARATYPE, Adalia galapagoensis, E. C. Van Dyke” (CAS). The type series of Adalia galapagoensis consists of 22 specimens. All of these were collected on Floreana Island with the exception of the single misidentified paratype (above) which was collected on Isabela (= Albemarle). This specimen is the most lightly marked example of the new species that I have encountered, with elytral markings similar to Fig. 2, but with the sutural and lateral spot of the first row, middle spot of the second row, and apical most spot lacking or indistinct.

Etymology.—From the Latin lacrimosus meaning “prone to tears or crying.” the name is a reference to the elytral markings which appear to have streaked and run down the beetle’s back in the manner of oldfashioned mascara.

Discussion.—The male genitalia of Olla lacrimosa has a siphalon apex (Fig. 7) which is intermediate in development to the elongate whiplike apex found in O. hageni (Fig. 8) and the shorter more robust apex of O. v-nigrum (Fig. 6; see also Vandenberg 1992 for variation within the latter species). Similarly, the basal lobe of O. lacrimosa (Fig. 11) is intermediate in form between the distally expanded wedgeshaped structure found in O. v-nigrum (Fig. 10) and the more slender, nearly parallelelsided basal lobe of O. hageni (Fig. 12); the distal denticles of the basal lobe are also of intermediate shape and width in the new species. No significant differences were observed in the female genitalia of O. lacrimosa and O. hageni (see Vandenberg 1992 for illustration), although differences in the membranous portions of the female tract are more difficult to assess. The prosternal intercoxal process of O. lacrimosa (Figs. 13–14) has a pair of median carinae as in O. v-nigrum; in O. hageni (Fig. 15) the carinae are abbreviated and displaced laterally so that they are juxtaposed above the clear amber edge of the process, forming a marginal bead. A yellow dorsal ground coloration is common to both O. lacrimosa and O. hageni, although less developed in terminal specimens of the former; in O. v-ni-

*O. v-nigrum* the ground color of the pale form is ashy gray or a drab beige.

A close relationship between *O. hageni* and *O. v-nigrum* was demonstrated by the formation of hybrid embryos in laboratory crosses (Vandenberg 1992), and is further supported by similarities in the genitalia of both sexes. Vandenberg (1992) provided a cladistic analysis of the 4 species of *Olla* known at that time, and hypothesized that *O. hageni* is a relatively young species, derived from a founding population of the widespread continental *O. v-nigrum* less than 3 or 4 million years ago, and modified through genetic drift and the unique selection pressures of the new island habitat. The discovery of *O. lacrimosa* on a neighboring island suggests that the evolution of *O. hag-
eni involved an intermediate step comprising an additional speciation event preceded by dispersal within the archipelago. Common trends found only in the two galapagan species which imply that they share a very recent ancestry and sister group relationship include the elongation of the siphonal apex of the male genitalia, reduction/loss of the median convexity at the apex of the basal lobe, and possession of a relatively saturated yellow ground coloration of the head, pronotum, and elytron. The essentially identical form of the female genitalia further supports the idea of a very recent divergence of the two island species.

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I am grateful to Stewart Peck for providing the series of the new Olla species from Isabela Island, which has allowed me to correct my earlier misidentification of the single previously known specimen. I also thank Dave Kavanaugh (CAS), for access to type material of Adalia galapagoensis Van Dyke, which contains the aforementioned specimen. The present publication has benefitted from the constructive reviews of Stewart Peck: Adam Ślipiński, CSIRO Entomology, Canberra, Australia; and Dave Nickle and Al Norrbom, Systematic Entomology Laboratory (SEL), Beltsville, Md., and Washington, D.C., respectively. Elisabeth Roberts (SEL) assisted with manuscript preparation and produced the pen and ink drawings for figs. 6–9.

LITERATURE CITED


NEW DISTRIBUTION RECORDS AND MOSS ASSOCIATIONS FOR THE
LACE BUGS ACALYPTA DURyi DRAKE AND A. LILLIANIS TORRE-BUENO
(HEMIPTERA: TINGIDAE)

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Abstract.—North American tingids of the mostly Holarctic, moss-inhabiting genus Acalypta are seldom collected, and records from specific mosses are scant. Our collections of a nymph and an adult of A. duryi Drake from Dicranum scoparium in North Carolina, nymphs and an adult from Hylocomiastrum umbratum in Tennessee, and adults from Anomodon rostratus in Tennessee are the first specific mosses associated with this lace bug. Records of nymphs and adults of A. lillianis Torre-Bueno from Polytrichum commune and P. juniperinun in the southeastern United States corroborate the association with hair-cap mosses, Polytrichum spp. New state records for A. lillianis are Alabama and South Carolina.

Key Words: Acalypta, Tingidae, insect distribution, new records, bryophagy, Anomodon, Dicranum, Hylocomiastrum, Polytrichum

Acalypta Fieber is a primarily Holarctic genus of lace bugs comprising about 40 species (Froeschner 1991, Péricart and Golub 1996). In the New World, Acalypta is found from Alaska and Newfoundland to Guatemala (Drake and Lattin 1963; Froeschner 1976, 1988, 1996; Scudder 1997). The Canadian and U.S. fauna includes eight (Allen et al. 1988, Froeschner 1988) or nine Nearctic species (Lattin and Moldenke 1990), in addition to the trans-Beringian A. cooleyi Drake and perhaps the Palearctic A. parvula Fallén (Golub 1973, Froeschner 1976). Uncertainty about the number of Nearctic species involves the taxonomic status of A. mera Drake, described from British Columbia and Oregon (Drake 1941), and synonymized by Drake and Lattin (1963) with A. barberi Drake, which was described from New York (Drake 1934). Golub (1973) synonymized A. barberi with A. parvula, suggesting that this European tingid has been accidentally introduced to the east and west coasts of North America. Froeschner (1976) followed Golub’s (1973) biogeographic interpretation but omitted reference to A. mera, as he also did in cataloguing the North American Tingidae (Froeschner 1988). Lattin and Moldenke (1990), without taxonomic explanation, reinstated A. mera as a valid species, a decision apparently based on its association with mature, old-growth forests of the Pacific Northwest (see Lattin 1997). In the current catalog of Palearctic Tingidae, both A. barberi and A. mera are retained as synonyms of A. parvula (Péricart and Golub 1996). Examination of European and North American type material is needed to determine the taxonomic status of A. mera and the identity of the moss tingid in northeastern North America that has been referred to as A. barberi or A. parvula.

Brachyptery is common in Acalypta, and
some species are known only from a short-winged form (Drake and Lattin 1963). As moss inhabitants, these lace bugs are seldom collected except when collecting devices such as Berlese or Tullgren funnels are used; mosses and other nonvascular plants generally receive little attention from entomologists (e.g., Beshear et al. 1976, Wheeler 2003). In referring to Acalypta species, Froeschner (1996) pointed out that their “cryptic moss-frequenting habit . . . undoubtedly shields them from being collected frequently.” Ranges of even the best-known North American species of Acalypta are inadequately known (Froeschner 1976). Moreover, specific moss associations have rarely been recorded for the Nearctic species.

On the basis of fieldwork in southeastern states, we provide new distribution records and moss associations for A. duryi Drake and A. lillianis Torre-Bueno. Specimens of A. duryi were obtained by placing moss samples in a Berlese funnel and recovering adults and nymphs from the extracted material. A Berlese funnel also was used to collect A. lillianis, but adults and nymphs were obtained mainly by placing an enamel pan in mats of Polytrichum mosses, tapping the overlying stems over the pan, and collecting any dislodged nymphs and adults. Voucher specimens have been deposited in the Clemson University Arthropod Collection, Clemson, SC; the Great Smoky Mountains National Park Museum, Gatlinburg, TN; and National Museum of Natural History, Smithsonian Institution, Washington, DC. Parenthetical numbers in the following list of material examined refer to the number of adults (number only) and nymphs (number + roman numeral indicating instar) collected or observed.

Acalypta duryi Drake

Acalypta duryi was described as Fenestrella ovata from Cincinnati, Ohio, by Osborne and Drake (1916), placed in Acalypta by Drake (1928), and renamed A. duryi by Drake (1930) because the name ovata was preoccupied in Acalypta. Reported since the original description only from Georgia, North Carolina, and Tennessee (Froeschner 1988). A. duryi has been collected from unidentified mosses (Drake and Lattin 1963, Beshear et al. 1976).


Acalypta lillianis Torre-Bueno

The distribution of A. lillianis, the most widespread Nearctic species of the genus, is hypothesized to have been shaped by the Pleistocene glaciations. Populations in the four areas of its range—central Alaska, northwestern United States, north-central and northeastern states plus Ontario and Quebec, and Newfoundland—correspond to some glacial refugia (Froeschner 1976). The previously reported eastern U.S. distribution extends from Maine to Georgia and west to Iowa, Minnesota, and Arkansas (Allen et al. 1988, Froeschner 1988), with Georgia (Beshear et al. 1976) and Arkansas (Allen et al. 1988) having been added since Froeschner’s (1976) zoogeographic analysis. Acalypta lillianis is one of the few North American members of the genus whose associated mosses have been identified to genus or species. Nymphs and adults are known from Polytrichum sp. in Massachusetts (Bailey 1951) and P. juniperinum Willd. in North Carolina (Horn et al. 1979).

Material examined.—ALABAMA: Chambers Co., granite outcrop, Rt. 77, ca. 3.2 km NNW of Penton, 9 Apr. 1997, ex Polytrichum commune Hedw., A.G. Wheeler (1);

DISCUSSION

The mosses Anomodon rostratus, Dicranum scoparium, and Hylocomium umbratum represent the first mosses specifically associated with A. duryi. The collection of a nymph and an adult from D. scoparium and multiple nymphs and an adult from H. umbratum suggest that these mosses serve as hosts of this lace bug. Our observations on A. lillianis support previously recorded associations with Polytrichum species (Bailey 1951, Horn et al. 1979). We found late instars in mats of P. commune in February, March, April, and September and adults mainly in April but also in May and June. One adult was extracted from a mixture of the mosses P. commune and A. palustre. Bailey (1951) reported that adults were collected most often in late spring (late May through June) in the northeastern states and that he generally was unable to collect this tingid later in the season from Polytrichum colonies that had yielded numerous individuals during spring. He suggested that A. lillianis is nocturnal or by day retires under stones and remarked that some of its habits are as yet unexplained (Bailey 1951). Bailey’s (1951) inability to collect the lace bug during summer might have involved the desiccation of moss colonies. Field and laboratory studies are needed to determine the seasonality of this lace bug and other aspects of its biocomics.

Species of Acalypta are considered musciculous (e.g., Drake and Lattin 1963), and several North American species have been observed to feed on mosses (e.g., Bailey 1951, Allen et al. 1988). At least one species, A. parvula, inserts its eggs into moss stems under laboratory conditions (Leston 1953). A consistent association with mosses in the Old and New World (Drake and Lattin 1963, Péricart 1983, Stehlík 2002) suggests that many Acalypta species develop on these bryophytes. Mosses probably do serve as hosts of A. duryi and A. lillianis. Even though we found nymphs of both tingids on certain mosses, we refer to an association with mosses, rather than a host relationship, until the plants have been demonstrated to support the bugs’ growth and development.

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**LITERATURE CITED**


TWO NEW CHINESE SPECIES OF *TENOMERGA* NEBOISS (COLEOPTERA: CUPEDIDAE), WITH A WORLD CATALOG OF THE GENUS

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Abstract.—*Tenomerga* gaolingziensis, new species, and *T. tianmuensis*, new species, are described from China. The distinctive characters of the new species in relation to other species of the genus are discussed. Habitus photographs and illustrations of the male genitalia, head and pronotum, and elytra are included. Also a world catalog of the genus *Tenomerga* Neboiss is given.

Key Words: China, *Tenomerga*, Cupedidae, Coleoptera, new species, catalog

The genus *Tenomerga*, mainly distributed in the western Pacific, eastern Asian, southern African, and northern American regions, was erected by Neboiss in 1984. Prior to 1984, species now assigned to *Tenomerga* were attributed to the genus *Cupes* (*sensu lato*). Crowson (1962) divided *Cupes* into three species groups: capitatus, lugubris and clathratus. In 1984, Neboiss described males of 21 species of *Cupes*. Combined with external morphological structures and male genital characters, he raised the species groups to generic rank. Species of *Tenomerga* were these hitherto assigned to the *clathratus* species group. In the present study, we describe two new species using characters of the male genitalia and external morphological structures. The type specimens are deposited in the Institute of Zoology, Chinese Academy of Sciences, Beijing. We also give a catalog of all known species of *Tenomerga*.

Genus *Tenomerga* Neboiss


Type species: *Cupes mucida* Chevrolat 1829 (original designation).

Diagnosis.—Head wider than long, angles rounded, bearing two pairs of conical tubercles, one pair above base of antenna, the other posteriorly above eyes, a pair of elevations behind second pair of tubercles, similar to elongate elevations at middle of head; without antennal grooves; antenna long, filiform, usually laterally flattened, about three-quarters length of body, not covered with obvious scales; gula short and wide, angular, widest anteriorly, reaching posterior ridge of head, gradually transversely depressed anteriorly, anterior margin elevated. Pronotum quadrate, wider than long, anterior angles more or less acute; prosternum with moderately deep tarsal grooves along lateral and anterior margins, separated anteromesally by elevated ridge, anterior margin narrow. Elytra conjointly slightly wider than prothorax, dorsal surface flattened, each usually bearing nine rows of punctures, row 10 present only in basal quarter; scales present on most intervals, punctures distinct, outlines not obscured by scales; elytral apices not extended to acute point. Hind wing with costa, subcosta and radius united at stigma; radio-medial cross vein at or proximad divergence of radial sector; no apical extension of me-
dia beyond oblongum cell. Male abdominal tergite IX with long, bifurcate process; dorsal plate only slightly sclerotized, about half length of a paramere.

Distribution.—Worldwide except the Australian Region and Europe.

**Descriptions of New Species**

*Tenomerga gaolingziensis* Ge and Yang, new species

(Figs. 1, 3–6, 11, 13)

Description.—Length: 10.8–11.0 mm; width: 2.1–2.2 mm. Color: Brown with sections of dark brown scales on intervals (Fig. 1). Head: Projecting and moderately elongate (Fig. 11); mandibles strong, each with two teeth and dense, long setae. Antenna moderately elongate, longer than head and prothorax combined; ratio of antennomere lengths: 0.32: 0.08: 0.41: 0.45: 0.64: 0.56: 0.56: 0.56: 0.56: 0.73; ratio of antennomere widths: 0.32: 0.25: 0.29: 0.32: 0.32: 0.29: 0.26: 0.24: 0.23: 0.21; antennomere length/width ratios: 1.0: 0.32: 1.39: 1.38: 2.0: 1.75: 1.96: 2.15: 2.33: 2.43: 3.64.

Thorax: Prothorax about 0.7 times as long as wide (PL/PW = 1.12/1.6) (Fig. 11), sides parallel; anterior angles forward-pointing but not sharp; hind margin raised forward to form a ridge; impression moderately deep. Scutellum relatively small, more or less trapezoid. Elytron 3.17 times as long as wide (EL/EW = 6.58/2.08) and 5.87 times as long as pronotum (EL/PL = 6.58/1.12), 1.3 times as wide as pronotum (EW/PW = 2.08/1.6), with raised, longitudinal ridges marked with alternating lines of dark brown scales, longitudinal stripes of grey scales and three longitudinal ridges; first ridge along lateral margin of elytron entire, second roughly parallel to first and joining third ridge, third ridge merging with first close to apex, both slightly prolonged apically (Fig. 13). Legs moderately long and slender, ratio of profemur: protibia: protarsomerces = 0.96: 1.04: 0.72; profemur 2.47 times as long as wide; protibia 6.19 times as long as wide; ratio of mesofemur:
Tenomerga gaolingziensis. male genitalia. 3, Abdominal segment IX, ventral. 4, Bifurcate process. 5, Aedeagus, ventral. 6, Aedeagus, dorsal.

mesotibia: mesotarsomeres = 0.8: 1.14: 0.84; mesofemur 3.23 times as long as wide; mesotibia 4.45 times as long as wide; ratio of metafemur: metatibia: metatarsomeres = 0.92: 1.04: 1.12; metafemur 5.3 times as long as wide; metafemur 3.23 times as long as wide; metatibia 4.45 times as long as wide; ratio of metafemur: metatibia: metatarsomeres = 0.92: 1.04: 1.12; metafemur 5.3 times as long as wide; metatibia 6.5 times as long as wide.

Abdomen: Male genitalia with median section of tergite IX extending beyond lateral lobe apically. Aedeagus moderately stout, parameres with apical hooks moderately robust, curved apically; inner dorsal lateral ridges without acute distal angle; ventro-marginal spines arising near basal opening, not exceeding length of dorsal plate; lateral margins of mesal lobe widened near base (Figs. 3–6).

Material examined.—Holotype: ♂, Heilongjiang: Gaolingzi (44.8°N, 128.8°E), 2 July 1939, collector unknown. Paratypes: 2 ♂, same data as holotype.

Diagnosis.—The new species is quite similar to Tenomerga anguliscutis (Kolebe) differing primarily in aedeagal morphology. In T. anguliscutis, tergite IX is extended beyond the lateral lobe and widened; the aedeagus is moderately stout, the parameres have the apical hooks bipointed apically, the inner dorsolateral ridge has an acute distal angle, the ventro-marginal spines are slender, arising at about basal quarter and extending nearly to the tip of the apical hooks, the mesal lobe is tapered distally, and the apex notched mesally. The character separating these two species from the other species is the apical bifid hook of the aedeagus.

Etymology.—Latinized form of Gaolingzi, the county in which the species was first collected.

Tenomerga tianmuensis Ge and Yang, new species
(Figs. 2, 7–10, 12, 14)

Description.—Length: 12.3–12.5 mm; width: 2.8–2.9 mm. Color: Yellowish brown with sections of pale white scales on intervals (Fig. 2). Head: With an impressed median line; projecting and moderately elongate (Fig. 12); mandibles strong, with two teeth; clypeus and mandibles with dense long setae; antenna moderately elongate, longer than head and prothorax combined; ratio of antennomere lengths: 0.34: 0.08: 0.48: 0.64: 0.65: 0.72: 0.79: 0.78: 0.77: 0.77: 0.98; ratio of antennomere

widths: 0.24: 0.18: 0.25: 0.24: 0.27: 0.28: 0.23: 0.24: 0.24: 0.12; antennomere length/width ratios: 1.42: 0.47: 1.95: 2.67: 2.75: 2.66: 2.91: 3.38: 3.27: 8.27.

Thorax: Prothorax (Fig. 12) about 0.8 times as long as wide (PL/PW = 1.12/1.4), sides parallel; anterior angles pointing forward and sharp; hind margin raised forward to form a ridge; impression moderately deep; scutellum relatively small, more or less cordiform; elytron about 3.24 times as long as wide (EL/EW = 6.73/2.08) and 6.01 times as long as pronotum (EL/PL = 6.73/1.12). 1.49 times as wide as pronotum (EW/PW = 2.08/1.4), with longitudinal stripes of grey sales and three longitudinal ridges; first ridge along lateral margin entire, prolonged to suture; second ridge subparallel to first, its apical end joining with the third ridge; third ridge itself joining first ridge close to apex of elytra (Fig. 14); legs moderately long and slender, ratio of mesofemur: mesotibia: mesotarsomeres = 0.8: 1.04: 0.8; mesofemur 1.11 times as long as wide; mesotibia 4.19 times as long as wide; ratio of metafemur: metatibia: metatarsomeres = 0.72: 0.98: 1.12; metafemur 2.19 times as long as wide; metatibia 6.13 times as long as wide.

Abdomen: Male genitalia with median section of tergite IX extended beyond lateral lobe and widened, rounded apically; aedeagus moderately stout, parameres with apical hooks bifid; ventral marginal spines slender, arising at about basal middle to apex of hooks; mesal lobe bifurcated distally; lateral margins widened basally (Figs. 7–10).

Material examined.—Holotype: δ, Zhejiang: Tianmu Shan (34.4°N, 119.5°E), 23 August 1936, coll. O. Piel. Paratypes: 2 δ and 1 ?, same data as holotype; 2 δ, 1 ?, Zhejiang: Tianmu Shan (34.4°N, 119.5°E), 22 July 1937, collector unknown.

Diagnosis.—This new species is quite similar to T. mucida (Chevrolat), differing primarily in aedeagal morphology. In T.
nucida tergite IX is widened distally, extended slightly beyond the lateral lobe, less than in T. anguliscutis; the inner dorsolateral ridge has an acute distal angle; the ventro-marginal spines are slender, arising at about the basal quarter and extending nearly to the tip of the apical hooks, the mesal lobe is tapered distally, with the apex notched mesally. The characters separating these two species from the other species are the slender, laterally compressed antennal segments and the pronotal median ridge not acute.

Etymology.—Latinized form of Tianmu the county in which the species was first collected.

WORLD CATALOG OF THE GENUS

Tenomerga Neboiss

Tenomerga anguliscutis (Kolbe)
Cupes anguliscutis Kolbe 1886: 200.
Cupes formosanus Tamauki 1928: 251, fig. 4; Atkins 1963: 151, figs. 12.

Distribution.—China (Heilongjiang, Jilin, Liaoning, Nanjing, Shanghai, Zhejiang, Taiwan); Vietnam (Tonkin); Laos; Korea.

Tenomerga cinerea (Say)

Cupes cinerea Say 1831: 6; Say 1835: 167.
Cupes concolor Westwood 1835: 440; Atkins 1963: 150; Atkins 1979: 2 (includes information on synonyms and references); Vulcano and Pereira 1975: 42, fig. 5.
Cupes trilineata Melsheimer 1845: 310.
Cupes oculatus Casey 1897: 638.

Distribution.—Eastern USA and Canada.

Tenomerga favella Neboiss


Distribution.—Indonesia: Kalimantan.

Tenomerga gaolingziensis Ge and Yang, new species

Distribution.—China.

Tenomerga kapnodes Neboiss


Distribution.—Papua New Guinea.

Tenomerga kurasawai Miyatake

Tenomerga kurasawai Miyatake 1986: 11.

Distribution.—Japan.

Tenomerga japonica (Tamanuki)

Cupes japonica Tamanuki 1928: 252; Atkins 1963: 151, fig. 14.
Tenomerga japonica: Neboiss 1984: 449. figs. 8–10. 75.

Distribution.—Japan. Record by Vulcano and Pereira 1975: 64 could not be confirmed.

Tenomerga leucophaea (Newman)

Cupes leucophaea Newman 1839: 304; Atkins 1963: 150, 152. Fig. 9.
Cupes capensis Kolbe 1897: 354.

Distribution.—Southern Africa.

Tenomerga moultoni (Gestro)

Tenomerga moultoni: Neboiss, 1984: 456, figs. 81, 114.

Distribution.—Malaysia (Sarawak).

Tenomerga mucida (Chevrolat)

Cupes mucida Chevrolat 1829: 58; Atkins 1963: 154.
Cupes clathratus Solsky 1871: 370; Atkins 1963: 148.
Cupes ocularis Pascoe 1872: 319.
Cupes clathratus var. fuscus Tamanuki 1928: 251.
Tenomerga mucida: Neboiss 1984:
Distribution.—Philippines, eastern Asia, Japan, Hawaii. Record of Caroline Islands by Vulcano and Pereira (1975) not confirmed.

*Tenomerga sibyllae* (Klapperich)
*Cupes sibyllae* Klapperich 1950: 83, fig. 1; Atkins 1963: 155.

Distribution.—Southeastern China.

*Tenomerga tianmuensis* Ge and Yang, new species

Distribution.—Eastern China.

*Tenomerga trabacula* Neboiss
*Tenomerga trabacula* Neboiss 1984: 450, figs. 11–14, 76, 98, 112.

Distribution.—Eastern China and Taiwan.

*Tenomerga yamato* Miyatake

Distribution.—Japan.

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### LITERATURE CITED


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A REVIEW OF TWO NEARCTIC SHORE-FLY SPECIES IN THE GENUS
PSILOPA FALLEN THAT WERE INCLUDED IN THE GENUS
CRESSONOMYIA ARNAUD (DIPTERA: EPHYDRIDAE)

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Abstract.—Psilopa aeneonigra Loew, a shore fly that was described in Psilopa but was for many years placed in the genus Cressonomyia Arnaud, is returned to Psilopa. A second species, P. loewi n. sp. (New Jersey. Ocean: Tuckerton (10 km N; 39°41.3’N, 74°21.6’W), that had been misidentified as P. aeneonigra is also recognized and described. The descriptions of these two species include the first illustrations of structures of the male terminalia.

Key Words: Diptera, Ephydridae, Nearctic, shore flies, Cressonomyia, Psilopa

Hermann Loew (1878) described Psilopa aeneonigra from specimens that a Russian diplomat and early promoter of American dipterology, Baron C. R. Osten Sacken, had acquired from Texas (see Osten Sacken 1903 and Smith 1978 for an appreciation and short biography of Osten Sacken). The specimens were subsequently sent to Germany where Loew resided, and after Loew’s study and description of the new species, the syntypic series was eventually deposited in the Museum of Comparative Zoology, Harvard University. Loew’s species, which is now known to be more widespread, and a new species that was misidentified as P. aeneonigra are the subjects of this paper. As appropriate, these species are either redescribed or described, including the first illustrations of structures of the male terminalia.

Psilopa aeneonigra remained in its original nomenclatural combination for nearly a century until Wirth (1965) transferred the species to the genus Cressonomyia Arnaud. The transfer was presumably made because of the slightly darkened base of the wing. Apparently, the darkened base of the wing is a homoplasious condition, as a more extensively darkened base (extending onto the base of the remigium) is a synapomorphy that establishes the sister-group relationship between Cressonomyia and Peltopsilopa Cresson (Mathis and Zatwarnicki 2004).

This paper is a further result of a recent revision of Cressonomyia (Mathis and Zatwarnicki 2004). While studying specimens of Cressonomyia we discovered that P. aeneonigra is not a congener, and, moreover, that there is a second species that is similar, closely related, and apparently undescribed. These discoveries occurred while studying structures of the male terminalia, which prompted us to re-examine external characters as well. For example, the color of the halter is dark brown to black in Cressonomyia (a synapomorphy that further es-
tablishes the monophyly of Cressonomyia and Peltopsilopa), whereas in these two species the knob is white to yellowish white, which is the plesiomorphic state.

Another available name, Psilocap fulvipennis Hine (1904), has also been considered in our treatment of these species. Hine’s species was described from specimens collected in Louisiana, a locality well within the known distribution of P. aeneonigra. In 1942, Cresson suggested that these two species are synonyms. We examined the primary types of both species, which are conspecific, and here reconfirm Cresson’s synonymy.

METHODS AND MATERIALS

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. We have followed the terminology for most structures of the male terminalia that other workers in Ephydridae have used (see references in Mathis 1986, and Mathis and Zatwarnicki 1990a, 1990b), such as surstylus. Zatwarnicki (1996) suggested that the pre- and poststurystylus correspond with the pre- and postgonostylus and that the subependrial plate is the same as the medandrium. The terminology for structures of the male terminalia is provided directly on Figs. 1–14. The species descriptions are composite and not based solely on the holotypes. One head and two venational ratios that are used in the descriptions are defined below (all ratios are based on three specimens (the largest, smallest, and one other). Costal vein ratio: the straight line distance between the apices of R_{2+3} and R_{4+5}/distance between the apices of R_1 and R_{2+3}. M vein ratio: the straight line distance along vein M between crossveins dm-cu and r-m/distance apicad of dm-cu.

Distribution maps were made using ESRI ArcView® GIS 3.2. Longitude and latitude coordinates were obtained for the locality where each specimen was collected and entered into a Microsoft Excel® spreadsheet. If unavailable directly from specimen labels, longitude and latitude were estimated using gazetteers and maps to determine the geographical coordinates.

Although many specimens examined for this study are in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM), we also borrowed and studied numerous specimens that are deposited in the following museums: ANSP—Academy of Natural Sciences of Philadelphia, Pennsylvania; MCZ—Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; and OHSU—Ohio State University, Columbus, Ohio.

SYSTEMATICS

KEY TO NEARCTIC SPECIES OF PSILOPA WITH SLIGHTLY DARKENED WING BASE

1. Apical tarsomere dark brown, contrasted with yellow remaining tarsomeres; scutellum trapezoidal, posterior margin truncate

2. Apical tarsomere pale, colorless with other tarsomeres; scutellum triangular, posterior margin broadly pointed

Psilocap aeneonigra Loew

(Figs. 1–15)

Psilocap aeneonigra Loew 1878: 196.—Cresson 1942: 125 [fauna, eastern United States].


Psilocap fulvipennis Hine 1904: 64.—Cresson 1942: 125 [synonymy with Psilocap aeneonigra Loew].

Description.—Moderately small shore flies, body length 2.30–2.65 mm; largely black.

Head: Frons sparsely microtomentose, subshiny. Antenna yellow except for black-
ish apicodorsal portion of 1st flagellomere; arista bearing 6 dorsal rays. Face moderately densely microtomentose, mostly flat, bearing 1 large, ventral, cruciate seta.

Thorax: Mesonotum sparsely microtomentose, subopaque to subshiny, micropapulose; scutellum triangular, posterior margin broadly pointed. Wing hyaline, only stem base blackish; costal vein ratio 0.89–0.93; M vein ratio 0.65–0.70. Knob of halter white to pale yellow, stem brownish. Legs black except for yellow apex of tibiae and tarsi, including the apical tarsomere.

Abdomen: Tergites more sparsely micro-
tomentose than mesonotum, subshiny to shiny black. Male terminalia (Figs. 1–14): Epandrium in posterior view (Fig. 1) broadly U-shaped, rounded, moderately wider ventrolaterally than dorsally; cerci in posterior view (Fig. 1) rodlike, medial margin shallowly concave, much narrower dorsally, dorsal apex slightly recurved, ventral margin with submedial indentation; presurstylus in posterior view (Fig. 1) as gradually tapered rods, apex pointed, base curved dorsally, in lateral view (Fig. 2) shallowly curved, nearly parallel sided; postsurstylus in lateral view (Figs. 4, 12) 3–4× longer than wide, elbowed at middle, bearing tiny setae on apical half, in ventral view (Figs. 3, 11) appearing narrower and more angularate, base with rounded, angulate dorsally curved process; pregonite in lateral view (Figs. 4, 10) as a simple, rodlike sclerite, bearing 3 setae in ventral view (Figs. 3, 9) with length about twice height, rounded; postgonite in lateral view (Figs. 4, 10) larger than pregonite, also rodlike, slightly bulged medially, base drawn out into narrow, short process; aedeagus in lateral view wide basally, curved and narrowed to slender, apex, dorsal margin with 2 shallow prominences; phallopodeme in lateral view (Figs. 4, 6) with keel well developed, broadly and asymmetrically extended; subepandrial plate in lateral view much longer than wide, bearing 2 apical, small, setae, in dorsal view as in Fig. 7; hypandrium in lateral view (Figs. 4, 14) angulate, roughly L-shaped, with deep, pointed indentation in inner angle, in ventral view (Figs. 3, 13) much wider than long, anterior margin evenly arched, posterior margin concave with sublateral stepped process.

Type material.—The lectotype, which is apparently the only remaining male of Psiolopa aeneonigra Loew, is here designated to preserve stability and make more universal the use of this name, is labeled “Tex-as Lefr. [green; handwritten] Loew Coll./aeneonigra m. [handwritten]/Type 11139 [red; number handwritten]/Cressonomyia aeneonigra (Lw.) WWirth/61 [black sub-
margin; all except “WWirth” handwritten/LECTOTYPE δ Psiolopa aeneonigra Loew By Mathis & Zatwarnicki [handwritten except for “LECTOTYPE” and “By”’; black sub-border].” The lectotype is directly pinned, is in good condition (abdomen removed and dissected, parts in an attached microvial), and is deposited in the MCZ (11139).

The lectotype female of Psiolopa fulvipennis Hine, here designated to preserve stability and make more universal the use of this name, is labeled “Cameron, L[ouisiana] Aug. 14–28, 1903/TYPE/Psilopa fulvipennis Hine [handwritten; black border]/LECTOTYPE Psiolopa fulvipennis Hine ♀ By Mathis and Zatwarnicki [handwritten except for “LECTOTYPE” and “By”’; black sub-border].” The lectotype is double mounted (glued to a narrow, paper point), is in excellent condition, and is deposited in OHSU. There are two female paralectotypes that bear the same locality label as the lectotype.

Other specimens examined.—Nearctic: UNITED STATES. FLORIDA. Levy: Cedar Key, 21 Feb 1990, W. H. Pierce (1♂; USNM). Orange: Orlando, 7 Feb 1918, J. M. Aldrich (1♂; ANSP).

LOUISIANA. Orleans: New Orleans, 28 Mar 1905 (3♀♀; 3♀♂; ANSP).


MASSACHUSETTS. Barnstable: Falmouth (41°33’N, 70°37’W), 9 Aug 1952, A. H. Sturtevant (1♀; USNM), Sandwich (41°45’N, 70°29’W), 22 Jun 1924, A. H. Sturtevant (1♀; USNM), Woods Hole (41°31’N, 70°41’W), 5–21 Jul 1922, A. H. Sturtevant (5♀; USNM), Bristol: New Bedford (41°38’N, 70°56’W), 28 Oct 1922, A. H. Sturtevant (2♀; USNM).
Montauk, Long Island. 17 Aug 1946, L. D. Beamer (1♀; USNM).

NORTH CAROLINA. Hyde: Lake Landing (35°28'N, 76°04'W), 13 Nov 1939, J. E. Graf (1♀; USNM).

VIRGINIA. King George: Mathias Point (38°24'N, 77°03'W), 4 Aug 1913, R. C. Shannon (1♀; USNM).

Distribution (Fig. 15).—Nearctic: United States (Florida, Louisiana, Maryland, Massachusetts, North Carolina, New Jersey, New York, Texas, Virginia). The distribu-
tion of this species is primarily along the coastal plain of the eastern United States as far north as Massachusetts. Although there are a few records from freshwater sites, most localities are predominantly brackish-water habitats.

Remarks.—Although the base of the wing is slightly darkened, as in species of Cressonomyia, there are no other synapomorphic features of this species that indicate its relationships with that genus.

Since Cresson (1942), the generic placement of this species has been confused. Cresson (1942: 125, 127) treated it twice, first under Psilopa (key and listing) and then again in his key to the species of Plagiopsis (= Cressonomyia Arnaud). In the latter key, however, Cresson continued to cite the species as "Psilopa aeneo-nigra Loew." Apparently Wirth (1965) noted Cresson’s double usage and decided that the species should be cataloged under Cressonomyia, where it has remained since. As part of this study, we examined characters of the external morphology and male terminalia. Based on these observations, this species was returned to Psilopa. We also discovered that there are two species (this species and the new species described below), represented among the specimens previously identified as this species.

**Psilopa loewi** Mathis and Zatwarnicki, new species
(Figs. 16–30)

Description.—Moderately small shore flies, body length 2.25–2.85 mm; largely black.

Head: Frons sparsely microtomentose, subopaque to subshiny. Antenna yellow except for blackish apicodorsal portion of 1st flagellomere; arista bearing 6 dorsal rays,
rarely 5 (probably representing a ray that was broken off). Face moderately densely microtomentose, mostly flat, bearing 1 large, ventral, cruciate seta.

Thorax: Mesonotum sparsely microtomentose, subshiny; scutellum trapezoidal posterior margin truncate. Wing hyaline, only stem base blackish; costal vein ratio 0.87–0.90; M vein ratio 0.68–0.70. Knob of halter white to pale yellow, stem brownish. Legs black except for apex of tibiae and tarsi; apical tarsomere brownish black to black.

Abdomen: Tergites more sparsely micro-
tomentose than mesonotum, subshiny to shiny black. Male terminalia (Figs. 16–29): Epandrium in posterior view (Fig. 16) broadly U-shaped, rounded, in lateral view (Fig. 17) considerably wider ventrolaterally than dorsally; cerci in posterior view (Fig. 16) almost rodlike, less curved ventrally, lateral margins rounded, medial margin very shallow; presurstylus in posterior view (Fig. 16) deeply incised mediadorsally, forming a narrow, parallel sided base that expands abruptly on apical half to wide apex that bears row of short, stout, peglike setulae along ⅔ length; postsurstylus in lateral view (Figs. 19, 25) longer than wide, rounded angulate, apical ½ bearing setulae, very gradually tapered, almost parallel sided; pregonite in lateral view (Figs. 19, 27) L-shaped, arm bearing 3 apical setae wider than basal, slender arm; aedeagus in lateral view (Figs. 19, 21) wide basally, curved and narrowed to slender, parallel sided apex; phallapodeme in lateral view (Figs. 19, 21) with keel well developed, broadly and asymmetrically extended; subepandrial plate in ventral view (Figs. 22) deeply incised medially and with smaller incision basolaterally, extended laterally as a narrowed
process: hypandrium in lateral view (Fig. 29) L-shaped, extended arm tapered to more narrow process, in ventral view (Figs. 28) broadly U-shaped with anterior margin projected medially and with symmetrical, shallow, lateral pointed projection anterolaterally.

Type material.—The holotype male is labeled “USA. NJ. Ocean: Tuckerton (10 km N: 39°41.3’N, 74°21.6’W), 26 Sep 2003,” D. & W. N. Mathis/USNM ENT 00201689 [plastic bar code label]/HOLOTYPE ♂ Psilopa loewi W.N. Mathis & T. Zatwarnicki USNM [red: species name, gender symbol, and “& T. Zatwarnicki” handwriten].” The holotype is double mounted (minuten in a block of plastic), is in excellent condition, and is deposited in the USNM. Thirty-four paratypes (16♂, 18♀; USNM) bear the same label data as the holotype. Other paratypes are as follows: United States.


Distribution (Fig. 30).—Nearctic: USA (Delaware, Georgia, Massachusetts, North Carolina, New Jersey).

Etymology.—The species epithet, loewi, is a genitive patronym to recognize the pioneering research and publications of Hermann Loew on North American Ephydridae.
Remarks.—This species is very similar to *P. aeneonigra*, especially externally, and until now, *P. loewi* was often misidentified. Structures of the male terminalia, however, differ markedly, and after segregation based on genitalic characters, we discovered external characters that will distinguish these two species (shape of scutellum and color of apical tarsomere).

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LITERATURE CITED


A NEW HOLCOCERA CLEMENS (LEPIDOPTERA: GELECHIOIDEA: COLEOPHORIDAE) FROM MOUNTAINOUS SOUTHEASTERN ARIZONA

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Abstract.—Holcocera fergusoni. new species, is described from two high-altitudinal collecting sites in the Santa Catalina Mountains and the Chiricahua Mountains in southeastern Arizona. A photograph of the holotype and illustrations of wing venation and male and female genitalia are provided.

Key Words: Holcocerini, microlepidoptera, North America, taxonomy

Hodges (1983) treated 109 species of North American Blastobasinae. Later Adamski and Hodges (1996) discovered 61 synonomies, reducing the total number of Blastobasinae by more than one half. Although this taxon is little known, it is one of the most commonly collected gelechioid groups at light. Moreover, I have observed many undescribed species in institutional and private collections indicating that the Blastobasinae could be a much more speciose group than previously considered.

The monophyly of the Blastobasinae has been collaborated from studies by Adamski and Brown (1989) and Hodges (1998). Generally, species are dull gray or brown with few, if any, diagnostic wing patterns, making identification difficult unless the genitalia are examined. I follow the current phylogenetic classification of the Gelechioidea proposed by Hodges (1998). In this work, the Blastobasinae (sensu Adamski and Brown 1989) are treated as a subfamily within the Coleophoridae. Thus, the Blastobasinae are subdivided into two clades, the Holcocerini and the Blastobasini.

The North American Holcocerini include three genera, Asaphocrita Meyrick 1931, Holcocera Clemens 1863, and Calosina Dietz 1910. It contains many of the largest moths in the subfamily yet it is the least speciose of the two tribes within the Blastobasinae. Holcocerini can be recognized by the following features: ring support at the base of the aedeagus, anterior margin of the eighth sternum medially emarginate in female, eighth sternum setose in female, and inception of ductus seminalis anterior from posterior margin of seventh sternum. Additional plesiomorphic characters found in Holcocerini that separate them from Blastobasini are listed in Adamski (2002).

About a month before Douglas C. Ferguson’s untimely death he gave me six specimens of an undescribed Holcocera that he collected at a high elevation collecting site in the Santa Catalina Mountains in southeastern Arizona. Initially, this species was to be included in a future fascicle on the Blastobasinae in the Moths of America north of Mexico series published by the Wedge Entomological Research Foundation. However, after Doug Ferguson’s death, I was compelled to describe the new moth in a separate paper to honor the life of a fellow colleague and friend.
Kornerup and Wanscher (1978) was used as a color standard for descriptions of the adult vestiture. Male and female genitalia were dissected as described by Clarke (1941), except mercurochrome and chlorazol black were used as stains. Pinned specimens were examined with dissecting and compound microscopes. Measurements were made with a calibrated ocular micrometer.

**Holcocera fergusoni** Adamski, new species
(Figs. 1–4)

**Diagnosis.**—*Holcocera fergusoni* is closest to *Holcocera zonae* Adamski (2002) of Costa Rica by sharing a ventral part of valva with an enlarged proximal flange, and a stout apical process. However, *Holcocera fergusoni* differs from the latter species having a darker forewing pattern, an apicoventral part of the proximal flange that is more lobelike, and ventral margin of valva that is reflexed beyond ventral margin of the proximal flange.

**Description.**—**Head:** Vertex and frontoclypeus with narrow gray scales, each tipped with pale gray; outer surface of labial palpus with gray scales tipped with pale gray intermixed with dark gray scales, and pale gray scales to near distal apices of segments I and II; inner surface similar but paler; scape of antenna with dark gray scales tipped with pale gray intermixed with gray scales; flagellum pale gray or, basal 6–10 flagellomeres dark gray, remaining distal flagellomeres pale gray; first flagellomere deeply notched in male, unmodified in female; proboscis with gray scales tipped with pale gray.

**Thorax:** Mesonotum and tegula mostly gray intermixed with pale gray scales, gradually intermixed with pale gray scales distally. Legs with dark gray scales (some tipped with pale gray) intermixed with pale gray scales near midsegments and distal apices of all segments and tarsomeres. Forewing (Figs. 1–2) length 11.0–12.1 mm (n = 9), with gray scales tipped with white intermixed with gray scales (some tipped with pale gray or white) and dark gray scales; 4 dark gray or gray, transverse, jagged streaks present: one near midlength, one near distal end of cell, one subapical,
and one submarginal; one large dark gray spot present near distal end of cell; fringe pale gray, tipped with white; undersurface pale brownish gray; venation with chorda present as a slight fold within cell; M₁ straight; M₂ slightly arched toward M₁; M₃ and CuA₁ approximate basally, slightly divergent from base; CuA₁ and CuA₂ nearly parallel basally, slightly divergent to margin. Hindwing: Pale gray; frenulum with an acanthus in male, 3 acanthae in female; venation (Fig. 2), with Sc + R₁ straight, anastomosed basally with medius; chorda present as a slight fold within cell; M₂ broadly arched toward M₁ beyond midlength; M₃ and CuA₁ branched beyond posterodistal angle of cell; CuA₁ and CuA₂ nearly parallel.

Abdomen: Dorsum with pale gray scales intermixed with irregular rows of spinelike
setae on terga 1–7 in male and terga 1–6 in female; venter pale gray.

Male genitalia (Fig. 3): Uncus setose, slightly elongate, conical; gnathos widened medially, with narrowed arms free; vinculum narrow, upturned along posteroventral margin; valva divided, digitate costal part fused with widened lower part; lower part widened basally, gradually narrowed distally into a broadened, inwardly curved and short spikelike process; margin of ventral part of valva broadly upturned, overlying ventral part of enlarged proximal flange; proximal flange acutely angled dorsally, extending ventrally to the base of an elongate, rounded, slightly upturned lobe; juxta elongate, widely emarginate laterally, fused at point of overlap with sclerite of aedeagus and base of anellus; aedeagus elongate, acutely curved basally; sclerite of aedeagus with a basal ring support; anellus elongate, conical, with many microsetae.

Female genitalia (Fig. 4): Ovipositor telescopic, with three membranous subdivisions: anterior margin of eighth sternum with a deep notchlike emargination extending posteriorly to about midlength; basal third of anterior apophysis fused along posterolateral margin of eighth sternum, laterally enlarged, forming a flattened winglike flange extending from lateral margin of posterior third; medioanterior part of eighth tergum with a short linear invagination; eighth sternum setose from posterior margin to apex of notch; ostium bursae near anterior end of eighth sternum; antrum membranous, slightly elongate; ductus bursae elongate; inception of ductus seminalis anterior to subtrapizoidal seventh segment and posteriad a slightly constricted area of ductus bursae; corpus bursae slightly elongate, with a platelike signum near anterior end.


Paratypes (2 ♂, 6 ♀): 2 ♀, same data as holotype; 1 ♀, same data as holotype except, “15 July 1998”; “♀ USNM Genitalia...
“♂ USNM Genitalia Slide by D. Adamski No. 80099”; “♀ USNM Wing Slide by D. Adamski No. 80458”; “Holcocera sp 3. Adamski/Brown’89. Voucher”; “♂ USNM Genitalia Slide by D. Adamski No. 80100”; 1 ♀, same label data as above except, “29 July”;
“♀ USNM Genitalia Slide by D. Adamski No. 80098”; “♀ USNM Wing Slide by D. Adamski No. 80459”; “Holcocera sp 3. Adamski/Brown’89. Voucher”
All paratypes in USNM.

Etymology.—This species is named in honor of the late Douglas C. Ferguson of the Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington, D.C., for his encouragement of my studies of Gelechioidea, especially Blastobasinae.

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LITERATURE CITED

IMMATURE StAGES AND LIFE CYCLES OF FIVE SPECIES OF OZOPHORA UHLER (HEMIPTERA: RHYPAROCROMIDAE: OZOPHORINI) ASSOCIATED WITH FIGS IN MEXICO

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Abstract.—Descriptions and illustrations of adult and immature stages of Ozophora atropictoides Slater and Baranowsky, O. baranowskii Slater and O’Donnell, O. concava Distant, O. consanguinea Distant, and O. maculata Slater and O’Donnell are presented. Biology, duration of life cycle, and host plants are mentioned for each species. A key for fifth instar nymphs is included. These species seem to be feeding only on fig seeds. They occupy different micro-habitats so it seems that there is no competition for their feeding resource. Ozophora consanguinea is the only arboreal species, although it can also be found near the base of the trunk. Ozophora concava is mainly found near the base of the trunk. Ozophora atropictoides, O. baranowskii, and O. maculata are all terrestrial species and are found mainly on the leaf litter around fig trees. Ozophora baranowskii is usually the most abundant species, and O. atropictoides and O. maculata are present when O. baranowskii is absent or is found in low numbers.

Key Words: Ozophora, Ficus, Lygaeoidea, Mexico, Rhyparochromidae

The genus Ozophora Uhler, is one of the most diverse lygaeoid genera in the tropics. It is known only from the Western Hemisphere. Slater and Baranowski published numerous papers on this genus. Slater (1983) described 13 new species from Panama. Baranowski (1987) described a new species, O. slateri, from Costa Rica, including descriptions of immature instars, and mentioned that this species was found in leaf litter of Ficus spp. Slater (1986) suggested that this genus is very diverse in the Neotropics and mentioned that the Mexican fauna will be large but is still unknown; he described two new species: Ozophora vazquezae from Mexico, Honduras, and Guatemala, and O. nana from Quintana Roo, Mexico. Slater (1988) studied the species of Ozophorini from western United States and Baja California. Probably the most important work is by Slater (1995), who described 15 new species of Ozophora from Central and South America, and included a key to the known species from the Neotropical mainland. Rodriguez (1997) studied the natural history of O. baranowskii, and O. maculata in Costa Rica, and mentioned that they were found on Ficus pallifolia HBK.

Of the 94 species described, there are only descriptions of immature stages for 14 species, with just a few illustrations. Furthermore, most of the species described have been collected only using black light. Slater and Baranowski (1978) named a new species of bromeliad lygaeid, Ozophora hoehenbergia, including all nymphal instars; Slater and Baranowski (1979) described nymphs of three new species of Ozophora from Jamaica, O. josephina associated with
figs and *O. hirsuta* and *O. longirostris*. Slater and O’Donnell (1979) in their analysis of the *O. laticephala* complex, described four nymphal instars of *O. laticephala*. In the revision of *Ozophora* of Florida, Slater and Baranowski (1983), described nymphs of several species, *O. burmeisteri*, *O. di-varicata*, *O. gigia*, *O. picturata*, and *O. ri-notata*; Baranowski (1987) described the instars of *O. slateri*, from Costa Rica, and Slater (1987) described the nymphs of *O. agilis*, *O. quinquemaculata subtilis*, and *O. umbrosa*. Only illustrations for fifth instar nymphs of *O. josephina* and *O. laticephala* have been made. Only Slater and Baranowski (1983) presented a key to the nymphs of six species found in Florida. None of the species included in this key are subject of the present study.

Although it is well known that several species of *Ozophora* are associated with figs, there are records for only 12 species feeding on *Ficus* spp. and almost nothing is known about their immature stages and their biology.

In this study we include the descriptios and illustrations of all stages in the life cycle of *Ozophora atropictoides*, *O. baranowskii*, *O. concava*, *O. consanguinea*, and *O. maculata*. Host plants and most of the biological information were obtained from two reserves in the state of Veracruz, Mexico, although we also include information from a study of the lygaeid fauna associated with figs in other states on the Gulf Coast of Mexico. We also provide a key to fifth instar nymphs of these five species

**Materials and methods**

Biological information was obtained mainly from two biological research stations. Estacion Biologica La Mancha is situated at sea level on the coast of Veracruz, 30 km NE of Ciudad Cardel (9°22'40"W, 19°35'23"N); Estacion Biologica Los Tuxtlas (94°40'W, and 18°00'N), varies from sea level to around 400 m in elevation, and it is also situated in the state of Veracruz, but 150 km south. The type of vegetation in the first area is mainly medium tropical dry forest, and Los Tuxtlas is dominated by high tropical rain forest.

In these two areas, around 200 fig trees that produced fruit at different times were sampled, with visits made every month during 2001 and 2002. The ground area covered by the crown of each tree, including leaf litter, buttresses, and aerial roots, was checked. Top parts of each tree were searched by climbing the tree with the use of ropes, or by free-hand using their aerial root systems. Bugs were collected by using an aspirator or by cutting small branches bearing fruits. Insects were kept alive and put into plastic containers (9 × 8 cm) covered with muslin cloth to avoid condensation. A dry fig leaf and an opened fruit were put in each container as well as a small damp cotton ball; these were changed every three days. Containers were checked daily for the presence of eggs. Individuals were kept under laboratory conditions at about 20° C and 70% RH. Individuals fixed in 70% alcohol were used for illustrations and descriptions; measurements are given in mm ± 1DS.

Voucher specimens have been deposited at the following collections: Coleccion Entomologica del Instituto de Ecologia, A.C. Xalapa, Veracruz, Mexico (IEXA), Coleccion Nacional de Insectos, Universidad Nacional Autonoma de Mexico (CNIN), and The Natural History Museum, London (NHM).

**Results**

*Ozophora atropictoides*

Slater and Baranowski

(Figs. 1A–G)

Egg.—Elongated, with posterior end slightly narrow and anterior end slightly flattened. Length, 0.91 ± 0.01 mm; width, 0.36 ± 0.06 mm. Yellow white when laid, turning reddish later. Corium with a ornamental pattern with elevated, spots distributed mainly on anterior pole. Operculum with three to four micropylar processes.
First instar.—Body long, antenna slightly longer than body length. Head, pronotum, mesonotum, antennal segments II and III, and labial segment I, brown. Eyes red; antennal segments I and IV yellow white with bases brown, union between antennal segments III–IV reddish; labial segments III and IV, and legs pale yellow. Metanotum and thoracic pleura pale brown with a mesial yellow area. Abdominal segments I to III pale yellow; rest of abdomen red with small pale yellow areas. Dorsal and ventral surface of body with erect hairs, more abundant on abdominal venter. Labium reaching base of abdominal sternite II. Scent gland openings not apparent. Mea-
surements (n = 10): Body length 1.11 ± 0.15; head length 0.31 ± 0.06; width across eyes 0.32 ± 0.01; interocular distance 0.21 ± 0.01; postocular distance 0.08 ± 0.02; antennal segments: I 0.16 ± 0.01, II 0.24 ± 0.02, III 0.25 ± 0.0, IV 0.4 ± 0; labial segments: I 0.22 ± 0, II 0.15 ± 0. III 0.17 ± 0. IV 0.16 ± 0.1; pronotum length 0.12 ± 0, width across humeral angles 0.27 ± 0, width across anterior margin 0.27 ± 0; hind leg: femur length 0.32 ± 0; tibia length 0.37 ± 0; tarsus length: I 0.13 ± 0.02, II 0.17 ± 0.

Second instar.—Slightly pyriform, antenna less than body length. Head and pronotum dark brown, eyes reddish-brown. Antennal segment I and legs grayish yellow. Mesonotum brown with a pale yellow area on each side of middle line near posterior margin. Metanotum mostly pale yellow, except some brown semi-triangular maculae near lateral margin. Abdominal segment I pale brown with mesial area pale yellow. Abdominal segment II and anterior half of segment III pale brown. Rest of abdomen pale yellow, except for some pale brown elongate maculae situated on lateral margins and some semi-rectangular maculae situated mesially on segments IV and V. Scent gland openings III–IV brown with border of openings dark brown, openings of segments IV–V and V–VI faintly apparent and reduced to a small pale brown band. Eyes prominent, labium reaching metacoxae; other characteristics as in first instar. Measurements (n = 3): Body length 1.16 ± 0.14; head length 0.34 ± 0.03; width across eyes 0.42 ± 0; interocular distance 0.26 ± 0.01; postocular distance 0.08 ± 0.07; antennal segments: I 0.18 ± 0.02, II 0.37 ± 0, III 0.37 ± 0, IV 0.47 ± 0; labial segments: I 0.28 ± 0.03, II 0.26 ± 0.01, III 0.22 ± 0.01, IV 0.2 ± 0; pronotum length 0.17 ± 0, width across humeral angles 0.36 ± 0.01; width across anterior margin 0.32 ± 0.03; hind leg: femur length 0.46 ± 0.01; tibia length 0.55 ± 0; tarsus length: I 0.17 ± 0, II 0.18 ± 0.3.

Third instar.—Pyiform, with maximum width across abdominal segment III. Head dark brown; eyes reddish-brown, antennal segments I and II pale brown with distal ends yellow white; segment III dark brown; segment IV with a white annulus near base, base and distal half brown. Pronotum brown with lateral emarginated margins pale brown, middle line and two small maculae situated near posterior margin pale yellow. Meso- and metanota pale yellow with pale brown spots near lateral margins, near middle line, and some others situated between them. Femora and tibiae pale brown, femora with distal ends slightly paler, tarsi grayish yellow. Abdomen similar to second instar, although scent gland openings more apparent. Abdominal venter pale yellow, with some maculae pale brown situated generally close to lateral margins. Fore femur with a row of spines on internal margin. Other characteristics as in second instar. Measurements (n = 10): Body length 2.4 ± 0.28; head length 0.51 ± 0.01, width across eyes 0.56 ± 0.05; interocular distance 0.32 ± 0.03; postocular distance 0.1 ± 0; antennal segments: I 0.31 ± 0.08, II 0.62 ± 0.14, III 0.58 ± 0.09, IV 0.62 ± 0; labial segments: I 0.46 ± 0.01, II 0.4 ± 0.07, III 0.37 ± 0.01, IV 0.22 ± 0.03; pronotum length 0.32 ± 0.07, width across humeral angles 0.6 ± 0, width across anterior margin 0.43 ± 0.02; hind leg: femur length 0.82 ± 0.17; tibia length 0.96 ± 0.2; tarsus length: I 0.27 ± 0.07, II 0.25 ± 0.07.

Fourth instar.—Elongate, with antenna longer than body length. Head as in third instar. Pronotum dark brown with semicircular pale yellow macula on anterior and posterior margins and on each side of middle line. Most of meso- and metanota pale yellow, except for pale brown bands on each side of middle line and apex of wing pads also pale brown. Abdominal segments I to III dark brown, sometimes with a pale yellow area on mesial region of segment I. Union between connexivum and abdominal segments red. Abdominal sternites II, III, anterior half of IV, posterior half of VI, VII, and VIII brown; rest of abdominal venter
pale yellow. Labium reaching metacoxae. Lateral margins of pro- and mesonota emarginated and with serrated margins. Mesothoracic wing pads almost covering metanotum. Measurements (n = 3): Body length 3.05 ± 0.49; head length 0.7 ± 0.07, width across eyes 0.73 ± 0.05; interocular distance 0.38 ± 0.05; postocular distance 0.07 ± 0; antennal segments: I 0.46 ± 0.05, II 0.95 ± 0.15, III 0.9 ± 0.14, IV 0.99 ± 0.25; labial segments: I 0.47 ± 0.03, II 0.41 ± 0.08, III 0.34 ± 0.03, IV 0.3 ± 0; pronotum length 0.45 ± 0.07, width across humeral angles 0.77 ± 0, width across anterior margin 0.53 ± 0.09; hind leg: femur length 1.16 ± 0.19; tibia length 1.45 ± 0.35; tarsus length: I 0.4 ± 0.07, II 0.25 ± 0.

Fifth instar.—Elongate, maximum width across abdominal segment III, apex of abdomen slightly pointed. Very similar to fourth instar, although femora and tarsi more yellow and red areas of abdomen almost always not visible; in general meso-, and metanota and abdomen becoming lighter. Meso- and metathoracic wing pads reach over anterior half of abdominal segment III. Spines of fore femur more evident and numerous (between 5 or 6). Measurements (n = 10): Body length 3.9 ± 0.42; head length 0.68 ± 0.03, width across eyes 0.74 ± 0.03; interocular distance 0.4 ± 0.03; postocular distance 0.2 ± 0; antennal segments: I 0.46 ± 0.05, II 1.05 ± 0.1, III 0.98 ± 0.1, IV 1.05 ± 0.07; labial segments: I 0.48 ± 0.02, II 0.55 ± 0, III 0.37 ± 0, IV 0.3 ± 0; pronotum length 0.48 ± 0.02, width across humeral angles 0.78 ± 0.04, width across anterior margin 0.52 ± 0.14; scutellum length 0.84 ± 0.05, width 0.54 ± 0.1; hind leg: femur length 1.29 ± 0.05, tibia length 1.52 ± 0.1, tarsus length: I 0.46 ± 0.12, II 0.27 ± 0.1.

Adult.—Head and anterior pronotal lobe dark reddish brown. Anterior and lateral margins of pronotum, and posterior prono- tal lobe pale yellow. Scutellum brown, with two yellow maculae near distal third not reaching base of scutellum. Hemelytron pale yellow, with a dark brown macula situated between radial vein and anterior margin at level of claval commissure, a second macula at apex of corium, membrane smoky. Legs and antennal segments I and II pale yellow. Antennal segment III yellow, but distal end dark brown, antennal segment IV with a conspicuous subbasal white annulus. Dark brown punctures very small and disperse. Body almost glabrous dorsally. Head slightly declivent. Eyes large, sessile, occupying most of lateral surface of head. Lateral margins of pronotum carinated; calli granulated. Lateral margins of corium concave at midpoint. Metathoracic scent gland short, bending slightly posteriorly, evaporative area occupying two thirds of metapleuron. Fore femur armed with three large spines and 4–5 smaller and thinner spines. Labium reaching metacoxae.

Male: Measurements (n = 10): Body length 5.15 ± 0.92; head length 0.8 ± 0.07, width across eyes 0.87 ± 0.1; interocular distance 0.38 ± 0.09; interocellar distance 0.21 ± 0.02; postocular distance 0.08 ± 0.02; antennal segments: I 0.62 ± 0.1, II 1.6 ± 0.14, III 1.32 ± 0.1, IV 1.14 ± 0.2; labial segments: I 0.7 ± 0.28, II 0.7 ± 0.2, III 0.68 ± 0.37, IV 0.35 ± 0.07; pronotum length 0.92 ± 0.17, width across humeral angles 1.5 ± 0, width across anterior margin 0.66 ± 0.15; scutellum length 0.78 ± 0.25, width 0.75 ± 0.14; hind leg: femur length 2 ± 0.28, tibia length 2.25 ± 0.35, tarsus length: I 0.62 ± 0.03, II 0.3 ± 0; III 0.4 ± 0.

Female: Measurements (n = 10): Body length 5.98 ± 0.25; head length 0.77 ± 0.03, width across eyes 0.88 ± 0.04; interocular distance 0.38 ± 0.02; interocellar distance 0.25 ± 0; postocular distance 0.08 ± 0.02; antennal segments: I 0.55 ± 0.1, II 1.45 ± 0.1, III 1.22 ± 0.03, IV 1.2 ± 0; labial segments: I 0.5 ± 0.07, II 0.59 ± 0.05, III 0.41 ± 0.01, IV 0.31 ± 0.01; pronotum length 0.87 ± 0.02, width across humeral angles 1.29 ± 0.02, width across anterior margin 0.6 ± 0; scutellum length 0.7 ± 0.07, width 0.76 ± 0.05; hind leg: femur length 1.72 ± 0.03, tibia length 2.05 ±
0.07, tarsus length: I 0.62 ± 0.05, II 0.3 ± 0; III 0.35 ± 0.

Biology.—Adults of this species were found only in the area of Los Tuxtlas, and were common on herbs that grow below the crown of Ficus insipida Willd., F. maxima Mill. and F. yoponensis Desv. Nymphs were more commonly found in the leaf litter. Most of the time, adults and nymphs run solitary and were found associated with O. baranowskii. The life cycle took around 65 days. The eggs were white when laid. Then changed to amber and finally after 9 days became reddish when first instar nymphs appeared. The second instar also took 9 days to develop and 11 days later molted to the third instar; the fourth instar emerged only after 7 days, and during this stage nymphs were more active; the fifth instar appeared 15 days later, and they became adults after 14 days. Nymphs of fifth instar and adults were very active.

Ozophora baranowskii
Slater and O’Donnell
(Figs. 2A–G)

Egg.—Oval, elongated, posterior pole slightly narrowed and pointed. Anterior pole rounded: length 0.8 ± 0.04 mm, width 0.31 ± 0.02 mm. Operculum with four small micropylar processes at middle; corium covered by small ornamental patterns without any arrangement. After four days, eyes appear as red spots, and antennae and margins of abdomen also show as red markings.

First instar.—Elongated, with maximum width across mesonotum. Head and pronotum grayish yellow. Eyes bright red. Antennal segments I to III pale brown with their proximal and distal ends yellow white, segment IV with base white, basal half pale brown and distal half yellow white. Labial segment I pale brown, rest grayish yellow. Meso-, and metanota, and thoracic pleura dark brown; mesopleuron sometimes with a small red band near junction of mesonotum. Legs grayish yellow. Abdominal segments I to half of IV, and segments VI to IX yellow, variegated with light bright red spots. Antennal segment I smallest, II and III similar in size, and segment IV longest. Tylus longer than juga; labium exceeding metacoxae. Dorsal surface of body covered with long hairs, more abundant near middle line. Abdominal venter with some hairs on middle line. Scent gland openings just visible on segments IV–V. Measurements (n = 10): Body length 0.91 ± 0.04; head length 0.24 ± 0.01, width across eyes 0.33 ± 0.01; interocular distance 0.2 ± 0.01; postocular distance 0.02 ± 0.008; antennal segments: I 0.09 ± 0.02, II 0.14 ± 0.02, III 0.16 ± 0.01, IV 0.2 ± 0.03; labial segments: I 0.18 ± 0.01, II 0.15 ± 0.01, III 0.15 ± 0.01, IV 0.15 ± 0.02; pronotum length 0.14 ± 0.01, width across humeral angles 0.33 ± 0.1, width across anterior margin 0.28 ± 0.01; hind leg: femur length 0.2 ± 0.01, tibia length 0.3 ± 0.01, tarsus length: I 0.08 ± 0.11, II 0.11 ± 0.01.

Second instar.—Slightly pyriform, maximum width across abdominal segment IV. Head, pro- and mesonotum pale brown with middle line and suture yellow. Eyes red. Antennal segments I to III as in first instar, although segment IV with distal half also pale brown. Metanotum mostly yellow, except a small brown band near base. Propleuron sometimes surrounded by a red line. Abdominal dorsum variegated with irregular red and yellow areas, forming bands on segments II and III. A rectangular gray macula on middle area of segments II and III. Scent gland openings visible between segments III–IV, IV–V, and V–VI, as small brown areas which decrease in size from one on segments III–IV, to one on segments V–VI. Abdominal venter yellow. Long setae covering body disappear, only very small setae present. Measurements (n = 10): Body length 1.68 ± 0.15; head length 0.35 ± 0.02, width across eyes 0.4 ± 0.03; interocular distance 0.27 ± 0.02; postocular distance 0.06 ± 0.06; antennal segments: I 0.13 ± 0.02, II 0.24 ± 0.03, III 0.26 ± 0.02, IV 0.36 ± 0.03; labial segments: I 0.25 ± 0.03, II 0.24 ± 0.02, III 0.18 ± 0.01, IV 0.17 ± 0.01; pronotum length 0.19

± 0.03, width across humeral angles 0.45 ± 0.05, width across anterior margin 0.36 ± 0.05; hind leg: femur length 0.38 ± 0.05, tibia length 0.43 ± 0.04, tarsus length: I 0.12 ± 0.02, II 0.15 ± 0.01.

Third instar.—Sightly pyriform, maximum width across abdominal segment III. Head, pro- and mesonota pale brown; pronotum sometimes with humeral angles white; mesonotum with three or four white maculae near base. Antennal segments I and II pale brown with proximal and distal ends white; segments III and IV dark brown with base white. Labial segments I to III pale gray, most of segment IV dark brown, especially apex. Most of metanotum white.
except for a brown line near base. Thoracic pleura brown, propleuron sometimes surrounded by red lines; meso- and metapleura with two white maculae on middle area. Femora pale brown with distal ends white, tibiae and tarsi pale grayish yellow. Abdomen variegated with red and yellow areas; red bands at least present on borders of segments II to VII. Grayish maculae on segments II and III becommg more apparent and corners becoming rounded. Two more grayish maculae appear mesially on segments IV and V. Scent gland openings more apparent and coloration changing to dark brown. Labium reaching metacoxae. Measurements (n = 10): Body length 2.3 ± 0.12; head length 0.41 ± 0.05, width across eyes 0.54 ± 0.03; interocular distance 0.36 ± 0.04; postocular distance 0.07 ± 0.06; antennal segments: I 0.18 ± 0.04, II 0.33 ± 0.04, III 0.35 ± 0.02, IV 0.45 ± 0.04; labial segments: I 0.33 ± 0.03, II 0.32 ± 0.03, III 0.26 ± 0.03, IV 0.19 ± 0.02; pronotum length 0.2 ± 0.04, width across humeral angles 0.62 ± 0.03, width across anterior margin 0.46 ± 0.04; hind leg: femur length 0.55 ± 0.03, tibia length 0.62 ± 0.05, tarsus length: I 0.19 ± 0.02, II 0.18 ± 0.01.

Fourth instar.—Oval, slightly elongated, maximum width across abdominal segment II. Head brown; antennal segments I and II yellowish brown, segments III and IV dark brown; labial segments I and II yellowish brown, III yellow, and IV dark brown. Antennal segment I smallest; other three of similar size. Pronotum dark brown, sometimes with a pair of yellowish maculae on each side of middle line. Mesonotum brown, with five or six round yellow maculae sometimes joined. Metanotum brown and faintly visible, with one yellow macula on each side of middle line. Coxae whitish; femora and tibiae brown with proximal and distal ends white; tarsi I whitish, and tarsi II pale brown. Abdomen with red, yellow, and gray well defined. Red pattern generally begins near lateral margins of each segment, and sometimes extends to anterior and/or posterior borders. Gray patterns generally occur on middle region of segments II–III, IV, V, and on each side of middle line on segments VI and VII. Yellow patterns form divisions between segments. Abdominal venter with brownish-gray patterns with some red markings, divisions between sternites yellow. Cephalic venter with two furrows slightly marked, running from base of antennae to posterior border of head. Labium reaching procoxae. Lateral margins of pro- and mesonota expanded. Fore femur with four or five spines on external face. Wing pads covering metanotum. Measurements (n = 10): Body length 3.6 ± 0.25; head length 0.52 ± 0.04, width across eyes 0.7 ± 0.01; interocular distance 0.45 ± 0.01; postocular distance 0.08 ± 0.08; antennal segments: I 0.22 ± 0.001, II 0.51 ± 0.02, III 0.53 ± 0.02, IV 0.62 ± 0.02; labial segments: I 0.45 ± 0.04, II 0.44 ± 0.05, III 0.34 ± 0.02, IV 0.27 ± 0.04; pronotum length 0.44 ± 0.01, width across humeral angles 0.86 ± 0.03, width across anterior margin 0.58 ± 0.02; scutellum length 0.36 ± 0.02, width 0.57 ± 0.03; hind leg: femur length 0.76 ± 0.04, tibia length 0.88 ± 0.05, tarsus length: I 0.26 ± 0.01, II 0.21 ± 0.01.

Fifth instar.—Elongated, with maximum width across abdominal segment II. Head dark brown with a few yellow areas near its base. Ocelli sometimes apparent as two red spots over molting suture. Femora brown with distal ends yellow; tibiae and tarsi grayish yellow. Pronotum dark brown with two or four yellow maculae near base. Mesonotum and metanotum with well-defined yellow and brown patterns; apices of wing pads dark brown. White areas of meso- and metapleura bigger and more apparent. Abdomen with similar coloration as fourth instar, although, red areas reduced in size. Abdominal venter generally grayish, but with its lateral margins reddish. Measurements (n = 10): Body length 3.94 ± 0.16; head length 0.5 ± 0.05, width across eyes 0.89 ± 0.03; interocular distance 0.53 ± 0.04; interocellar distance 0.23 ± 0.23;
postocular distance 0.04 ± 0.04; antennal segments: I 0.29 ± 0.01, II 0.75 ± 0.03, III 0.75 ± 0.04, IV 0.79 ± 0.05; labial segments: I 0.59 ± 0.05, II 0.56 ± 0.05, III 0.42 ± 0.04, IV 0.3 ± 0.01; pronotum length 0.59 ± 0.06, width across humeral angles 1.17 ± 0.04, width across anterior margin 0.75 ± 0.06; scutellum length 0.63 ± 0.07, width 0.74 ± 0.02; hind leg: femur length 1.15 ± 0.05, tibia length 1.31 ± 0.12, tarsus length: I 0.38 ± 0.04, II 0.26 ± 0.02.

Adult.—Body slightly elongated. Head brown; antennal segments I to III pale yellow, segment IV with basal quarter yellow and rest reddish brown. Tylus longer than juga. Labium reaching metacoxae. Pronotal lobes not differentiated; both lobes with middle line dark brown, without transverse depression. Lateral margins of anterior pronotal lobe slightly expanded. Scutellum dark brown, except apex and distal margins white. Internal angle of corial margin translucent. Membrane with a few pale brown spots between veins.

Male. Measurements (n = 10): Body length 4.27 ± 0.1; head length 0.53 ± 0.02, width across eyes 0.8 ± 0.02; interocular distance 0.4 ± 0.02; interocellar distance 0.22 ± 0.21; postocular distance 0.04 ± 0.009; antennal segments: I 1.39 ± 0.03, II 0.99 ± 0.06, III 0.87 ± 0.05, IV 0.86 ± 0.05; labial segments: I 0.55 ± 0.04, II 0.6 ± 0.01, III 0.47 ± 0.04. IV 0.28 ± 0.02; pronotum length 0.78 ± 0.04, width across humeral angles 1.31 ± 0.05, width across anterior margin 0.63 ± 0.02; scutellum length 0.75 ± 0.03, width 0.72 ± 0.03; hind leg: femur length 1.3 ± 0.07, tibia length 1.54 ± 0.05, tarsus length: I 0.46 ± 0.03, II 0.13 ± 0.01; III 0.18 ± 0.02.

Female. Measurements (n = 10): Body length 4.7 ± 0.12; head length 0.57 ± 0.06, width across eyes 0.97 ± 0.04; interocular distance 0.48 ± 0.02; interocellar distance 0.24 ± 0.2; postocular distance 0.05 ± 0.02; antennal segments: I 0.38 ± 0.03, II 1.01 ± 0.03, III 0.91 ± 0.05, IV 0.92 ± 0.03; labial segments: I 0.6 ± 0.04, II 0.64 ± 0.05, III 0.53 ± 0.06, IV 0.33 ± 0.04; pronotum length 0.86 ± 0.06, width across humeral angles 1.52 ± 0.04, width across anterior margin 0.76 ± 0.08; scutellum length 0.84 ± 0.02, width 0.8 ± 0.03; hind leg: femur length 1.48 ± 0.06, tibia length 1.7 ± 0.09, tarsus length: I 0.5 ± 0.04, II 0.12 ± 0.02; III 0.18 ± 0.02.

Biology.—*Ozophora baranowkii* was the most common species. Nymphs and adults were found in the leaf litter feeding on the seeds of *Ficus aurea* Nutt., *F. colubrinæ* Standl., *F. insipida*, *F. maxima*, *F. perforata* L., *F. pertusa* L., *F. petenensis* Lundell., *F. tecolutensis* (Liemb.) Miq., and *F. yoponensis* in Los Tuxtlas, and of *F. cotinifolia* Kunth., *F. insipida*, *F. trigonata* L., and *F. obtusifolia* Kunth in La Mancha. Adults were also found near the base of trees, sometimes on the lower vegetation feeding on the seeds from birds or mammal droppings. They were found also on aerial roots and on the trees feeding on the opened fruits. Nymphs were found only in leaf litter, and this is why they are considered as obligatory terrestrial. They were generally very active. Newly molted females took around five days to oviposit; eggs were laid individually on the leaf or inside and outside the fruits that were offered as food while rearing them. A single female laid 34 eggs. Eggs turned reddish after four days, and first-instar nymphs emerged four days later. They fed very actively on seeds, and after seven days they molted to the second instar. It was during the second instar when the greatest mortality occurred. Second and third instars took five days to develop, while fourth and fifth instars took six days.

This species was found associated with *Ozophora maculata*, *Clígenes distinctus* Distant, and *Botocudo* sp., although it was usually the first one to arrive soon after a fruiting tree started to drop fruits. *Alloeoryynchus trimacula* (Stein) (Nabidae) was found preying on nymphs and adults of this species.
Ozophora concava Distant
(Figs. 3A–G)

**Egg.**—Cylindrical, with round poles, posterior pole slightly pointed. Length $1.0 \pm 0.12$ mm, width $0.42 \pm 0.03$. Pale yellow when laid, but turning reddish when nymphs start to develop. Eyes appear as red spots. Corial surface with small punctures and with a few small setae. Anterior pole with 4 or 5 small mycropilar processes.

**First instar.**—Elongated; body surface covered with long hairs. Head, pro-, meso-, metanota, labium, legs, and thoracic pleura pale brown. Eyes bright red. Antennal segments I and II gray, III dark brown, and IV dark brown at base and gradually
turning pale yellow anteriorly. Labium reaching first abdominal sternite. Thoracic pleura delimited by red lines. Unions between head, thoracic segments, middle line of thorax, and most of the abdomen pale yellow except a red band running transversely through segments IV and V. Plates of scent gland openings on segments III–IV, IV–V, and V–VI appear as narrow brown bands. Measurements (n = 10):

- Body length 1.54 ± 0.06; head length 0.32 ± 0.03, width across eyes 0.37 ± 0.02; interocular distance 0.22 ± 0.02; postocular distance 0.44 ± 0.03; antennal segments: I 0.14 ± 0.01, II 0.26 ± 0.01, III 0.28 ± 0.02, IV 0.46 ± 0.01; labial segments: I 0.25 ± 0.02, II 0.22 ± 0.02, III 0.20 ± 0.01, IV 0.17 ± 0.02; pronotum length 0.15 ± 0.08, width across humeral angles 0.39 ± 0.07, width across anterior margin 0.31 ± 0.20; hind leg: femur length 0.42 ± 0.02, tibia length 0.50 ± 0.1, tarsus length: I 0.15 ± 0, II 0.10 ± 0.06.

Second instar.—Elongated, with abdomen wider than the thorax. Body surface covered with long hairs, more apparent than in the first instar. Anterior end of head, from apex of eyes to apex of tylus pale brown, rest of head dark brown. Antennal segments I and II pale brown, segment III dark brown; union between segments III and IV red, base of segment IV dark brown, followed by a pale yellow annulus, distal half pale brown. Labium and legs pale brown, femora slightly darker. Venter and dorsum of abdominal segments I, II, and III dark brown. Joints between segments III to VII pale yellow. Scent glands only slightly apparent, delimited by dark brown lines. Abdominal sternites IV, VI, VII, and VIII variegated with pale yellow and brown areas; sternite V reddish brown, “Y” suture not very apparent. Labium only reaching metacoxae. Measurements (n = 10):

- Body length 1.88 ± 0.27; head length 0.41 ± 0.0, width across eyes 0.51 ± 0; interocular distance 0.29 ± 0.03; postocular distance 0.16 ± 0.02; antennal segments: I 0.19 ± 0.02, II 0.45 ± 0.02, III 0.44 ± 0.04, IV 0.16 ± 0.04; labial segments: I 0.35 ± 0.02, II 0.36 ± 0.07, III 0.26 ± 0.01, IV 0.22 ± 0.01; pronotum length 0.023 ± 0.01, width across humeral angles 0.51 ± 0.03, width across anterior margin 0.36 ± 0.03; hind leg: femur length 0.55 ± 0.03, tibia length 0.68 ± 0.05, tarsus length: I 0.22 ± 0.02, II 0.19 ± 0.03.

Third instar.—Elongated, with maximum width across abdominal segment IV. Body covered with long silvery and brown hairs. Eyes reddish brown. Labium pale brown. Head as in second instar, except for region posterior to eyes becoming darker. Antennal segment I pale yellow, segment II pale brown, III dark brown, joints between segment III and IV red; base of segment IV dark brown, with a yellow annulus and distal half pale brown. Middle line of pro-, meso-, and metanota pale yellow, followed by a dark brown band, then a yellow band; pro-, and mesonota with a wide dark brown band over lateral margins. Thoracic pleura dark brown; coxae, and trochanters pale yellow; femora dark brown; tibiae, and tarsi pale brown. Frontal margin of prosternum with a red line. First three abdominal segments dark brown, middle area of first, and distal third of third pale yellow; some areas of lateral margins of these segments with a reddish coloration. “Y” suture with yellow and red lines. Abdominal segments IV to VIII with irregular red, yellow, and pale brown spots. Two dark brown mesial maculae between segments IV and V. Abdominal venter with dark brown bands running closer to posterior margin of each sternite; rest of abdomen and spiracles pale yellow. Measurements (n = 10):

- Body length 2.43 ± 0.01; head length 0.46 ± 0.02, width across eyes 0.58 ± 0.05; interocular distance 0.32 ± 0.03; postocular distance 0.10 ± 0.01; antennal segments: I 0.22 ± 0.05, II 0.53 ± 0.12, III 0.57 ± 0.05, IV 0.66 ± 0.05; labial segments: I 0.4 ± 0.04, II 0.4 ± 0.03, III 0.28 ± 0.03, IV 0.23 ± 0.01; pronotum length 0.31 ± 0.03, width across humeral angles 0.64 ± 0.08, width across anterior margin 0.44 ± 0.02; hind leg: fe-
mur length 0.76 ± 0.11, tibia length 0.99 ± 0.08, tarsus length: I 0.26 ± 0.03, II 0.22 ± 0.02.

Fourth instar.—Body elongated, with posterior end slightly narrowed. Similar to third instar, although red coloration on abdomen lighter. Labium reaching abdominal sternite I. Distal half of hind femur darker. Wing pads present, covering metanotum almost completely. Lateral margins of abdomen slightly convex; dark brown areas with numerous punctures and setae. Fore femur with 6 spines. Measurements (n = 10); Body length 3.77 ± 0.26; head length 0.56 ± 0.03, width across eyes 0.77 ± 0.03; interocular distance 0.44 ± 0.03; postocular distance 0.20 ± 0.02; antennal segments: I 0.35 ± 0.05, II 0.92 ± 0.13, III 0.81 ± 0.08, IV 1.03 ± 0.04; labial segments: I 0.56 ± 0.05, II 0.56 ± 0.03, III 0.42 ± 0.03, IV 0.31 ± 0.01; pronotum length 0.51 ± 0.03, width across humeral angles 0.29 ± 0.05, width across anterior margin 0.6 ± 0.04; scutellum length 0.67 ± 0.11, width 0.63 ± 0.05; hind leg: femur length 1.17 ± 0.09, tibia length 1.5 ± 0.1, tarsus length: I 0.4 ± 0.04, II 0.3 ± 0.04.

Fifth instar.—Elongated, maximum width across abdominal segment II. Head with one dark area on each side of midline, starting near molting suture and extending slightly in front of eyes. Ocelli present as two red spots over molting suture. Antennal segments I and II, labium, femora, tibiae, and tarsi pale yellow; coxae and trochanters creamy yellow. Pronotal and wing pad margins pale yellow, followed mesially by a conspicuous dark brown line. Pale yellow areas of abdomen white in some individuals. Wing pads reaching middle area of abdominal segment III. Labium reaching metacoxae. Measurements (n = 10); Body length 4.59 ± 0.52; head length 0.64 ± 0.03, width across eyes 0.93 ± 0.09; interocular distance 0.48 ± 0.05; interocular distance 0.39 ± 0.01; postocular distance 0.26 ± 0.22; antennal segments: I 0.27 ± 0.05, II 1.21 ± 0.13, III 1.8 ± 0.15, IV 1.23 ± 0.18; labial segments: I 0.76 ± 0.04, II 0.73 ± 0.07, III 0.51 ± 0.07, IV 0.35 ± 0.0; pronotum length 0.66 ± 0.06, width across humeral angles 1.28 ± 0.09, width across anterior margin 0.7 ± 0.06; scutellum length 0.6 ± 0.04, width 0.83 ± 0.12; hind leg: femur length 1.87 ± 0.41, tibia length 2.41 ± 0.46, tarsus length: I 0.55 ± 0.08, II 0.33 ± 0.04.

Adult.—Large. 6 to 7 mm long; body elongated. Easy to distinguish from other species by numerous erect hairs covering dorsal surface. Head, pronotum, scutellum and thoracic pleura dark brown. Antennal segments I to III, labium, and legs brownish yellow; base and distal half of antennal segment IV dark brown, proximal half yellow. Hemelytron brown, covered with dark brown punctures and with few yellow areas near lateral margins. Veins and claval suture brownish yellow. Membrane smoky with pale yellow veins. Abdominal venter reddish brown. Labium reaching metacoxae. Lateral margins of pronotum rounded.

Male: Measurements (n = 10); Body length 6.33 ± 0.24; head length 0.89 ± 0.07, width across eyes 0.5 ± 0.04; interocular distance 0.44 ± 0.04; interocellar distance 0.24 ± 0.03; postocular distance 0.14 ± 0.04; antennal segments: I 0.84 ± 0.05, II 2.18 ± 0.17, III 1.77 ± 0.06, IV 2.06 ± 0.09; labial segments: I 0.89 ± 0.06, II 0.84 ± 0.08, III 0.67 ± 0.09, IV 0.36 ± 0.07; pronotum length 1.05 ± 0.05, width across humeral angles 1.69 ± 0.09, width across anterior margin 0.74 ± 0.02; scutellum length 0.99 ± 0.09, width 0.96 ± 0.09; hind leg: femur length 2.5 ± 0.24, tibia length 3.6 ± 0.38, tarsus length: I 0.88 ± 0.08, II 0.15 ± 0.03, III 0.22 ± 0.04.

Female: Measurements (n = 10); Body length 6.97 ± 0.24; head length 0.91 ± 0.09, width across eyes 1.14 ± 0.06; interocular distance 0.49 ± 0.01; interocellar distance 0.24 ± 0.02; postocular distance 0.22 ± 0.02; antennal segments: I 0.8 ± 0.05, II 2.04 ± 0.15, III 1.65 ± 0.07, IV 1.83 ± 0.10; labial segments: I 0.94 ± 0.12, II 0.91 ± 0.10, III 0.77 ± 0.08, IV 0.36 ± 0.04; pronotum length 1.17 ± 0.18, width
across humeral angles 1.89 ± 0.16, width across anterior margin 0.07 ± 0.22; scutellum length 1.08 ± 0.10, width 1.07 ± 0.07; hind leg: femur length 2.46 ± 0.23, tibia length 3.31 ± 0.2. tarsus length: I 0.9 ± 0.09, II 0.17 ± 0.02; III 0.22 ± 0.02.

Biology.—This species was common in Los Tuxtlas and rare in La Mancha. In the field it was easily mistaken for *Ozophora consanguinea* because both species could be found in the same microhabitat and are of similar size. *Ozophora concava* has a darker coloration and abundant hairs on the body surface. Adults and nymphs were found in the leaf litter or in the soil very near the base of the trunk, aerial roots, and buttresses. In Los Tuxtlas, was found associated with *Ficus aurea*, *F. colubrinae*, *F. insipida*, *F. maxima*, *F. perforata*, *F. pertusa*, *F. petensis*, *F. tecolutensis*, and *F. yoponensis*, and in La Mancha with *Ficus cotinifolia*, *F. insipida*, and *F. trigonata*. This species is considered an obligatory terrestrial. Laboratory observations showed that females oviposited five days after mating and attached the eggs to the fruit or leaf. Newly laid eggs were white. They turned yellow after one day; six days latter they turned reddish and eight days later the first instar nymphs emerged. Fifteen days latter the second instar appeared. It took 9 days to molt into third instar, 8 days to the fourth, 7 days to the fifth, and 15 days to the adult.

*Ozophora consanguinea* Distant
(Figs. 4A–G)

Egg.—Creamy yellow when laid; becoming reddish in 6 days, especially eyes and antenna. Length 1.05 ± 0.03 mm, width 0.44 ± 0.05 mm, with posterior pole round and anterior pole sightly flattened and with five short micropylar processes.

First instar.—Elongated. Head, and pronotum grayish yellow. Eyes red. Antennal segments I to III pale brown, with base and apex white; basal third of segment IV pale brown, rest pale yellow. Labium yellow, except pale brown distal end. Meso- and metanota, and meso- and metapleura dark brown. Legs pale yellow, femora pale grayish. Abdomen yellow, except a red transverse band across segments IV and V. Tylus slightly shorter than antennal segment I. Labium reaching base of abdominal sternite V. Scent gland openings faintly apparent on segments III–IV, IV–V, and V–VI. Head, thorax, and first two abdominal segments with long hairs on dorsal surface. Measurements (n = 10): Body length 1.16 ± 0.06; head length 0.26 ± 0.02, width across eyes 0.31 ± 0.01; interocular distance 0.21 ± 0.08; postocular distance 0.05 ± 0.01; antennal segments: I 0.11 ± 0.01, II 0.16 ± 0.01, III 0.17 ± 0.01, IV 0.28 ± 0.02; labial segments: I 0.19 ± 0.0, II 0.16 ± 0.01, III 0.16 ± 0.01, IV 0.14 ± 0.01; pronotum length 0.15 ± 0.02, width across humeral angles 0.33 ± 0.01, width across anterior margin 0.29 ± 0.01; hind leg: femur length 0.28 ± 0.02, tibia length 0.29 ± 0.01, tarsus length: I 0.08 ± 0.0, II 0.09 ± 0.01.

Second instar.—Head and thorax brown. Antennal segments pale brown; proximal and distal ends of segments I to III, and base of segment IV white. Labium and legs pale brown. Abdomen pale yellow; dorsal surface of segments II and III pale brown. Scent gland openings pale brown. Red abdominal band turns lighter and only margins apparent. Labium reaching abdominal sternite IV. Measurements (n = 10): Body length 1.57 ± 0.08; head length 0.36 ± 0.04, width across eyes 0.38 ± 0.04; interocular distance 0.26 ± 0.01; postocular distance 0.07 ± 0.01; antennal segments: I 0.1 ± 0.02, II 0.25 ± 0.02, III 0.27 ± 0.04, IV 0.4 ± 0.05; labial segments: I 0.24 ± 0.03, II 0.21 ± 0.02, III 0.17 ± 0.02, IV 0.18 ± 0.02; pronotum length 0.17 ± 0.01, width across humeral angles 0.4 ± 0.01, width across anterior margin 0.35 ± 0.05; hind leg: femur length 0.45 ± 0.05, tibia length 0.52 ± 0.03, tarsus length: I 0.18 ± 0.01, II 0.16 ± 0.02.

Third instar.—Head and pronotum dark brown. Antenna, labium, and legs as in second instar. Meso- and metanota with dark
brown and creamy yellow spots over lateral margins and on each side of middle line. Dorsal surface of segments II and anterior half of III pale brown, rest of abdominal segments pale yellow, except with a long red macula situated between scent gland openings of segments III-IV and IV-V, and some red lines on joints of segments IV-V and V-VI. "Y" suture marked slightly by red and dark brown lines. Scent gland openings of segments III-IV, IV-V, and V-VI pale brown. Labium reaching base of sternite III, inner side of fore femur with a series of equally separated spines. Measurements (n = 10): Body length 2.4 ± 0.49; head length 0.51 ± 0.1, width across eyes

0.58 ± 0.09; interocular distance 0.34 ± 0.03; postocular distance 0.08 ± 0.02; antennal segments: I 0.26 ± 0.08, II 0.51 ± 0.21, III 0.55 ± 0.17, IV 0.69 ± 0.17; labial segments: I 0.38 ± 0.08, II 0.37 ± 0.1, III 0.31 ± 0.06, IV 0.25 ± 0.04; pronotum length 0.31 ± 0.06, width across humeral angles 0.63 ± 0.1, width across anterior margin 0.48 ± 0.05; hind leg: femur length 0.77 ± 0.19, tibia length 0.98 ± 0.42, tarsus length: I 0.27 ± 0.08, II 0.22 ± 0.04.

Fourth instar.—Head, pronotum, and mesonotal dark brown; midline and some areas of pro- and mesonota pale yellow. Antennal segments I and II pale brown, segment III dark brown, segment IV with a subbasal white annulus and rest dark brown. Legs dark brown, except pale brown tarsus I. Dark brown mesial macula on abdominal segments II and III. Thoracic pleura dark brown. Other characteristics as in third instar. Labium reaching metacoxae. Wing pads covering metanotum. Measurements (n = 10): Body length 3.6 ± 0.53; head length 0.62 ± 0.08, width across eyes 0.76 ± 0.04; interocular distance 0.44 ± 0.03; postocular distance 0.09 ± 0.04; antennal segments: I 0.39 ± 0.08, II 0.88 ± 0.11, III 0.82 ± 0.12, IV 1.02 ± 0.14; labial segments: I 1.054 ± 0.06, II 0.5 ± 0.06, III 0.45 ± 0.07, IV 0.32 ± 0.02; pronotum length 0.51 ± 0.05, width across humeral angles 0.9 ± 0.08, width across anterior margin 0.61 ± 0.04; scutellum length 0.38 ± 0.06, width 0.49 ± 0.11; hind leg: femur length 1.24 ± 0.2, tibia length 1.53 ± 0.22, tarsus length: I 0.41 ± 0.08, II 0.3 ± 0.04.

Fifth instar.—Head, and pronotum dark brownish black, with a few brownish-yellow spots situated near juga and base of pronotum. Scutellum dark brown with a reddish macula on each side of midline. Bases of wing pads pale yellow, apices dark brown. Dark brown macula of abdominal segments II, and III darker, as well as scent gland openings. Rest of abdomen variegated with yellow, red and dark brown. Labium slightly longer than mesocoxae. Antennal segment I with short spines; antennal segments II, III, and IV covered by fine setae. Fore femur with 5 or 6 prominent spines. Wing pads reaching middle of abdominal segment III. Measurements (n = 10): Body length 5.5 ± 0.58: head length 0.81 ± 0.11, width across eyes 1.04 ± 0.04; interocular distance 0.54 ± 0.04; interocellar distance 0.25 ± 0.01; postocular distance 0.12 ± 0.05; antennal segments: I 0.74 ± 0.04, II 1.47 ± 0.07, III 1.29 ± 0.06, IV 1.7 ± 0.08; labial segments: I 0.74 ± 0.07, II 0.7 ± 0.06, III 0.59 ± 0.08, IV 0.4 ± 0.03; pronotum length 0.78 ± 0.07, width across humeral angles 1.42 ± 0.08, width across anterior margin 0.83 ± 0.05; scutellum length 0.82 ± 0.09, width 0.87 ± 0.08; hind leg: femur length 2.21 ± 0.09, tibia length 2.74 ± 0.09, tarsus length: I 0.67 ± 0.06, II 0.43 ± 0.05.

Adult.—Body elongated (one of largest species treated here), 6 to 7 mm long, lateral margins of posterior pronotal lobe knife sharp. Head, anterior pronotal lobe, and thoracic pleura dark brown. Antennal segments I to III, labium and legs brownish yellow; antennal segment IV with base and distal half dark brown, proximal half with a white annulus. Posterior pronotal lobe with dark brown bands and with numerous dark brown markings; generally posterior margin a creamy coloration. Scutellum generally dark brown, although in a few specimens with lighter coloration near its apex. Claval dark brown. Hemelytron creamy white with dark brown punctures and a transverse dark brown band near middle area; a pair of dark brown maculae near its apex; base sometimes with a dark brown macula. Membrane smoky with veins slightly lighter. Abdominal venter brownish red. Labium exceeding mesocoxae. Dorsal surface of body without long hairs.

Male: Measurements (n = 10): Body length 6.17 ± 0.38; head length 0.82 ± 0.08, width across eyes 1.06 ± 0.04; interocular distance 0.43 ± 0.03; interocellar distance 0.24 ± 0.05; postocular distance 0.12 ± 0.02; antennal segments: I 0.85 ± 0.1, II 1.81 ± 0.09, III 1.51 ± 0.08, IV 1.92
± 0.25; labial segments: I 0.87 ± 0.07, II 0.84 ± 0.09, III 0.62 ± 0.04, IV 0.46 ± 0.04; pronotum length 1.0 ± 0.04, width across humeral angles 1.78 ± 0.37, width across anterior margin 0.76 ± 0.04; scutellum length 1.02 ± 0.08, width 0.9 ± 0.09; hind leg: femur length 2.53 ± 0.24, tibia length 2.9 ± 0.28, tarsus length: I 0.78 ± 0.11, II 0.17 ± 0.02; III 0.21 ± 0.02.

**Female: Measurements** (n = 10): Body length 6.86 ± 0.45; head length 0.93 ± 0.06; width across eyes 1.12 ± 0.04; interocular distance 0.51 ± 0.03; interocellar distance 0.27 ± 0.04; postocular distance 0.14 ± 0.03; antennal segments: I 0.78 ± 0.13, II 2.01 ± 0.49, III 1.47 ± 0.17, IV 1.81 ± 0.32; labial segments: I 0.9 ± 0.08, II 0.93 ± 0.05, III 0.63 ± 0.07, IV 0.44 ± 0.04; pronotum length 1.11 ± 0.08, width across humeral angles 1.89 ± 0.13, width across anterior margin 0.82 ± 0.04; scutellum length 1.16 ± 0.1, width 1.08 ± 0.1; hind leg: femur length 2.52 ± 0.42, tibia length 3.02 ± 0.46, tarsus length: I 0.8 ± 0.15, II 0.18 ± 0.04; III 0.22 ± 0.02.

**Biology.**—This was common and is one of the largest species, found all year around. At Los Tuxtla, adults and nymphs were found on leaf litter near the base of trees, around tree buttresses, and on aerial roots, tree crevices, and tree forks where leaf litter had accumulated. In Los Tuxtla, *O. consanguinea* was found on *Ficus colubriae*, *F. insipida*, *F. maxima*, *F. perforata*, *F. pertusa*, *F. tecolutensis*, and *F. yoponensis*. In La Mancha, it was found on *F. cotinifolia*, *F. insipida*, and *F. trigonata*.

In the laboratory, adults took five to eight days to oviposit after mating. Females laid between 20 to 40 eggs on the leaves and the inside and outside of fruits. The entire life cycle lasted 63 days. Eggs were white when laid; 7 days later they turned reddish and 8 days later they hatched. First instars lasted seven days, second 10 days, third instar 12 days, fourth 10 days, and fifth 11 days. This species is considered arboreal. It was found several times associated with *O. concava*, and around the tree forks it was associated with *Cholilla maculatus* Distant.

**Ozophora maculata** Slater and O’Donnell (Figs. 5A–G)

**Egg.**—Cylindrical: length 0.8 ± 0.0 mm, width 0.33 ± 0.02 mm; with anterior pole rounded, and posterior pole slightly pointed. Pale yellow when laid, turning reddish with development. Eyes appear as red spots; corium without ornamentation, operculum with three to four micropylar processes.

**First instar.**—Elongated, with shape of egg; maximum width through abdominal segment III. Head, pro-, meso-, metanota, and thoracic pleura pale brown. Eyes bright red. Antennal segments I to III pale brown with proximal and distal ends white, segment IV with base pale brown and becoming lighter towards apex. Labium and femora grayish yellow; tibiae and tarsi pale yellow. Division between head and thoracic segments pale yellow. Abdominal segments pale yellow; segments III to VIII variegated with small red markings, although these markings more concentrated between scent gland openings III–IV and IV–V. Scent gland openings faintly visible as fine lines. Labium slightly exceeding metacoxae.

**Measurements** (n = 10): Body length 1.12 ± 0.06; head length 0.24 ± 0.03, width across eyes 0.28 ± 0.01; interocular distance 0.2 ± 0.01; postocular distance 0.08 ± 0.02; antennal segments: I 0.10 ± 0.0, II 0.13 ± 0.01, III 0.14 ± 0.01, IV 0.25 ± 0.0; labial segments: I 0.20 ± 0.01, II 0.16 ± 0.01, III 0.14 ± 0.01, IV 0.14 ± 0.01; pronotum length 0.11 ± 0.01, width across humeral angles 0.32 ± 0.02, width across anterior margin 0.26 ± 0.01; hind leg: femur length 0.26 ± 0.01, tibia length 0.26 ± 0.02, tarsus length: I 0.10 ± 0.0, II 0.12 ± 0.01.

**Second instar.**—Slightly pyriform, maximum width across abdominal segment IV. Head, pro- and mesonota, and thoracic pleura brown. Antenna, labium, and legs pale brown, femora slightly darker. Abdom-

inal segment II and anterior half of segment III pale brown; rest of abdomen with pale yellow and pale brown areas, sometimes pale brown areas form transverse bands. Labium reaching mesocoxae. Measurements ($n = 10$): Body length $1.54 \pm 0.1$; head length $0.34 \pm 0.03$, width across eyes $0.39 \pm 0.01$; interocular distance $0.26 \pm 0.02$; postocular distance $0.09 \pm 0.01$; antennal segments: I $0.13 \pm 0.01$, II $0.24 \pm 0.0$, III $0.25 \pm 0.01$, IV $0.36 \pm 0.02$; labial segments: I $0.25 \pm 0.01$, II $0.24 \pm 0.01$, III
0.18 ± 0.01, IV 0.17 ± 0.01: pronotum length 0.18 ± 0.01, width across humeral angles 0.44 ± 0.32, width across anterior margin 0.34 ± 0.01; hind leg: femur length 0.34 ± 0.02, tibia length 0.41 ± 0.04, tarsus length: I 0.12 ± 0.01, II 0.15 ± 0.01.

Third instar.—Pyriform, maximum width across abdominal segment III. Head, pro- and mesonota, and thoracic pleura brown; pronotum with area of humeral angles white and one white macula on each side of middle line near posterior margin; mesonotum with three white maculae, two very close to middle line and one slightly closer to lateral margin. Metanotum almost completely white, except a thin brown line over anterior margin. Antennal segments I and II pale brown, with base and apex white; segments III and IV brown, with base white. Labium grayish yellow, with apex of segment IV brown. Legs grayish yellow; femora slightly darker. Abdominal segments appear more reddish than in second instar, sometimes with red bands through each segment and in some individuals grayish bands also present. Scent gland openings of segments III-IV, IV-V, and V-VI slightly rectangular and brown. Labium slightly exceeding metacoxae. “Y” suture slightly visible. Measurements (n = 8): Body length 2.05 ± 0.08; head length 0.35 ± 0.04, width across eyes 0.48 ± 0.03; interocular distance 0.30 ± 0.02; postocular distance 0.13 ± 0.05; antennal segments: I 0.15 ± 0.02, II 0.31 ± 0.02, III 0.31 ± 0.02, IV 0.37 ± 0.03; labial segments: I 0.33 ± 0.05, II 0.31 ± 0.03, III 0.23 ± 0.02, IV 0.20 ± 0.01; pronotum length 0.25 ± 0.05, width across humeral angles 0.61 ± 0.05, width across anterior margin 0.38 ± 0.03; hind leg: femur length 0.42 ± 0.02, tibia length 0.54 ± 0.02, tarsus length: I 0.15 ± 0.01, II 0.15 ± 0.01.

Fourth instar.—Slightly elongated, abdomen wider than rest of body. Head completely brown; eyes reddish brown; antenna and labium as in previous instar. Pro-, meso-, and visible part of metanota with several white maculae as follows: pronotum with one long macula on each side of middle line and four round maculae over posterior margin; mesonotum with four maculae on area that corresponds to scutellum and one “A” shaped macula on wing pads, some individuals also with one small macula on lateral margins; metanotum almost all white with only a brown line over posterior margin. Abdomen yellow with red bands along each segment, mostly appearing as divided bands. One semicircular grayish yellow area in front of each scent gland opening. Lateral margins of pro- and mesonota slightly expanded. Fore femur with three spines on internal ventral margin. Labium only reaching metacoxae. Mesothoracic wing pads covering most of lateral areas of metanotum. “Y” suture slightly more apparent. Measurements (n = 10): Body length 2.69 ± 0.24; head length 0.44 ± 0.03, width across eyes 0.61 ± 0.03; interocular distance 0.41 ± 0.03; postocular distance 0.07 ± 0.04; antennal segments: I 0.21 ± 0.02, II 0.5 ± 0.01, III 0.45 ± 0.03, IV 0.57 ± 0.02; labial segments: I 0.47 ± 0.02, II 0.44 ± 0.03, III 0.32 ± 0.03, IV 0.24 ± 0.00; pronotum length 0.41 ± 0.03, width across humeral angles 0.71 ± 0.06, width across anterior margin 0.5 ± 0.04; scutellum length 0.31 ± 0.02, width 0.47 ± 0.03; hind leg: femur length 0.59 ± 0.04, tibia length 0.72 ± 0.02, tarsus length: I 0.26 ± 0.02, II 0.21 ± 0.01.

Fifth instar.—Elongated, maximum width across abdominal segment III. Head dark brown, two creamy-yellow semitrangular maculae on base of head and two small maculae on base of tylus; ventral surface of head brown with one longitudinal band running from base of antenna to base of head. Eyes reddish brown. First antennal segment pale brown; second segment grayish yellow with apex slightly brownish; third and fourth segments dark brown with base white. Labium grayish yellow. Third segment slightly paler. Pronotum with anterior half dark brown, except for long yellowish macula on each side of middle line, and two small maculae on each side of discal area; pos-
terior half creamy yellow with a wide brown band on each side of middle line and one thin band half way to lateral margin. Meso- and metanota variegated with well-defined patterns of creamy yellow and pale brown, dark areas defining scutellum and wing pads; apical fourth of mesothoracic wing pad dark brown. Pleura dark brown, propuleuron usually with only one small white macula, meso- and metapleura with two rectangular white areas. Coxae creamy; femora with proximal and distal ends creamy yellow, rest brown, fore femur slightly darker; tibiae and tarsi yellowish brown. Abdomen with a series of grayish areas anterior to scent gland openings III–IV, IV–V, and V–VI, first one slightly trap- ezoidal and other two oval. Rest of dorsal surface variegated with creamy yellow, red, and grayish areas; scent gland openings of segments III–IV, IV–V and V–VI on rectangular brown plates. Ventral surface almost all grayish, with divisions between segments creamy yellow. Labium slightly longer than mesocoxae. Lateral margins of pro- and mesonota emarginated. Mesothoracic wing pads slightly longer than base of abdominal segment III. Fore femur with four spines on internal margin. “Y” suture not very apparent. Measurements (n = 10): Body length 3.50 ± 0.22; head length 0.47 ± 0.06, width across eyes 0.77 ± 0.04; interocular distance 0.44 ± 0.02; intercercal distance 0.30 ± 0.02, postocular distance 0.05 ± 0.02; antennal segments: I 0.27 ± 0.02, II 0.69 ± 0.04, III 0.67 ± 0.02, IV 0.68 ± 0.04; labial segments: I 0.57 ± 0.03, II 0.51 ± 0.03, III 0.41 ± 0.04, IV 0.28 ± 0.04; pronotum length 0.53 ± 0.03, width across humeral angles 1.10 ± 0.06, width across anterior margin 0.61 ± 0.05; scutellum length 0.55 ± 0.03, width 0.61 ± 0.05; hind leg: femur length 0.71 ± 0.05, tibia length 1.09 ± 0.08, tarsus length: I 0.33 ± 0.02, II 0.24 ± 0.01.

Adult.—Head and pronotal calli brownish red. Pronotum with well differentiated calli, posterior lobe and lateral expanded margins brownish yellow, with some brown areas near base of pronotum. Most of legs and antenna pale yellow; distal half of antennal segment IV slightly darker. Dorsal surface of head with short silvery hairs. Posterior pronotal lobe with a pale yellow mesial line, not reaching posterior margin. Scutellum nearly black with white apex. Hemelytron brownish yellow; clavus with a dark brown area on each side of claval commissure; corium with a small brown macula at level of distal third of scutellum; internal angle of corium with a large dark brown macula that becomes narrow near its lateral margin; external apex of corium with a dark brown macula; membrane translucent. Abdominal venter reddish brown. Acetabula and posterior lobe of metapleuron white, with a few dark brown markings. Metathoracic scent gland auricle reddish orange. Labium slightly longer than metacoxae. Abdominal dorsum almost completely glabrous and venter covered with silvery hairs.

Male: Measurements (n = 10): Body length 3.6 ± 0.07; head length 0.45 ± 0.04, width across eyes 0.71 ± 0.06; interocular distance 0.42 ± 0.03; intercercal distance 0.28 ± 0.02; postocular distance 0.05 ± 0.0; antennal segments: I 0.28 ± 0.02, II 0.71 ± 0.06, III 0.66 ± 0.04, IV 0.72 ± 0.03; labial segments: I 0.52 ± 0.02, II 0.53 ± 0.03, III 0.37 ± 0.04, IV 0.24 ± 0.01; pronotum length 0.63 ± 0.03, width across humeral angles 1.12 ± 0.03, width across anterior margin 0.54 ± 0.01; scutellum length 0.54 ± 0.03, width 0.63 ± 0.02; hind leg: femur length 1.07 ± 0.05, tibia length 1.27 ± 0.02, tarsus length: I 0.38 ± 0.02, II 0.1 ± 0; III 0.14 ± 0.01.

Female. Measurements (n = 10): Body length 4.13 ± 0.2; head length 0.48 ± 0.04, width across eyes 0.74 ± 0.04; interocular distance 0.44 ± 0.04; intercercal distance 0.31 ± 0.02; postocular distance 0.05 ± 0.01; antennal segments: I 0.29 ± 0.03, II 0.73 ± 0.04, III 0.70 ± 0.02, IV 0.76 ± 0.05; labial segments: I 0.52 ± 0.03, II 0.51 ± 0.04, III 0.40 ± 0, IV 0.29 ± 0.01; pronotum length 0.71 ± 0.05, width across hu-
meral angles 1.32 ± 0.08, width across anterior margin 0.59 ± 0.01; scutellum length 0.65 ± 0.02, width 0.74 ± 0.03; hind leg: femur length 1.23 ± 0.03, tibia length 1.55 ± 0.05, tarsus length: I 0.44 ± 0.03, II 0.10 ± 0.01; III 0.15 ± 0.02.

Biology.—This species was not very abundant. It usually was present when O. baranowskii did not occur. In La Mancha this species was found from March to November. It was easily mistaken for Ozophora baranowskii, although it is smaller and it has a continuous dark brown macula through the hemelytra at the level of the claval commissure. It has been found feeding on raccoon excrement that contains fig seeds. It was slightly less active than O. baranowskii, and when disturbed it flies short distances. They were present on leaf litter of Ficus cotinifolia, and F. trigonata.

KEY TO FIFTH INSTAR NYMPHS

1. Dorsal surface clothed with numerous conspicuous erect hairs ........................ O. concava
   - Dorsal surface glabrous or nearly so .......... 2
2. Antennal segments III and IV unicolorous ...... 3
   - Antennal segment III dark brown, segment IV
     with a broad white annulus ..................... 4
3. Head dark brown; pronotum dark brown, usually with four round maculae near its base;
   femora and tibia unicolorous ... O. baranowskii
   - Head dark brown, usually with a pair of white
     areas near its base; pronotum with four maculae
     near its base, but also with small irregular
     white maculae on anierior lobe; femora usually
darker than rest of leg, and with a contrasting
     white annulus on distal ends ........ O. maculata
4. Apex of mesothoracic wing pad dark brown; dis-
   tal ends of femora and tibiae dark brown ...... O. consanguinea
   - Apex of mesothoracic wing pad pale yellow;
     femora and tibiae pale yellow ... O. atropictoides

DISCUSSION

This study is part of a larger project on the lygaeid fauna associated with figs in Mexico, and here we described five complete life cycles, including illustrations and taxonomic descriptions of all immature stages, host plants, and biology of O. atropictoides, O. baranowskii, O. concava, O. consanguinea, and O. maculata. The characters used to separated the fifth instar nymphs are coloration of the head, thorax, abdomen, and antennae; the presence of hairs on the body surface; and by the size of different structures, such as width across eyes, size of antennal segments, and total body length.

Most of the fig host records for Ozophora are cited as Ficus sp. There are only four specific records, F. religiosa L. and F. retusa L., which are introduced species in the Neotropics, and F. trigonata L., a strangler fig with a wide distribution (Slater and Baranowski 1990). Rodriguez (1997) gave a few natural history notes for O. baranowskii and O. maculata and found them associated with F. padifolia. Here we included records for 12 species of Ficus, F. aurea, F. colubrinae, F. cotinifolia, F. insipida, F. maxima, F. obtusifolia, F. perforata, F. pertusa, F. petenensis, F. tecolutensis, F. trigonata, and F. yoponensis. We found that there is not much specificity on the species of figs with which the lygaeids are associated. They seem to be present on almost all the species of figs that are found in an area, and it depends on which species of figs are fruiting.

Microhabitat specificity seems to occur in all the species studied. Ozophora baranowskii and O. maculata inhabited the superficial layers of litter, although adults of O. baranowskii are sometimes found on the vegetation under fig trees, or on the fig trees, feeding on opened fruits or fallen seeds. Adults and nymphs of O. atropictoides also were found on the superficial layers of leaf litter, but usually on the more shaded areas. Ozophora concava was found on the leaf litter near the base of the tree, around buttresses or on aerial roots. Ozophora consanguinea also was found around the base of the tree, but also in crevices and tree forks of the trunk where leaf litter accumulated. Ozophora baranowskii was the first one to appear; they were found soon after trees started to drop fruits. Ozophora consanguinea was probably the last one to
leave the tree, feeding on old seeds that had accumulated in crevices and tree forks.

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LITERATURE CITED


A NEW SPECIES OF *Derecyra* Smith  
(HYMENOPTERA: XIPHYDRIIDAE)  
FROM COLOMBIA AND ECUADOR  

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Abstract.—*Derecyra flavescens*, n. sp., is described from Colombia and Ecuador. It is separated from the related species *D. andrei* Konow and *D. pictipennis* Smith.

Key Words: wood borer, wood wasp, Neotropical

A strikingly colored specimen of *Derecyra* Smith was brought to my attention by Fernando Fernández C., Instituto Humboldt, Bogotá, Colombia, and an additional specimen was discovered in the Zoologische Staatssammlung München. This shiny, black and orange species with yellow wings is unlike described species of this Neotropical genus. Xiphydriids from South America are rare in collections; for a number of species, only the type or a few specimens are known. Therefore, it is important to document new material that is collected. Twelve species of *Derecyra* are known, ten of which were keyed by Smith (1988); additional ones were described by Smith (1995) from Chile and by Mecke et al. (2000) from southeastern Brazil. The latter, *Derecyra araucariae* Mecke, was reared from *Araucaria angustigolia* (Bert.) O. Kuntz, in Rio Grande do Sul, Brazil (Mecke et al. 2000, 2001). To date, this is the only confirmed food plant record for a Neotropical xiphydrid.

*Derecyra flavescens* Smith, new species  
(Figs. 1–6)

Female.—Length, holotype 15.0 mm; paratype 12.0 mm. Antenna, head, and mouthparts black. Thorax orange. Legs black. Abdomen orange with narrow apex of 7th segment and 8th segment to apex and sheath black. Wings yellow; apex of forewing black from midway between apex of stigma and apex of wing; extreme apex of hind wing blackish; veins yellow, black in black apices; stigma black.

Head (Figs. 4–6) smooth and shining behind ocelli and on gena almost to malar area; front rugose, somewhat longitudinally ridged. Mesopleuron (Fig. 2) shining and smooth, very few widely scattered punctures; mesepimeron with fine striae; metapleuron shining with scattered fine punctures; pronotum shining with a few ridges in central part of lateral groove, lateral angles finely punctate; mesoprestum with transverse ridges, lateral lobes finely punctate, mesoscutellum with transverse ridges and with central projecting spine near apex. Abdomen smooth and shining; small dull area with fine punctures on lateral side of basal plates.

Antennal length 3.1× head width; 23 segments in holotype, 19 segmented in paratype; segment 3 greater than 4, ratio of segments 1–5 as 10:55:32:55:35; remaining segments gradually decreasing in length. Ocypetal carina present; genal carina absent. Mid- and hind tibiae without preapical
Figs. 1–6. *Derecyrtta flavescens*, holotype. 1, Habitus, lateral view. 2, Thorax, lateral view. 3, Apex of abdomen and sheath, lateral view. 4, Head, dorsal view. 5, Head, frontal view. 6, Head, lateral view.
spines; hind femur about 4× longer than broad; hind tarsus with last segment shorter than basitarsus, basitarsus longer than following 3 segments; ratio of segments as 100:30:20:15:78. Pulvilli on segments 3 and 4 as hairlike brushes, barely evident. Fore- and midclaws with long inner tooth, a little shorter than outer tooth; hind claw enlarged, outer tooth long and curved, with basal lobe and a small tooth at dorsoapical corner of lobe. Forewing with crossvein 2r absent. Sheath long, about 3× longer than greatest height, 0.75× as long as basal plate.

Male.—Unknown.


Etymology.—The name is based on the bright orange wings.

Discussion.—The black head and legs, orange thorax and abdomen with the apex of the abdomen black, and yellowish wings with the black apices takes this species to Derecyrt a andrei Konow in couplet 4 of my 1988 key to Derecyrt a. These two species are similar, but D. andrei (Figs. 8, 9) is separated by the black costa and intercostal area of the forewing, entirely orange abdomen (except the black sheath), and short sheath which is only about two times longer than its greatest height and more broadly rounded at its apex. Also in D. andrei, the apex of the forefemur, foretibia, and all tarsi except the apical tarsal segment of each are dark orange and the malar area from the antennal insertion to the occipital carina is dark orange. Derecyrt a andrei is known only from the type and was described from “Ecuador” by Konow (1897).

The color of the head and body are similar to D. pictipennis Smith from Amazonas (Smith 1860; described from “Ega”). Brazil, and recorded from “St. Paul, Braz.” and Peru by Smith (1988). Derecyrt a pictipennis, however, is separated from D. flavescens by its wing maculation, with a black band across the center of the forewing and black at the apex, with hyaline areas in between (Fig. 7).

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LITERATURE CITED


NEW SPECIES AND DISTRIBUTION OF THE GENUS MARILIA MÜLLER (TRICHOPTERA: ODONTOCERIDAE) IN MEXICO AND CENTRAL AMÉRICA

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Abstract.—Nine new species of the genus Marilia Müller (Odonoceridae) are described from Mexico, Belize, Guatemala, and Costa Rica: M. baumnanni, M. flinti, M. furthi, M. holzenthali, M. kingsolveri, M. mathisi, M. morsei, M. spangleri, and M. williammerrilli. The male genitalia are illustrated. The distribution of M. flexuosa Ulmer, M. nobscia Milne, and M. mexicana (Banks) is provided. A key to the males of the species of Marilia (with the exception of M. mexicana Banks) from Mexico and Central America is included.

Key Words: caddisflies, Neotropical, Mexico, Belize, Guatemala, Costa Rica

The genus Marilia Müller is widely distributed in the world, with 42 recognized extant and two fossil species. In the New World, the genus is distributed from Canada to Argentina including the Greater Antilles. However, it has not been collected in the Chilean subregion nor in the Lesser Antilles (Flint 1991).

At present, there are only three species known for North America including Mexico: Marilia flexuosa Ulmer, M. nobscia Milne, and M. mexicana (Banks). Of these, M. flexuosa has the widest distribution having been recorded from Canada to Brazil (Flint 1991). Most of the North American species are recorded from southwestern United States through Mexico and Central America.

The immature stages of M. flexuosa, M. amnnicolata, and M. scudderii were described by Wiggins (1996), Flint (1968), and Botosaneanu (1994), respectively.

In this paper, we describe nine new species of Marilia found after studying 602 specimens deposited in the collections at the University of Minnesota, St. Paul (UMSP), National Museum of Natural History, Smithsonian Institution, Washington, D.C. (NMNH), University of California at Berkeley (UCB), California Academy of Sciences, San Francisco (CAS), and Colección Nacional de Insectos, UNAM (CNIN). Acronyms are used below to indicate type depositaries.

To identify the species here described, we studied the male genitalic structures and some additional morphological characters such as the size of the eyes and the sutures of the IX segment as used by Flint (1983, 1991). All the species here described are treated in alphabetical order.

Marilia baumnanni

Bueno and Rojas, new species

(Figs. 1–5)

This species may be related to Marilia morsei by the rectangular shape of the lateral sutures of segment IX and by the similar shape of apical portion in lateral and dorsal views of segment X. However, M.
baumannii can be separated from this species, by the large eyes almost touching mid-dorsally, the shorter and wider segment X in dorsal view, and the two long, parallel, separated sutures on segment IX.

Male.—Eyes large. almost touching mid-dorsally. Length of forewing 8–10 mm. Light brown. Spurs 2,4.4. Genitalia: Segment IX in lateral aspect with anterior margin nearly straight; posterior margin lightly produced; with two curved sutures prolonged in two, parallel side arms over lateral region, and one dorsal arm along the posterior margin of segment IX. Cercus in lateral and dorsal views thumblike. Segment X in lateral aspect rectangular, apex
with a short, triangular process ventrally directed, with posterodorsal margin lightly rounded; in dorsal aspect short, stout, wide and membranous; apical region with a shallow notch mesally, dividing lateral lobes with sagittate apices. Inferior appendage in lateral aspect with basal segment cylindrical, with a distinct triangular, basal insertion; in posterior aspect preapically curved; apical segment small, ovoid with dark, conical spines. Phallus in lateral view tubular slightly curved at base, endotheal membrane with small spines; phalotremal selerite rodlike, in ventral aspect V-shaped.


Etymology.—It is a pleasure to name this species after Dr. Richard Baumann specialist in Plecoptera at Brigham Young University.

Marilia crea Mosely 1949: 40. 41 (Figs. 6-10)

The rectangular shape of the lateral sutures on segment IX distinguish this species from all other species of this genus.

Distribution.—COSTA RICA.

Material examined.—COSTA RICA: Puntarenas, S. Finca Helechales, Rio Singri 9.057°N 83.082°W el. 720 m. 21-ii-1986, Holzenthal, Morse, Fasth, 5 δ (UMSP); Alajuela, Rio Pizote, ca. 5 km N Dos Rios, el. 470 m. 10.948°N, 85.291°W, 9-iii-1986, Holzenthal & Fasth, 1 δ (UMSP); Heredia, Est. Biol. La Selva, Rio Puerto Viejo, 10.440°N, 84.012°W. 10.11-ii-1986, Holzenthal, 1 δ (UMSP).

Marilia flexuosa Ulmer 1905: 70 (Figs. 11-17)

This species can be recognized by the small size of the adults (6 mm), tibial formula 2,4,2, and the stigma in the subcostal area of forewing.

Distribution.—CANADA, UNITED STATES: AZ, CA, TX; MEXICO: Baja California Norte, Baja California Sur. Sonora, Chihuahua, Durango, Tamaulipas, Veracruz; GUATEMALA: COSTA RICA; PANAMA; PERU; COLOMBIA; BRAZIL.

Fig. 6-10. *Marilia crea*, male genitalia. 6, Lateral view. 7, Phallus, lateral view. 8, Phallus ventral view. 9, Dorsal view. 10, Ventral view.

Figs. 11-17. *Marilia flexuosa*, male genitalia. 11, Lateral view. 12, Phallus lateral view. 13, Phallus ventral view. 14, Dorsal view. 15, Ventral view. 16, Forewing. 17, Hindwing. Em = Endothecal membrane; Pm = phalotremal membrane.

Marilia flinti
Bueno and Rojas. new species
(Figs. 18-23)

Marilia flinti belongs to the group of species with tibial formula 2,4,4 and with large spines in the endothecal membrane of the phallus, as in M. nobscia. However, M. flinti can be recognized from the other species of this group by the elongated lateral suture in segment IX and by the elongate lateral arms of segment X.

Male.—Eyes small, well separated middorsally. Length of forewing 10 mm. Yellowish brown. Spurs 2,4,4. Genitalia: Segment IX in lateral view with anterior margin lightly produced in a triangular projection; posterior margin produced at mid-length, with lateral sutures almost parallel, dorsal brace slightly curved, ventral one almost straight. Cercus in lateral and dorsal view thumblike. Segment X in lateral aspect produced in a narrow process with apex truncate and ventrally directed; in dorsal aspect membranous with square mesal excision, with long lateral arms. Inferior appendage in lateral aspect with basal segment cylindrical with a distinct triangular, basal insertion, in posterior aspect curved; apical segment small, ovoid with dark, conical spines. Phallus in lateral view tubular slightly curved, endothecal membrane with large, dark, dentiform spines, phallotremal sclerite with a curled, dorsomesal process and a ventral curved sclerite in ventral aspect V-shaped.

Type material.—Holotype, δ. MEXICO: San Luis Potosi: 25 mi. N Tamazunchale, 400'. 3,4-viii-1963, Duckworth & Davis (NMNH). Paratype: Same data as holotype, 1 δ (NMNH).

Etymology.—This species is named with gratitude and affection for Dr. Oliver S. Flint Jr., emeritus researcher at the National Museum of Natural History, Smithsonian Institution, who has contributed extensively to the knowledge of this group.

Marilia furthi
Bueno and Rojas. new species
(Figs. 24-27)

This species may be related to Marilia baumannii because of the rectangular shape of the lateral sutures on segment IX and its nearly straight anterior margin and the similar shape of the apical portion of segment X in lateral and dorsal views. However, M. furthi can be distinguished from this species by the middorsally well-separated small eyes, by the two long parallel, anteriorly touching sutures on segment IX, and by the elongate, narrow, segment X in dorsal view.

Male.—Eyes small and well separated middorsally. Length of forewing 10 mm. Light brown. Spurs 2,4,4. Genitalia: Segment IX in lateral aspect with anterior margin almost straight, posterior margin slightly produced, sutures consisting of two, parallel arms touching anteriorly. Cercus in lat-
eral and dorsal views digitiform. Segment X in lateral aspect rectangular, apex with a short, triangular process ventrally directed, with posterodorsal margin rounded; in dorsal aspect long, narrow; a membranous apical region with a shallow notch mesally, dividing lateral lobes from sagittate apices. Inferior appendage in lateral aspect with basal segment cylindrical with a distinct triangular, basal insertion; apical segment elongate; in posterior aspect basal segment cylindrical; apical elongate with dark, conical spines. Phallus in lateral view tubular, slightly curved at base, endothecal membrane with small spines; phallotremal sclerite semicircular, in ventral aspect rounded.

Barba (CNIN). Paratypes: Same data as holotype, 5♂ (CNIN).

Etymology.—This species is named with gratitude and affection for Dr. David Furth, notable coleopterist and friend.

**Marilia holzenthali**

*Bueno and Rojas, new species*  
(Figs. 28–32)

*Marilia holzenthali* appears to be related to *M. flinti* by the similar shape of the segment IX in lateral aspect, with its produced posterior margin and similar distribution of sutures. However, *M. holzenthali* can be recognized from *M. flinti*, by the sagittate apex of segment X and by the presence of small spines on the endothecal membrane of the phallus.

Male.—Eyes large, separated middorsally. Length of forewing 9 mm. Fuscous. Spurs 2.4.4. Genitalia: Segment IX with anterior margin lightly produced in a square projection; posterior margin produced at midlength, with lateral sutures almost parallel, dorsal brace slightly curved, ventral one almost straight. Cercus in lateral and


dorsal view thumblike. Segment X in lateral aspect rectangular, with apex produced in a short, rectangular, ventral process and a posterodorsal rounded, small process; in dorsal aspect membranous, with a deep, wide notch on apex, with lateral, sagittate processes. Inferior appendage in lateral aspect with basal segment cylindrical with a distinct triangular basal insertion; in posterior aspect curved; apical segment small, ovoid with dark conical spines. Phallus in lateral view tubular, slightly curved, endotheal membrane with small, dark spines; phallotremal sclerite rod-like, in ventral aspect V-shaped.

Etymology.—It is a pleasure to name this species with gratitude and affection for Dr. Ralph Hozenthal, notable Trichopterist and long time friend at the University of Minnesota.

*Marilia kingsolveri*  
**Bueno and Rojas, new species**  
(Figs. 33–37)

*Marilia kingsolveri* appears to be related to *Marilia morsei* by the similarities of the elongate cercus and by the presence of only one small suture on segment IX. However, in *M. kingsolveri* the cercus appears elongate in lateral and dorsal aspects, with the apical region digitiform while in *M. morsei* the apex is spatulate.

Male.—Eyes large, almost touching middorsally. Length of forewing 8.5 mm. Fuscous. Spurs 2,4,4. Genitalia: Segment IX in lateral aspect with anterior margin slightly
concave, posterior margin sinuous, lateral suture incomplete, parallel to anterior border, slightly curved. Cercus in lateral view longer than segment X, rectangular, tapering from midlength to apex, with apical region digitiform: in dorsal aspect with apical region long and lightly curved, with basal lobes convergent. Segment X in lateral aspect widely rounded midventrally, with small posterodorsal dentiform process: in dorsal aspect membranous, with a deep, mesal notch on apical region, dividing lateral lobes with sagittate apices. Inferior appendage in lateral aspect with basal segment cylindrical, basally inserted by elliptical process, apical segment elongate, narrower at midlength. Phallus in lateral view cylindrical, lightly curved at base, endotheal membrane with small spines; phalotremal sclerite in lateral aspect sinuous, in ventral view V-shaped.

Type material.—Holotype, ♂. COSTA RICA: Puntarenas, Rio Bellavista, ca. 1.5 km NW Las Alturas, 8.951°N, 82.846°W, el. 1400 m, 8.9-iv-1987, Holzenthal, Hamilton & Heyn (UMSP). Paratypes: COSTA RICA: Puntarenas: Rio Bellavista, ca. 1.5 km NW Las Alturas, 8.951°N, 82.846°W, el. 1400 m, 2.3-viii-1987, Holzenthal, Morse & Clausen, 2 ♂ (UMSP); Puntarenas, Rio Guineal, ca. 1 km (air) E. Finca Helhechales, 9.076°N, 83.092°W, el. 840 m, 22-ii-1986, Holzenthal, Morse & Fasth, 1 ♂ (UMSP); Guanacaste: Parque Nacional Guanacaste, Rio San Josecito, Est. Mongo, 10.922°N, 85.470°W, el. 960 m, 22-29-vii-1987, Holzenthal, Morse & Clausen, 1 ♂ (UMSP).

Etymology.—It is a pleasure to name this species for Dr. John Kingsolver, notable coleopterist.

Marilia mathisi
Bueno and Rojas. new species
(Figs. 38–41)

Marilia mathisi belongs to the group of species with tibial spurs 2,4,4, and is related to M. nobsca by the similar shape of the apex of segment X in lateral and dorsal view. However, M. mathisi can be distin-
guished from this species by the two different size squares produced by lateral sutures of segment IX, of which the larger square is incomplete.

Male.—Eyes large, virtually touching middorsally. Length of forewing 12 mm. Fuscos. Spurs 2,4,4. Genitalia: Segment IX with anterior margin slightly sinuous, posterior margin lightly produced with apex rounded, sutures forming two different size squares, large square with suture anterobasally incomplete. Cercus in dorsal and lateral view, long and digitiform. Segment X in lateral aspect wide at base, with narrow apex curved ventrad; in dorsal aspect sagittate, dorsum elongate with a shallow notch at apex. Inferior appendage in lateral aspect with basal segment terete, basal insertion triangular; apical segment short, digitiform. Phallus in lateral aspect curved basally, endotheal membrane with very small spines; phalotremal sclerite in lateral view, hooklike.


Etymology.—It is an honor to name this species with gratitude and affection for Dr. Wayne Mathis, notable Dipterist and long time friend at the National Museum of Natural History. Smithsonian Institution.

Marilia mexicana (Banks)
Leptocerus mexicanus Banks 1901: 368.
Athripsodes mexicans: Fischer 1965: 211.

This species is based on the female holotype, and males have not been associated. Therefore, are unable to present figures of the male.

Marilia morsei
Bueno and Rojas. new species
(Figs. 42–46)

Marilia morsei appears to be related to M. kingsolveri by the similar elongate size
of the cercus and by the presence of only one small suture on segment IX. However, *M. morsei*, can be recognized by the cercus which appears elongate with apex spatulate in lateral and dorsal aspect, while in *M. kingsolveri* the apex is narrowed and digitiform.

Male.—Eyes large, almost touching mid-dorsally. Length of forewing 9 mm with bands dark and pale. Fuscous. Spurs 2.4.4. Genitalia: Segment IX in lateral aspect with anterior margin lightly concave; posterior margin sinuous, lateral suture lightly curved, incomplete and parallel to anterior border. Cercus in lateral and dorsal views longer than segment X; in lateral aspect wide at base, slightly narrowed at mid-length, with apical region spatulate; in dorsal aspect long and curved, with apical region squared. Segment X in lateral aspect conical; in dorsal aspect membranous centrally, with a wide, mesal notch on apical region, separating lateral lobes with sagitate apices. Inferior appendage in lateral aspect with basal segment cylindrical, basally inserted by elliptical process; apical segment elongate and digitiform. Phallus in lateral view cylindrical, lightly curved at base, endothecal membrane with small spines; phallostremal sclerite in lateral aspect curved, in ventral view V-shaped.

Figs. 42-46. *Marilia morsei*, male genitalia. 42, Lateral view. 43, Phallus lateral view. 44, Phallus ventral view. 45, Dorsal view. 46, Ventral view.

Paratype: Same data as holotype, 1 ♂ (NMNH).

Etymology.—This species is named with gratitude and affection for Dr. John C. Morse, notable trichopterist and long time friend.

*Marilia nobsca* Milne 1936:79  
(Figs. 47–51)

This species, with tibial formula 2. 4. 4, can be recognized by the numerous large spines on the endothecal membrane of the phallus.


New records.—MEXICO: Baja California Sur, Sonora, Chihuahua, Durango, Veracruz, Guerrero, Estado de Mexico, Oaxaca, Chiapas. GUATEMALA.

**Marilia spangleri**

Bueno and Rojas. *new species* (Figs. 52–56)

This species and *Marilia holzenthali* have segment X with a deep and wide cleft that separates the lateral lobes, and the position of the lateral sutures is very similar in segment IX. However, *M. spangleri* can be recognized by the short, stout cercus in lateral and dorsal views, and by the lateral lobes of segment X having their apices rounded with a small, dark, preapical dentiform process.

Male.—Eyes small, widely separated middorsally. Length of forewing 10 mm. Fuscous, posterior wings white. Spurs 2,4,4. Genitalia: Segment IX in lateral aspect with anterior margin lightly rounded; posterior margin lightly produced and continuous with segment X, with dorsal sutures prolonged in two parallel side arms over dorsal region, and two ventral arms widely separated, forming with ventral suture a triangle-like area. Cercus in lateral and dorsal view thumblike. Segment X in lateral aspect rectangular, apex with short, rectan-
gular, ventral process and posterodorsal slightly rounded lobe; in dorsal aspect membranous, apical region with a deep, wide mesal notch, separating lateral lobes with rounded apices and a small, dentiform, preapical process. Inferior appendage in lateral aspect with basal segment cylindrical with a distinct triangular, basal insertion; in posterior aspect curved; apical segment small, ovoid with dark, conical spines. Phallus in lateral view tubular, slightly curved, endothecal membrane smooth; phalloctremal sclerite rodlike; in ventral aspect rounded and dark.


Etymology.—It is a pleasure to name this species with gratitude and affection for Dr. Paul J. Spangler, notable coleopterist and long time friend.

**Marilia williammerrilli**

Bueno and Rojas. *new species* (Figs. 57–61)

*Marilia williammerrilli* can be considered a distant relative of *M. flexuosa* because of the presence of similar tubial formula, 2.4.2, same size of forewing 6.5 mm, and similar spatulate shape of segment X in lateral view. However, *M. williammerrilli* can be distinguished from that species by the paler coloration of the body, by the lack of stigma in the forewing subcostal area, and by the lateral sutures of segment IX forming two similar squares.

Male.—Eyes large, widely separated middorsally. Length of forewing 6.5 mm. Pale brown. Spurs 2.4.2. Genitalia: Segment IX in lateral view with anterior margin almost straight with small triangular process near base; posterior margin mesally produced with apex rounded; posterior bor-
der with a long suture outlining two similar rectangular areas. Cercus, in dorsal and lateral views, long, and digitiform. Segment X in lateral aspect rectangular, with small rounded, posterodorsal lobe; in dorsal aspect, membranous with apex sagittate, with a deep narrow, notch at apex, separating lateral sagittate lobes. Inferior appendage in lateral aspect with basal segment terete, basal insertion triangular; apical segment short, and rounded. Phallus in lateral aspect curved basally, endothecal membrane with small spines; phallotremal sclerite elongate, in ventral view V-shaped with a dorsal rounded arms.

Type material.—Holotype, ♂. COSTA
RICA: Alajuela: Reserva forestal San Ramon, Rio San Josecito y tributarios, 10.216°N, 84.607°W, el. 980 m, 30-iii,1-iv-1987, Holzenthal, Hamilton and Heyn (UMSP). Paratype: Alajuela: Cerro Campana, R. Bochinche Trib., 6 km (air) NW Dos Rios, 10.945°N, 85.413°W, el. 600 m, 22,23-vii-1987, Holzenthal, Morse and Clausen, 1 δ (UMSP).

Etymology.—This species is named with gratitude for Dr. William Merrill, notable Anthropologist at the National Museum of Natural History, Smithsonian Institution.

KEY TO MARILIA SPECIES OF MEXICO AND CENTRAL AMERICA

1. Tibial formula 2, 4, 2 ............................ 2
- Tibial formula 2, 4, 4 ............................ 3
2. Eyes widely separated middorsally .......................... M. williammerrilli, n. sp.
Eyes almost touching middorsally .................M. flexuosa Ulmer

3. Eyes small, widely separated middorsally ..........4
Eyes large, slightly separated middorsally ..........6

4. Segment X in dorsal aspect with a square mesal excision (Fig. 22) ...............M. flinti, n. sp.
Segment X in dorsal aspect without a square mesal excision (Figs. 26, 55) ...........5

5. Segment X in dorsal aspect with apical region with a shallow mesal notch (Fig. 26) ..............M. furthi, n. sp.
Segment X in dorsal aspect with apical region with a deep mesal notch (Fig. 55) ..............M. spangleri, n. sp.

6. Eyes well separated middorsally ..................M. holzenthali, n. sp.
Eyes slightly separated middorsally .................7

7. Segment IX in lateral view with only one simple suture (Figs. 33, 42) .................8
Segment IX in lateral view with more that one simple suture (Figs. 1, 6, 38, 47) ..........9

8. Cercus in dorsal view with apex rounded, digitiform (Fig. 36) ..................M. kingsolveri, n. sp.
Cercus in dorsal view with apex spatulate (Fig. 45) ..................M. morseli, n. sp.

9. Phallus with large visible spines (Figs. 9, 10) ..............M. nobesca Milne
Phallus with tiny, barely visible spines (Figs. 2, 7, 39) ..................10

10. Segment IX in lateral view, with sutures forming a small square on posterior border. (Fig. 38) ..................M. matisisi, n. sp.
Segment IX in lateral view, with sutures not forming such a square on posterior border (Figs. 1, 6) ..................11

11. Segment IX in lateral view with anterior suture apparently lacking (Fig. 1) ..................Marilia baumannii, n. sp.
Segment IX in lateral view with anterior suture apparently present (Fig. 6) ..................Marilia crea Mosely

ACKNOWLEDGMENTS

We are grateful to Oliver S. Flint Jr., Smithsonian Institution, and Ralph W. Holzenthal, University of Minnesota, for their invaluable assistance in sorting material, verifying identifications, and critically reviewing the manuscript. We are also grateful to Nancy Adams, Smithsonian Institution, for her help during the visit of the senior author at the Smithsonian Institution, to Cheryl Barr, University of California at Berkeley (UCB), and to Keve Rivardo and Vincent Lee, California Academy of Sciences (CAS), for the loan of specimens, and to Rafael Barba-Alvarez for his help during the collection of material in Mexico.

LITERATURE CITED

DESCRIPTION OF THE LARVA OF PHAEOGALA RUF A ABDULLAH
(COLEOPTERA: MYC TER IDAE: LAC CONOTINAE), WITH
NOMENCLATURAL NOTES FOR THE GENUS PHAEOGALA

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Abstract.—The mature larva of Phaeogala rufa Abdullah (Myceridae: Lacconotinae) is described and illustrated, representing the first description of a mycterid larva from Madagascar. The larva of P. rufa is compared to all other described and several undescribed larvae of Lacconotinae. Aeschyntelus signatus (Grouvelle) (Bothrideridae: Bothriderini) and an unidentified chaetosomatid larva are reported to parasitize and prey upon P. rufa, respectively. The following new combinations and synonyms are proposed: Phaeogala Fairmaire 1896 = Falsistictodrya Pic 1931 new synonym, Phaeogala biimpressa (Pic) new combination; Phaeogala breviscutata Fairmaire 1898 = Mimophyscius madecassus Pic. 1935 new synonym, Mimophyscius breviscutata (Fairmaire) new combination.

Key Words: Madagascar, Myceridae, Bothrideridae, Chaetosomatidae, larvae

The lacconotine Myceridae are a diverse assemblage of 20 described genera and over 100 species, especially well represented in tropical regions of the world, but known also from temperate Australia and North and South America (Blair 1928, Lawrence et al. 1999a). The taxonomy and systematics of the group have not been treated comprehensively, although this an ongoing research project (DAP, unpubl.).

Despite the relatively large number of lacconotine taxa, only eight species, representing five genera have formally described larvae. The described taxa are: Eurypus rubens Kirby (Bondar 1940), Eurypus muelleri Seidlitz, Stilpnonotus postsignatus Fairmaire (Costa et al. 1988), Lacconotus piniculus Horn (Lawrence 1991), Physcius fasciatus Pic (Pollock 1995), Physiomorphus subcostulatus Pollock. Physiomorphus angustus Pollock and Physiomor mus melanus (Champion) (Pollock et al. 2000). We add the larva of the first known Phaeogala species, and compare it to those lacconotines previously described, as well as undescribed specimens assembled from several collections (Table 1).

Phaeogala was described by Fairmaire (1896) in the Pedilidae, where it resided until Abdullah (1965) revised the genus (seemingly based solely on type material) and transferred the five included species to the lacconotine Myceridae. Although Abdullah (1965) speculated that Phaeogala is related closely to the Chilean genus Loboglossa Solier, in the absence of an analysis, the phylogenetic relationships of Phaeogala remain unknown. Larval characters are expected to provide useful data for such an analysis, and the larval description herein is a step toward providing these data.
Table 1. Matrix of characters and character states for selected larvae of Mycteridae: Lacconotinae. Taxa indicated by numerals represent undescribed/unassociated larvae. References are given for described larvae, undescribed specimens are cited by museum Coden. Characters and character state definitions are given in the text.

<table>
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<tr>
<th>Source</th>
<th>Taxon/Characters</th>
<th>1</th>
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<th>3</th>
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<th>6</th>
<th>7</th>
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<td>1</td>
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<td>—</td>
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<td>1</td>
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<td>1</td>
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<td>2–4</td>
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<td>2–5</td>
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<td>2</td>
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<tr>
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MATERIALS AND METHODS

This study is mainly based on 100+ larvae, six pupae and 14 (10 female and four male) adults collected under the bark of the trunk of a single dead tree lying on the ground at: MADAGASCAR, Tuléar Province, near Mananjary Reserve, 24°46’38’’S, 46°51’54’’E, ca. 25 km NNW of Tolonaro (Fort Dauphin), 80 m elev., M.A. Ivie and D.A. Pollock, collectors. Specimens were collected over the 3 days 16–18 November 1994. These specimens, as well as additional material of larval and adult Mycteridae were obtained from or deposited in the authors’ collections (DAPC, MAIC) and the following:

ANIC. Australian National Collection of Insects, Canberra, Australia.
MZSP. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil.

Verbatim label data from types are enclosed in quotation marks; individual labels are separated by a slash (/). Information in square brackets is added for clarity.

Diagnostic features of mycterid larvae (some of which are undescribed/unassociated) are given in Table 1. None of these characters has been analyzed in a phylogenetic context, and character states have not been polarized. The characters are coded as follows: 1, Urogomphal pits: 0 = absent; 1 = present. 2. Number of ventral aspersities along posterior margin of segment 8. 3. Number of abdominal segments with dorsal aspersities. 4. Shape of dorsal abdominal aspersities: 0 = linear; 1 = U-shaped. 5. Number of abdominal segments with ventral aspersities. 6. Shape of ventral abdominal aspersities: 0 = linear; 1 = U-shaped. 7. Posterior margin of urogomph plate: 0 = smooth; 1 = denticulate; 2 = with 3 small tubercles. 8. Abdominal spiracles: 0 = round, accessory openings around peritreme; 1 = oblong, accessory openings clustered at one end; 2 = elliptical, accessory openings forming diamond shape on either side of peritreme.

Phaeogala rufa Abdullah
(Figs. 1–11)

Figs. 1–8. *Plaeogala rufa*. 1. Dorsal habitus. 2. Detail of dorsum of head and thorax. 3. Left mandible, dorsal. 4. Right mandible, dorsal. 5. Right mandible, ventral. 6. Left mandible, ventral. 7. Epipharynx. 8. Labium and hypopharynx. Scale bar = 1 mm (Figs. 1–2); 0.25 mm (Figs. 3–8).
The holotype of *P. rufa* is in poor condition, but appears to be conspecific with the newly collected material reported in this study.

Mature larva.—*Body* (Fig. 1): Parallel-sided, widened posterior to midlength, distinctly flattened dorsoventrally; lightly sclerotized except for head, tarsal tibia, lateral edges of A8, and urogomphal plate; vestiture consisting of scattered setae.

*Head* (Figs. 1–2): Prognathous, lateral edges evenly rounded, evenly sclerotized except for unsclerotized ventral band extending from posterior extent of hypostomal rods to near anterior stemmata; epicranial stem very short; two small, incised sutures along posterior margin of epicranial plate, one on either side of midline; frontal arms V-shaped posteriorly, extending laterally to near stemmata; hypostomal rods distinct, slightly divergent posteriorly; antenna 3-segmented, ratio of antennomere lengths approximately 1:1:0.4; antennomere 1 parallel-sided basally, then asymmetricaly dilated apically; antennomeres 2 and 3 parallel-sided; antennomere 2 with low, dome-like ventral sensorium; antennomeres very sparsely setose, antennomere 3 with long apical seta (missing on Fig. 2); 5 stemmata per side: anterior tightly clustered group of three, and posterior group of 2. Mandibles (Figs. 3–6) symmetrical, each apically tridentate, with single short, subapical tooth on dorsal carina; dorsal ornamentation absent; molae small, symmetrical, each with anterior premolar tooth, and indistinctly tuberculate occlusal surface. Labrum free, transverse, with pair of long discal setae and row of shorter, anterior marginal setae; posterior margin of epipharynx (Fig. 7) distinctly sclerotized, with raised W-shaped sclerome coincident with circular patch of sensilla on disc; tormae distinct, elongate. Ventral mouthparts retracted; maxilla with malar apex rounded, not cleft apically, without uncus; inner edge of mala with long tooth subapically, and several dorsally directed, thickened apical setae; palpus distinct, 3-segmented; ligula (Fig. 8) broadly rounded or subtruncated anteriorly; labial palpus 2-segmented, distinctly shorter than ligula.

*Thorax* (Figs. 1–2): Prothorax transverse, sides subparallel, slightly constricted posteriorly; anterior transverse region more distinctly sclerotized; distinct mediad ecdysial suture present; meso- and metathorax more or less equal in size and shape; ventrally, a distinct, longitudinal sclerotization present along midline of intersternite between pro- and mesothorax; thoracic spiracle large, slightly elliptical, annular-multiforous, with small accessory chambers along posterior wall of peritreme; legs distinct, with sparsely scattered, slender setae.

*Abdomen* (Figs. 1, 9–10): A1 to A7 similar in size and shape, segments broader posteriorly; A8 distinctly longer than A7; sterna and terga without elliptical patches of asperities; S8 deeply emarginate, enclosing U-shaped S9; each side of S9 with 3 asperities along posterior margin, decreasing in size medially; each side of A8 divided into several smaller sclerites in association with articulation of urogomphal plate; spiracles annular-multiforous, round, smaller than thoracic spiracle.

Urogomphal plate (Figs. 9–10) hinged to posterior margin of A8, distinctly wider than long, and wider than posterior margin of A8; laterobasally broadly lobate, produced posteriorly into pair of acute, apically upturned urogomphi; posterior edge of urogomphal plate slightly bisinuate; accessory urogomphal teeth absent; surface with minute tubercles with pores, several elongate setae on each side of plate: posteroventral surface of urogomphal plate with rugose sculpturing; urogomphal pits present, circular, oriented posteroventrally; pits separated by >3× their diameters; setae within pits densest on ventral and anterior pit walls.

Natural history.—The habitat where our material was collected was relatively undisturbed (especially in comparison with the surrounding area), although not true primary forest. The collection locality was
Figs 9–11. Phaeogala rufa. 9, Dorsal detail of A8 and urogomphal plate. 10, Ventral apex of A8 and urogomphal plate. 11, Aeschyntelus signatus larva embedded in P. rufa larva. Scale bars = 1 mm.

part of a forest patch being at least partially cleared through burning, even as we collected, but adjacent to closed-canopy moist, primary forest protected in the Manangotry Section of the Tsitongabarika Forest Reserve.

Larvae of P. rufa were found subcortically on the inner bark surface of a single unidentified dead hardwood tree with branch and bole diameters ranging from about 5 to 25 cm. The inner bark surface was rather dry, quite sound and smooth, without any loosened, friable material. This habitat was shared with many larval and adult Monomma sp. (Zopheridae: Monommatinae) [MAIC]. A variety of sizes of P. rufa larvae were present, presumably representing several instars. Larvae exhibited preference for the undersides and shaded parts of the tree branches. Pupae and adults were found in elliptical pupal cells constructed of inner bark material. Larval exuvia were attached to the posterior end of pupae, and were collected in association with the pupae. Larvae were compared to the exuvia and the two were found to be
conspecific. All material was preserved in 70% ethanol. Larval voucher specimens of *P. rufa* are deposited in ANIC, DAPC, MAIC.

Two predatory/parasitic species were found associated with *P. rufa* specimens, both worthy of note. A single larval Bothriderini [MAIC] was found within a pupal cell with the head and part of its thorax embedded in the thorax of a prepupal larva of *P. rufa*. The parasitoid and host were preserved together, and then separated after being illustrated (Fig. 11). Three adult *Aeschynelus signatus* (Grouvelle) (Bothrideridae: Bothriderini) were found nearby in the tunnels of *P. rufa*. They agree with the larva attacking *P. rufa* in size, and are presumed to belong to the same species (see below). This represents the first record of a mycterid host for a bothriderid (Lawrence et al. 1999b).

MAIC had the opportunity to compare the three adult *A. signatus* collected from the same locality as the *P. rufa*, with a series of seven specimens (including the lectotype and paralectotype designated by Dajoz 1980) from the MNHN. Only the types had locality labels, naming the tropical far-northern city of Antsiranana (= Diego-Suarez). The other three were from the Sicard collection, and Dajoz (1980) attributed those specimens to the Montagne d’Ambre, also in the extreme north. Six of the MNHN specimens differed from the seventh and our three in size and degree of punctuation. The large individuals ranged from 4.4–4.8 mm in elytral length, the intermediate specimen was 3.7 mm, while our series ranged from 3.3–3.5 mm. The larger individuals differed in having denser, deeper, and coarser punctuation on the head, pronotum, prosternum, and abdomen; in the more under-cut apex of the carinate second elytral interstria; and a longitudinally grooved prosternal process. Our series had noticeably shallow punctuation, especially on the venter, more truncate second elytral interstria, and a smooth intercoxal process. They also had traces of golden setae between the two patches on the second elytral interstria. The intermediate specimen, labeled December 01, is distinctly closer to the larger series in punctuation density, prosternal groove, and pubescence, but has lighter punctuation, and a truncate second interstria, suggesting the trends seen in our series. Therefore, we consider all of the specimens examined to belong to a single, variable, species.

A single larval Chaetosomatidae [MAIC] was also found in a pupal cell of *P. rufa*. No associated adult of this species was found, but two genera (*Malgassochaetus Ekis and Menier and Somatochaetus Menier and Ekis*) occur in Madagascar (Ekis and Menier 1980, Menier and Ekis 1982). This is the first report of a larva of Malagasy chaetosomatids and the first report of mycterid prey for the family, the only previously reported associations being from New Zealand, which lacks Mycteridae (Lawrence et al. 1999a).

Discussion.—The larva of *Phaeogala* shares with all other described mycterid larvae several defining characters, especially the horseshoe-shaped sternite 9, which encloses segment 10, and bearing several asperities along its posterior margin. Lawrence (1991), Pollock (1995), and Pollock et al. (2000) listed several other features of larval Mycteridae, notably the asperities on abdominal sternites and tergites, and the pair of urogomphal pits or the median process on the urogomphal plate. All mycterid larvae examined (including some undescribed taxa, indicated above in quotation marks) exhibit the U-shaped sternite 9. However, the other characters are not found in all taxa.

**New Synonyms and Combinations**

In the course of this project, four required nomenclatural changes have been discovered. We take this opportunity to make these corrections.

Although *Phaeogala* was reviewed by Abdullah (1965), he failed to compare the type of *P. breviscutata* Fairmaire with gen-
era of Lacconotinae described by Pic. During examination of the Pic types of Lacconotinae, DAP discovered that the holotype of *P. breviscutata* is conspecific with *Mimophyscius madecassus* Pic, the type species of the monotypic genus *Mimophyscius* Pic. This requires the following taxonomic changes:

*Mimophyscius breviscutata* (Fairmaire), new combination


Another monotypic Pic genus, *Falsostictodrya*, was found to be synonymous with *Phaeogala*, producing the following new synonym and new combination:

*Phaeogala* Fairmaire


*Phaeogala biimpressa* (Pic), new combination


**ACKNOWLEDGMENTS**

Our field work and the study of types in Paris were made possible by Grant No. 687-0517-G-00 from the US Agency for International Development (Biocontrol of Locusts in Madagascar), and we thank Will Swearingen and Dan Swanson (Montana State University) for their support for our portion of this project. The Department of Entomology, Montana State University, and a Rea Postdoctoral Fellowship, Carnegie Museum of Natural History, provided further support for the research. Our colleague, Joseph Rasolomandimby of the Service Antiaridien of the Malagasy Département de la Protection des Végétaux was invaluable in the field. Thanks also to our driver Georges, who somehow got us to the Manangotry site over treacherous “roads” and “bridges.” Nicole Berti, Muséum National d’Histoire Naturelle, gave generously of her time in the often difficult search for type specimens. John Lawrence provided specimens from the ANIC, and Cleide Costa and Sergio Ide for those from the MZSP. Richard Hurley, Jeff Littlefield and Alistair Ramsdale kindly reviewed an earlier version of the manuscript. This is contribution J2003-14 of the Montana Agricultural Experiment Station.

**LITERATURE CITED**


nales de la Société Entomologique de France (N.S.) 16: 197–208.

DESCRIPTION OF A NEW SPECIES OF HYADINA HALIDAY
(DIPTERA: EPHYDRIDAE)
FROM SOUTHERN CALIFORNIA

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Abstract.—Hyadina clauseni, new species, from Tecopa Hot Springs (California, Inyo County) is described, and information on its natural history is provided. Hyadina Haliday is redescribed, it nomenclatural status is discussed, and a revised key to known Nearctic species of the genus is provided.

Key Words: Diptera, Ephyridae, shore flies, Hyadina clauseni, California

The shore-fly genus Hyadina Haliday is represented in the Nearctic Region by eight species and one subspecies (Clausen 1983, 1984; Mathis and Zatwarnicki 1995). Recent field work in southern California resulted in the discovery of a very unusual and undescribed species of Hyadina, which we describe here to highlight its anomalous morphology, especially the flexure of its wings, and its distribution.

In living and preserved specimens, the wings of this species are folded over the abdomen at two specific flexure points, similar to some species of Stegana Meigen (Diptera: Drosophilidae) and somewhat like the elytra of coleopteran forewings. Perhaps these flies are imitating small beetles or maybe the folding affords greater protection of the abdomen. When we initially collected specimens in the field, we first guessed that they represented a species of Clano- neurum Becker (Diptera: Ephyridae), which folds its wings in a similar manner over the abdomen and which also occurs in arid, saline areas where there are host plants of the family Chenopodiaceae (Mathis and Zatwarnicki 1995). The arid and saline conditions coupled with plant species of the family Chenopodiaceae characterize, in part, the environs of Tecopa Hot Springs (Inyo County), where we collected the type series. We were surprised, on closer inspection, to discover that the specimens represent a species of Hyadina. Although some species of Hyadina are known to have brachypterous wings (Clausen 1984), we are unaware of any congener that demonstrates this unusual folding of wings. These morphological anomalies further prompted the research that has resulted in this paper.

Tecopa Hot Springs, the provenance of the new species, is near the southern end of Death Valley in southern California, and hydrographically it is part of the Amargosa River drainage system of the Great Basin (Morrison 1991, Madsen et al. 2002). The habitat associated with the Springs is also the type locality for another shore fly, Paracoenia wirthi Mathis, and in just two hours of recent field work there, we found the area to be rich in shore-fly species (Psilopa gir- schneri von Röder, Psilopa sp (probably...
new). *Ptilomyia occidentalis* Sturtevant and Wheeler, *P. pleuriseta* (Cresson), *P. sp* (probably new), *Notiphila decoris* Williston, *Typopsilopa atr"a* (Loew), *Allotrichoma sp* (?), *Illythea flaviceps* Cresson, *Lytogaster gravida* (Loew), *Pelina prospinosa* Clausen, *Calocen"ia platypelta* (Cresson), *Paracoen"ia wirith Mathis, Ephy"dra packardi* Wirth, *Lamproscatella occidentalis* Mathis, *Philotelma* sp (probably new), *Haloscatella muria* (Mathis), *H. salinaria* (Sturtevant and Wheeler). *Scatella paludum* (Meigen), *Scatella sp* (frequently and questionably identified as *S. stagnalis* (Fallén); Nearctic species of *Scatella* need revision), and *Scatophila variabilis* Cresson). Moreover, the occurrence of some shore-fly species at these springs, such as the undescribed species of *Philotelma*, the new species of *Hyadina* being described here, and *Pelina prospinosa*, is somewhat atypical for their respective genera. Species of *Philotelma* and *Pelina*, for example, are more typically boreal in distribution (Clausen 1973) or at more southern latitudes, such as Chiapas, Mexico (San Cristobal de las Casas (20 km E, 2050 m)), they are found at much higher elevations (Clausen 1987).

Because there is an unusual concentration of endemic shore-fly species at Tecopa Hot Springs, we suggest that this area, including the springs, is and may have been a refugium for shore flies during interglacial periods of aridity, such as now. The area around Tecopa Hot Springs has been subjected to repeated and fluctuating climatic cycles. There have been periods of much higher rainfall, such as during the Pliocene and Pleistocene when the pluvial Lake Tecopa covered the area (Lowenstein 2002), followed by extended periods of aridity, similar to the existent climate, when aquatic systems and these springs are isolated. These fluctuating climatic events, with transitions sometimes over relatively short periods of time, may have contributed to the isolation and speciation of some of the apparently endemic shore-fly species that occur there.

**Methods**

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. We follow the terminology for most structures of the male terminalia that other workers in Ephyridae have used (see references in Mathis 1986; Mathis and Zatwarnicki 1990a, b) and these agree with terms Zatwarnicki (1996) proposed in the “hinge” hypothesis for the origin of the eremoneuran hypopygium. The terminology for structures of the male terminalia is provided directly on Figs. 12–13, 17–20 and is not repeated for comparable illustrations of other species. The species descriptions are composite and not based solely on the holotypes. One head and three venational ratios that are used in the descriptions are defined below (all ratios are averages of three specimens (the largest, smallest, and one other).

1. Gena-to-eye ratio is the genal height measured at the maximum eye height divided by the eye height.
2. First costal vein ratio is the straight line distance between the apices of R_{2,3} and R_{4,5} (costal section II) divided by the distance between the apices of R_1 and R_{2,3} (costal section III).
3. M vein ratio is the straight line distance along M between crossvein dm-cu and r-m divided by the distance apicad of crossvein dm-cu.
4. Wing ratio is the greatest wing width divided by the length (from base of cell bm to wing apex).

**Genus Hyadina** Haliday

*Hydrina* Robineau-Desvoidy 1830: 794.

type species: *Hydrina vernalis* Robineau-Desvoidy 1830 (= *Notiphila gutta*ta Fallén 1813), subsequent designation.
Coquillett 1910: 553. Preoccupied (Rafinesque 1815, Coelenterata).


**Diagnosis.**—Small to medium-sized shore flies, body length 1.20–2.70 mm: mostly shiny black, often with dense microtomentum on abdomen; setation generally weakly developed.

**Description.**—**Head:** Frons bare to densely microtomentose. Face generally paler than frons, yellow to dark yellowish brown with golden, yellowish silver, or silvery gray microtomentum extended to gena. Gena often concolorous with ventral parafacial plate, sometimes ventral gena bare or with sparse microtomentum. Chaetotaxy: ocellar setae well developed, divergent, proclineate; pseudopostocellar setae minute, divergent, proclineate; fronto-orbital setae, minute, 3–5 pairs, proclineate; medial vertical setae well developed; lateral vertical well developed or reduced; facial setae, minute, in 2–3 rows. Antenna yellow, yellowish brown, or brown; scape, pedicel, and 1st flagellomere often darker dorsally; scape with row of setulae along apicoventral margin; 1st flagellomere microtomentose with numerous setulae; arista bearing very short rays on dorsum. Palpus prominent, yellow to dark yellowish. Gena low to moderately high.

**Thorax:** Mesonotum bare or with sparse to dense microtomentum, ground color pale brown to dark brown, microtomentum gold- en, silver, velvety black or brown, often marked with distinct vittae. Scutellum trap-zoidal with posterior margin slightly rounded, lateral margins sometimes with dense velvety black patches; pleura often paler than mesonotum; anepisternum bare or with dense microtomentum, often dorsally with black velvety patches; katepisternum bare or with sparse to dense microtomentum. Chaetotaxy: pre and poststural dorsocentral setae lacking; scutellar and acrostichal setae well developed: 1 prominent supra-alar seta; anterior notopleural setae either well developed, reduced, or lacking; 1 anepisternal seta, small to minute, inserted along postero medial margin; 1 katepisternal seta, small to minute, inserted along dorsomedial margin; 2 lateral scutellar setae, posterior seta inserted apically, lateral seta ½–½ length of posterior seta. Wing: hy aline to yellowish brown; crossvein dm-cu often with dark borders and hyaline spots in the surrounding wing areas; rarely with additional stump veins or brownish pattern in wing; costa extended to vein M. Legs: yellow, yellowish brown, to dark brown; covered by rows of minute setulae; femora and tibiae often with pattern of pale and dark areas; apical tarsomere and sometimes tarsomere 4 often darker than proximal tar someres. Halter knob white, yellow to yellowish brown.

**Abdomen:** Five abdominal tergites normally exposed in males, cerci well developed; abdominal tergites 6–8 normally exposed in female, cerci well developed; generally shiny with sparse microtomentum; ground color yellowish brown, brown to dark brown; partially bare, and usually with distinct areas of sparse to dense microtomentum; tergites setulose, with setal rows along margins. In some species tergites 2 and 3 laterally with separated plates, reaching ventral margin of abdomen. Female without fused sternites. Male terminalia: epandrium often narrow, especially dorsally, lacking setae, separated from cerci; surstylus attached with venter of epandrium, variously shaped, mostly triangular or
rounded anteriorly, bearing 1 to several strong setae towards or at anterior margin; cercus semicircular to oval; aedeagus in most species long, slender, bearing posterodorsal process, rarely oval in ventral view, usually conspicuously arched in lateral view; phallapodeme usually long and narrow, rarely triangular in lateral view; gonite fused with hypandrium, rarely bearing anteroventral seta, usually without setae, often arcuately triangular and tapered apically in lateral view; hypandrium shallow, directed perpendicularly [transversely] to gonites.

Discussion.—The nomenclatural issues associated with Hyadina are rather complex and warrant further explanation. Robineau-Desvoidy (1830) first described the genus Hydrina but without designating a type species. Coquillett (1910) subsequently designated Hydrina vernalis Robineau-Desvoidy (= H. guttata (Fallén), 1813) as the type species for Hydrina, thus making Hydrina
the senior synonym of Hyadina. Both genus-group names share H. guttata (Fallén) as its type species. As the senior synonym, Hydrina was used by some authors as the valid generic name (Cresson 1926, Frey 1945). Hydrina, however, is preoccupied (Rafinesque 1815, Coeletenterata) and is thus not a valid genus-group name in the Ephydrae. Although Loew (1862) noted that Hydrina was preoccupied much earlier, this generic name continued to be used in faunistic papers (Cresson after 1926 and almost all European authors until 1975), and until 1968 it was also used for species descriptions in the genus Philygria Stenhammar. This resulted in part because Cresson (1930) did not accept Coquillet's designation of H. guttata Fallén as the type species of Hyadina, assuming that it was not the senior synonym of Hydrina vernalis. Cresson (1930) reasoned that H. guttata was ineligible to be the type species because it was not a species that Robineau-Desvoidy (1830) had included in his genus, and thus Cresson (1930) designated H. maculipennis Robineau-Desvoidy (junior synonym of Philygria interstincta (Fallén 1813)) as the type species for Hydrina, making Philygria and Hydrina synonyms. Coquillet's designation, however, is valid (ICZN article 69.2.2., ITZN 1999) and Cresson's (1930) subsequent typification is thus superfluous. Two other subsequent designations of type species for Hydrina are also invalid as they did not designate an originally included species: (1) Westwood's (1840) designation of H. punctatonervosa (Fallén 1813) and (2) Becker's (1926) designation of H. stictica Meigen. Thus, Hyadina is the valid senior synonym for this genus.

Although Hollmann-Schirrmacher (1998) recently synonymized Lytogaster with Hyadina, following the precedent of Sturtevant and Wheeler (1954), we question the basis for the synonymy and prefer recognition of both genera until we have better studied and analyzed the evidence.

We are recognizing the subspecies of H. furva (H. furva furva and H. furva flavipes) as Clausen (1983) treated them, mostly being identified on the basis of their distribution. We have not examined pertinent specimens in any further detail.

Species of Hyadina are found throughout the world in temperate and tropical regions (Mathis and Zatwarnicki 1995). Larvae of Hyadina are multivoltine, specialized consumers of soil-inhabiting Cyanobacteria (blue-green algae; Foote 1977, 1993). Adults occur in marsh-reed habitats, sedge marshes, and grass lawns adjacent to aquatic habitats (Deonier 1965, Foote 1993).

**KEY TO NEARCTIC SPECIES OF HYADINA** (modified from Clausen 1983, 1984)

1. Wing with crossveins r-m and dm-cu white ........................................ 2
2. Wing with crossveins yellow to blackish brown .................................. 3
3. Only inner vertical seta present, outer vertical seta absent (Jamaica) H. puntiloboveneros Clausen
   - Both inner and outer vertical setae well developed (eastern and southwestern United States, eastern Canada, Mexico, and El Salvador) ....... H. albovenosa Coquillet
4. Scutellum with lateral and dorsal surfaces more or less similar, uniformly golden to coppery microtomentose (western United States, southwestern British Columbia, and northwestern Baja California Norte) ... H. pruinosa (Cresson)
   - Scutellum with dense, black microtomentum laterally, appearing velvety, especially from a posterodorsal angle ......................................................... 5
5. Face with lateral area of dense, black microtomentum, appearing velvety, medially with dense grayish to silvery microtomentum; bearing 1 well-developed, laterocline, fronto-orbital seta (Canada; Ontario to Nova Scotia) ....... H. vockerothi Clausen
   - Face uniformly densely gray to golden microtomentum; bearing 1–5 greatly reduced fronto-orbital setae (widely distributed in the United States and Canada) ........ H. binotata (Cresson)
6. Scutellum with dense, black microtomentum patch laterally, appearing velvety .......... 7
   - Scutellum lacking dense, black microtomentum patch laterally .................. 8
7. Vein R_{1-3} appendiculate apically (northeastern United States from Iowa to Pennsylvania) .... H. corona (Cresson)
   - Vein R_{1-3} not appendiculate (northern United

709
States and southern Canada) ..................  
8. Inner vertical seta and ocellar seta very short and stout, length less than distance between anterior ocellus and either posterior ocellus. Wing with dark patches basally (subbasally in cell r1, anterobasally in discal cell, and along posterior margin of CuA1); vein CuA1 not extended beyond crossvein dm-cu (southern California) .................. H. clauseni, new species
9. Eastern Canada, eastern and southeastern United States and Bermuda (mesonotum lacking denser grayish stripes; legs reddish brown to brown) .................. H. furva furva (Cresson)
10. Southwestern United States and western Mexico (mesonotum with denser gray stripes between acrostichal setal rows and along dorsocentral rows; legs yellowish to light brown) .................. H. furva flavida Sturtevant and Wheeler

Hyadina clauseni Mathis and Zatwarnicki, new species
(Figs. 1–21)

Description.—Moderately small shore flies, body length: male 1.28–1.64 mm, female 1.24–1.86 mm.

**Head** (Figs. 1–6): Frons trapezoidal (Fig. 3), anterior margin half width of posterior margin; frons and ocellar triangle moderately microtomentose, dull, more densely microtomentose anteromedially, grayish to tannish, otherwise subshiny, brownish black, appearing microgranulose; ocelli (Fig. 4) arranged in isosceles triangle, dis-
tance between posterior ocelli much greater than between either posterior ocellus and anteromedial ocellus; ocellar setae short, stout, length less than distance between anteromedial ocellus and either posterior ocellus; fronto-orbital setae (Fig. 2) reduced to very short, stout anterior 2–3 setulae; only medial vertical seta well developed, seta short, stout, with procline orientation. Scape and pedicel grayish black to black; 1st flagellomere yellowish orange basally, otherwise blackish brown to black apically; arista bearing 9–10 short hairs (Fig. 5), length of longest hairs only slightly greater than basal arista width. Face immediately ventrad of antenna almost vertical, thereafter produced anteriorly then reeded on ventral half; face moderately to densely microtomentose, whitish gray to gray, but with medial vertical stripe less microtomentose, subshiny, stripe wider dorsally; lateral, wide densely microtomentose portions of face bearing numerous setulae in 3 rows, no setulae distinctly larger than others. Parafacial gray microtomentose, lacking setulae. Eye (Fig. 2, 6) obliquely oriented, obovate, mostly bare of interfacetal setulae. Gena high; gena-to-eye ratio: male 0.35–0.38, female 0.31–0.42. Clypeus small, button-like, moderately densely, grayish microtomentose.

**Thorax** (Figs. 7–11): Mesonotum: Length of scutum: male 0.23–0.27 mm, female 0.26–0.31 mm; length of scutellum: male 0.11–0.13 mm, female 0.11–0.15 mm. Scutum and scutellum moderately to mostly sparsely microtomentose, dull to subshiny, brownish black, with short, gray, anterior stripes lateral of rows of acrostichal setulae and dorsocentral setulae, the latter stripes as 2 sections, being divided by transverse suture; scutellum (Fig. 10) without densely microtomentose, velvety black areas laterally, mostly subshiny to shiny; apical scutellar seta ⅓× length of basal seta; more basal seta close to apical seta, distance between apical seta twice distance between apical and more basal setae; except for posteriormost dorsocentral seta and postalar seta, generally lacking larger setae; 2 rows of acrostichal setulae; anterior notopleural seta reduced, less than half length of posterior seta; posterior notopleural seta slightly shifted towards anterior margin of notopleuron; anepisternum and katepisternum lacking larger setae; anepisternum moderately densely microtomentose, faintly subshiny dorsally, less to ventrally; katepisternum densely gray microtomentose, especially posteriorly; anepisternum more sparsely microtomentose than anepisternum, subshiny, brownish black; dorsal half of anepisternum lacking velvety black spot around anterior spiracle. Wing (Fig. 11): generally hyaline except for brown patches subbasally in cell r1, anterobasally in discal cell, and along posterior margin of CuA1, also faintly brownish along veins; wing unusual with 2 points of transverse folding lines: 1st and more conspicuous flexure line at level of subcostal break (subcostal break wide); 1st line at apex of R2+3 and level of crossvein dm-cu; anterior margin of wing with arched prominence between R1 and just beyond R2+3; vein R4+5 and M shallowly curved forward, vein M ending at apex; crossvein r-m aligned just basad of juncture of R2+3 with C; section of vein M between crossveins r-m and dm-cu short, slightly longer than crossvein r-m; vein CuA1 not extended beyond crossvein dm-cu; wing length: male 0.65–0.68 mm, female 0.73–0.78 mm; wing ratio: male 0.30–0.54, female 0.46–0.47; width of wing: male 0.32–0.34 mm, female 0.34–0.37 mm; first costal vein ratio: male 1.22–1.45, female 1.18–1.28; M vein ratio: male 0.16–0.19, female 0.16–1.7. Halter with blackish brown knob. Legs with femora and tibiae black except for "knees"; "knees" and tarsi yellow, with apical tarsomere brown.

**Abdomen** (Figs. 12–21): Tergites blackish brown; abdomen in ventral view (Fig. 21) broadly oval, slightly more narrowed apically; 2nd sternite triangular, pointed posteriorly; 3rd sternite longer than wide, lateral margins tapered posteriorly, width of posterior margin less than half anterior mar-
Figs. 17–21. Structures of the male terminalia of *Hyadina clauseni* (California. Inyo: Tecopa Hot Springs). 17, Aedeagus and phallapodeme, ventral view. 18, Hypandrium and gonites, ventral view. 19, Gonite, lateral view. 20, Aedeagus and phallapodeme, lateral view. 21, Abdomen of male, ventral view. Scale bar = 0.1 mm.

gin, rounded; 4th sternite slightly longer than 3rd, longer than wide, anterior corners more angulate and posterior corners rounded; 5th sternite only slightly longer than wide, posterior margin wider than anterior margin. Male terminalia (Figs. 12–20): Epandrium in posterior view (Fig. 12) broadly oval, with narrow, deep incisions ventrally, dorsal margin thin, becoming wider with ventral ⅔ about equally wide in lateral view (Fig. 13); cerci in posterior view (Fig. 12) narrowly hemispherical, acutely pointed dorsally and ventrally, slightly wider dorsally, in lateral view (Fig. 13) more broadly hemispherical; internal genital structures as in Figs. 14–20; hypandrium in ventral view (Figs. 14–15, 18–19) like a symmetrical saddle along basal margin, apical margin more evenly and shallowly arched; gonite in lateral view (Figs. 15–16, 19) sickle shaped, narrow, tapered, pointed, apex bearing an apical setula, in ventral view both left and right gonite oriented medioapically, somewhat parallel sid-
ed, lateral margin shallowly sinuous; aedegus in lateral view (Figs. 15–16) more or less narrowly rectangular, generally parallel sided, bearing a basal, narrow process, in ventral view (Figs. 14) slightly tapered from base to truncate apex; phallapodeme in lateral view (Figs. 15, 20) with narrow, elongate keel.

Type Material.—The holotype male is labeled "USA CA. Inyo: Tecopa Hot Spr[ings]. (36°52.7’N. 116°13.9’W), 17 Apr 2003, W. N. Mathis & T. Zatwarnicki/USNM ENT 00197406 [plastic bar code label]/HOLOTYPE Hyadina clauseni δ W.N. Mathis USNM & T. Zatwarnicki [red; species name, gender symbol, and "& T. Zatwarnicki" handwritten]" (USNM). Forty-five paratypes (28 δ, 17 ♀; USNM) bear the same locality data as the holotype.

Distribution.—Nearctic: United States. (California). Although this species is presently known only from Tecopa Hot Springs (Figs. 22–23), the type locality, we would not be surprised to find specimens at other springs in the area, especially those that were or are now associated with the Amargosa River system, such as Saratoga Spring.

Etymology.—The species epithet, clauseni, is a genitive patronym to honor and recognize the numerous contributions of our friend and colleague, Dr. Philip J. Clausen, to the study of shore flies generally and to the tribe Hyadiniini specifically.

Remarks.—Among Nearctic species of Hyadina, this species is perhaps most similar to H. furva flavida but is easily distinguished from the latter by the unique features of the wing (brown areas, flexure points, venation) and other characters as noted in the key.

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LITERATURE CITED


**HETERARTHUS OCHROPODA (KLUG) (HYMENOPTERA: TENTHREDINIDAE), A NEW RECORD AND NEW PEST OF POPULUS SPP. (SALICACEAE) IN TURKEY**

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**Abstract.**—A leafminer, *Heterarthrus ochropoda* (Klug 1818), is a new record for the Turkish fauna and a new pest of *Populus tremula* L. and *P. nigra* L. in Turkey. Its developmental stages, biology, damage, and infestation levels were studied in Erzurum during 2001 and 2002. There is one generation a year, and overwintering is in a pupal case in the leaf. Adults appear during mid-June to the first of July, and females oviposit into leaf tissue near the leaf apex. The early instar mines from the apex to the center of the leaf. Each leaf has one larva. The last instar forms a case in the mine at the end of the season and remains in the leaf until pupation the next year. Infestation levels may be as high as 70%.

**Key Words:** Heterarthrus ochropoda, Tenthredinidae, Hymenoptera, poplar pest, *Populus*

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Poplar species (*Populus* spp.; Salicaceae) are very important in Turkey because of their use in industry as firewood and timber. Seven billion cubic meters of timber are obtained from all kinds of forest trees, and approximately half of this production comes from poplar (anonymous 1994).

Most sawflies associated with poplar in Turkey feed externally on the foliage. Some recorded, all Tenthredinidae, are *Staurone-matus compressicornis* (F.), *Pristiphora conjugata* (Dahlbom), and *Trichicampus viminalis* (L.) (Sekendiz 1974, anonymous 1994, Çanakçıoğlu 1993, Çanakçıoğlu and Mol 1998). One leafminer, *Messa hortulana* (Klug) also has been recorded as a pest of poplar (Güçlü and Özbek 1999). However, the leafminer *Heterarthrus ochropoda* (Klug 1818), has not been recorded from Turkey. It is known as a poplar pest in Europe, Crimea, northern Caucasus, Tien Shan, Latvia, Russia, and central Asia where it has been recorded from *Populus alba* L., *P. nigra* L., and *P. tremula* L. (Benson 1952, Zhelochovtsev 1988, Liston 1995, Taeger and Blank 1998, Lacourt 1999). *Heterarthrus ochropoda* was discovered in Erzurum, Turkey, in 2001 and has been found on both *Populus tremula* L. and *P. nigra* L. This study was conducted to determine the nature of this new pest and its biology.

All species of *Heterarthrus*, a Holarctic genus of about 12 species, are leaf miners, and hosts other than *Populus* include *Betula*, *Acer*, *Alnus*, and *Salix*. The most complete biological studies are by Pieronek (1963) on several species in Poland, Altenhofer (1980a, b, c) on species in Europe, and the species on *Acer* by Altenhofer et al. (1987). Few studies have been done on *H. ochropoda* on *Populus*, the most comprehensive being included in the leaf-miner studies by Altenhofer (1980a, b, c).
**Fig. 1.** Monthly average temperature and humidity at Erzurum, Turkey, in 2001 and 2002.

**MATERIALS AND METHODS**

This study was conducted on the campus of Atatürk University in Erzurum, located in the eastern Anatolia Region of Turkey (39°54'N, 41°14'E) at an altitude of 1850 m. More than 2000 acres of wooded area are on the campus. Although the trees are predominately pines, large areas of poplar trees also occur sporadically. The climate in Erzurum Province is rather extreme, with a cold and snowy winter, rainy spring, and dry summer, with an annual average temperature of 6°C and relative humidity of 60%.

In the study area, damaged leaves were collected four or five times a month from June to November in 2001 and 2002. More than 100 poplar trees were randomly examined in August to determine the infestation level. Branches of trees with infested leaves were brought to the laboratory and to obtain adults. Infested leaves were put in vials with water and kept in dessicators to rear the larvae. After the larvae made cocoons, they were put in a refrigerator and kept for about 5 months, then they were transferred to laboratory conditions.

To obtain adults in field conditions, some of the branches with infested leaves were caged in August and kept until the following year.

**RESULTS**

**Description.**—Adult (Fig. 3D): Length, 5.0–5.5 mm. Female bright black; wings uniformly lightly infuscated, costa and veins black; legs yellowish; male with white spots laterally and ventrally on abdomen. Antenna 14-segmented. Head from above transverse, much broader than long.

Egg: White, water-drop shaped.

Larva: Late instar 9.6–10.8 mm long. Dorsoventrally flattened; thoracic legs small, prolegs absent. Whitish with head brown and eyespot, mandible, and narrow ring surrounding anal proleg dark brown; most of pronotum, prosternum, and small central spots on meso- and metasterna pale amber.

Pupa: Length 3.6–4.0 mm. Free type; whitish, later turning brown.

**Biology** (Fig. 2).—Observations are similar to those observed in Europe for *H. ochropoda* by Altenhofer (1980a, b, c). Hibernation is in the prepupal stage in the leaf between the two epidermal layers within
fallen leaves on the ground. Adults were first observed on May 10, 2001, and May 18, 2002, in the laboratory, and on June 16, 2001, and July 2, 2002, in the field. The differences in emergence time of adults in 2001 and 2002 in the field probably were the result of higher temperatures in 2001 than in 2002 (Fig. 1). The duration of adult flying was approximately 15–20 days. Females oviposit into leaf tissue near the apex of the leaf, depositing one egg per leaf. The first larval instar and damage was seen on July 17, 2001, and July 30, 2002. These differences also might be related to higher temperature in 2001 than in 2002 (Fig. 1). Each leaf contained only one larva. The larva feeds in the gallery and enlarges the gallery by feeding toward the middle of the leaf (Fig. 3A). The larval feeding period continued until the first part of September when they made a disc-shaped pupal case in the leaf tissue. They hibernate as prepupae in the leaf, dropping to the ground with the leaves when the leaves fall in the autumn. Consequently, *H. ochropoda* had only one generation a year under the ecological conditions at Erzurum during the two years observed.

Damage consists of a large blotchlike part of the leaf which the larvae eats out, thus browning the leaves. About the apical half of the infested leaves get dry and turn brown. The infestation levels in the study area were determined as 70% in 2001 and 50% in 2002.

In the laboratory, one pupal parasitoid, *Olesicampe* sp. (Ichneumonidae), was reared from *H. ochropoda*.

*Messa hortulana* (Klug) is another leaf-mining sawfly damaging poplar trees in the same locality (Güçlü and Özbek 1999). However, the damage of the larva of *H. ochropoda* differs from that of *M. hortulana*. *Heterarthrus ochropoda* larvae begin feeding at the tip of the leaf between the epidermal tissues and mine toward the middle. The damaged leaves are somewhat hard, tough, and brown in color, and the larva in the leaf is invisible. The larvae of *M. hortulana* feed by making galleries...
within the two epidermal layers near the borders or lateral edges of the leaves, the damaged leaves are almost transparent, and the larvae in the leaves are visible. The infested leaves of *H. ochropoda* have only one larva per leaf and those of *M. hortulana* generally have more than one larva. Güçlü and Özbek (1999) observed up to seven larvae of *M. hortulana* in one leaf. Overwintering is within the leaf in *H. ochropoda*, whereas the larva of *M. hortulana* leaves the leaf to overwinter in the soil. Since 2001, there has been an epidemic of *P. hortulana* on *Populus alba* in the narrow valleys along the branches of the Çoruh River (Yusufeli, Ispir, Uzundere, Tortum, Olur, Oltu, and Narman districts). We observed up to 13 larvae per leaf in these locations. Another important difference between the two species is that the activity of *H. ochropoda* starts in the middle of the summer and continues until the fall (end of September), and *M. hortulana* begins emerging in the spring and continues until the beginning of the summer.

**ACKNOWLEDGMENTS**

We thank L. Zombori, Hungarian Natural History Museum, Budapest, for identifying the sawfly, and J. Kolarov, Paissi Hilendarski University, Plovdiv, Bulgaria, for identifying the ichneumonid.

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Note

Solenonotus angustatus Poppius, a Synonym of Dufouriellus ater Fieber (Hemiptera: Heteroptera: Anthocoridae)

Solenonotus angustatus was described from southern California in 1913 by Poppius. The female type was collected in “Mts. near Claremont, Cal.” by Baker. This species has puzzled Anthocoridae workers since the genus Solenonotus was described by Reuter (1871) from Brazil based upon Anthocoris sulcifer Stål (1860) from “Rio Janeiro.” Van Duzee (1916, 1917) reported S. angustatus from California as did Henry (1988), both following Poppius. Champion (1900) reported Solenonotus sulcifer from Brazil, Colombia, and Panama; described S. canalculus from Guatemala and Panama and S. nigromarginatus from Guatemala and Panama; and illustrated S. sulcifer and S. nigromaculatus—both very different than Dufouriella ater (Dufour), being broadly oval and not slender and straight-sided (see Champion 1900, figs. 30, 31). Carpintero et al. (1997) reported S. nigromarginatus from Nicaragua. The type specimen of Solenonotus angustatus could not be located. A. Jansson reported the type was not in the Helsinki Museum (personal communication, April 2000). It was assumed that Poppius returned the type to Baker in California. The Baker Collection was transferred to the California Academy of Science some years ago. V. Lee was unable to locate the specimen in the collections of the California Academy of Sciences (personal communication, 14 April 2000). He reported the specimen might have been sent to the National Museum in Washington, D.C. T.J. Henry stated that he could not find the type in the collections of the National Museum of Natural History (personal communication, September 2001). H.M. Harris worked on the Anthocoridae many years ago and left his collections to Louisiana State University and Iowa State University. Both institutions reported the specimen was not to be found in their holdings.

A thorough review of the original description by Poppius ultimately led to an identification of the species before him as Dufouriellus ater (Dufour). Although Poppius indicated that the individual resembled species of the genus Scoloposcelis Fieber in general shape, small size (not stated), and flattened, narrowly elongate body, it differed by the unarmed fore femora—a distinctive character of Scoloposcelis. He placed the species in Solenonotus Reuter, a genus that occurs in South America and portions of Central America—well removed from semi-arid southern California. Solenotus angustatus differs substantially in size from species of Scoloposcelis species—length 2.00 mm versus 2.80-3.64 mm. Further, species of Scoloposcelis have distinct ostiolar canals—curved parallel-sided and round apically (see Kelton 1978, fig. 73), while S. angustatus has the canal straight and the surrounding area flattened, curved anteriorly with a sharp apex (see Dufouriellus ater, Kelton 1978, fig. 75).

Characters cited by Poppius for S. angustatus included the elongate shape, narrow body shape, strongly flattened, shiny body, only a few long setae on the head, sides pronotum and hemelytra; color brownish black and membrane brownish black, pale white on basal half. Second antennal segment slightly thickened apically, pale at the middle. tibiae pale; rostrum reaching anterior coxae, segment one almost reaching anterior edge of eye. Pronotum shining, sides straight, narrowly emarginate, disc smooth without transverse impression, with a distinct, longitudinal impression down the middle. Scutellum
smooth. Membrane of hemelytron with four veins, inner three veins obscure, inner two parallel to one another. All legs unarmmed, anterior femora slightly enlarged. These characters are exactly what one finds on _Dufouriellus ater_. Additional characters from specimens examined included small, but well-developed apical pads (fossa spongiosa) on the anterior tibiae of the male and small, but poorly developed apical pads on the anterior tibiae of the female (see Carayon 1972 for discussion of this character). One should mention the considerable discrepancy in the width of _S. angustatus_ Poppius as published. The length was given as 2.0 mm and the width as 1.6 mm. This creates a strongly oval shape, quite different than the small, narrowly parallel-sided description Poppius gave in the text. It seems likely that the 1 before 0.60 was in error. I have measured the width of 11 specimens of _D. ater_ from California and Oregon and the width varies from 0.60–0.74 mm—certainly not 1.6 mm. The California specimens varied from 0.60–0.72 mm. The Oregon specimens varied from 0.71–0.74 mm. Kelton (1978: 56) cited length at 1.20–2.24 mm, width 0.70–0.84 mm (males) and length 2.10–2.24 mm, and width 0.70–0.84 mm (females). Péricart (1972: 276) reported length as 1.80–2.30 mm in Europe. By comparison, Kelton (1978) reported the length of _Scoloposcelis flavicornis_ Reuter as 2.80–3.50 mm and width 0.87–1.12 mm (males and length 3.15–3.64 mm and width 0.81–1.05 mm (females). Péricart (1972) stated the length of _Scoloposcelis pulchella_ (Zetterstadt) as 2.80–3.50 mm and width 0.90–1.10 mm, and similar dimensions for _Scoloposcelis obscurella_ (Zetterstadt). _Dufouriellus ater_ may be recognized by the small size (2.00–2.24 mm length, 0.60–0.84 mm width), flattened shape, narrow, parallel-shaped body, fuscous color, polished dorsum, obsolete punctures; pronotum with distinct median groove; fuscous, anterior wing membrane fuscous, basal half pale; unarmmed fore femora, fore tibiae with a small, but distinct apical pad; and distinct ostiolar canal. On the basis of information given above, _Solenonotus angustatus_ Poppius 1913 is considered a synonym of _Dufouriellus ater_ (Dufour) 1833 (new synonym).

_Dufouriellus ater_ is a Palearctic species that has been introduced into North America. Van Duzee (1916) first reported it from the Eastern States and subsequently from California (1917). This subcorticular species is also found in stored products. Blatchley (1934) collected this species under the bark of deciduous trees in the Los Angeles area of California in the winter of 1927–28. Cobben (1958) described the habits of this bug in the Netherlands. Carayon (1972) provided structural and systematic information and Péringuey (1972) gave a complete description of its structure, distribution and habits, and later (1996) published on the distribution of this species in the Palearctic. Kelton (1978) published a description, distribution map in Canada, figure of the male clasper, electromicrograph of the scent gland opening, and an illustration of the adult. Awadallah et al. (1984) published a brief paper on the nymphs and developmental time in the laboratory in Egypt where it was considered a potential predator of stored-product insects. Arborgast (1984) provided a detailed study of the demography of the species under laboratory conditions in Georgia, where it was associated with stored products. Henry (1988) reported _D. ater_ from British Columbia, California, Idaho, Kentucky, North Carolina, New York, and Ontario, to which I add Oregon. Maw et al. (2000) reported it from British Columbia and Ontario. Lattin (1999, 2000) discussed a variety of attributes in the Old and New World.

Acknowledgments.—My thanks to the late A. Jansson, V. Lee, T.J. Henry, and G. Courtney for assistance in trying to locate the type specimen; and to L. Parks for careful attention to the manuscript.

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John D. Lattin. Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331-2902, U.S.A.
Crophius disconotus (Say) (Hemiptera: Lygaeoidea: Oxycarenidae): Southeastern Extension of the U.S. Range, with Rectification of an Old Alabama Record

The nine North American species of Crophius Stål are mostly boreal and western (Ashlock and A. Slater 1988, Hoffman 1996). In addition, seven Neotropical species are known from Mexico to Peru and Argentina (Slater 1964, Slater and O’Donnell 1995). Hoberlandt (1987) tentatively synonymized Crophius with the Old World Anomaloptera Amyot and Serville. The synonymy was followed in the recent catalog of Palearctic Heteroptera: included in Anomaloptera were A. bermani Vinokurov, described in Crophius and known only from East Siberia, and the type species A. heliannthemi Amyot and Serville, a mainly Mediterranean oxycarenid (Périckart 2001). Because the generic name Crophius continues to be used in North American literature (e.g., Scudder 1997, Maw et al. 2000, Sweet 2000), it is used herein, pending taxonomic reevaluation of Old and New World species of the two genera.

Crophius disconotus (Say) is an infrequently collected lygaeoid of the Oxycarenidae (sensu Henry 1997) that has been termed rare (Van Duzee 1894), rather rare (Torre-Bueno 1915), scarce (J. A. Slater and Baranowski 1978), and uncommon (Sweet 2000). Although this species was described from “Missouri” by Say (1832), no specimens from Missouri were available when Froeschner (1944) treated that state’s lygaeid fauna.

Known in Canada from New Brunswick to the Yukon (Maw et al. 2000), C. disconotus is recorded in the western United States from Alaska, California, Colorado, Utah, and Wyoming (Ashlock and A. Slater 1988, Scudder 1997). Eastern U.S. records are mainly from New England, New York, and the mid-Atlantic states (Ashlock and A. Slater 1988). The southern limit of its eastern range has been Alabama (Van Duzee 1917, Blatchley 1926, J. A. Slater 1964, Ashlock and A. Slater 1988), based on Van Duzee’s (1910) record from “Banff Springs.” In listing Heteroptera from the Yukon, Scudder (1997) followed Henry and Froeschner’s (1988) catalog in recording general distributions for species. Scudder (1997), however, did not include the Alabama record for C. disconotus that was listed in the lygaeid chapter of the catalog (Ashlock and A. Slater 1988) and probably realized that Banff Springs referred to Alberta, Canada. This seed bug is listed from Alberta in the recent checklist of Canadian Heteroptera (Maw et al. 2000). The published southern limit of the range of C. disconotus in the East, therefore, is Blackburg, Virginia, where an adult was taken on 3 July 1961 (Hoffman 1996).

The following records extend the known southeastern range of C. disconotus. I collected all specimens and have deposited voucher material in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).


Georgia, North Carolina, and Tennessee are new state records for C. disconotus. In the Southeast, I encountered most adults at higher elevations (1,685–1,860 m) in the southern Appalachians. Only one adult was found in the piedmont of Georgia (ca. 250 m), and C. disconotus was not observed in the mountains or piedmont of South Carolina despite extensive collecting. No specimens of this seed bug from Georgia, North Carolina, or South Carolina were found in collections at Clemson University (CUAC), North Carolina State University (NCSU), University of Georgia (UGCA), or the USNM.

My collections of adults and a fourth instar of C. disconotus from Solidago spp. (Asteraceae) support an association with goldenrod that has been mentioned by others (Van Duzee 1894; Torre-Bueno 1924, 1925; Sweet 2000). Nymphs have not been described, but a fourth instar of C. disconotus was beaten from the inflorescence of S. arguta Ait. in Buncombe County, North Carolina; the nymph molted once but died as a fifth instar. Native North American oxycarenids are thought to feed on members of the Asteraceae (Sweet 2000). Collections from oak (Quercus; Fagaceae) (Torre-Bueno 1912) and pine (Pinus; Pinaceae) (J. A. Slater and Baranowski 1978) likely represent resting records, as might the collection from Polygonum sachalinense F. Schmidt ex Maxim. (Polygonaceae; as “Polygonum sachaliense”) (Procter 1946). This oxycarenid also has been found in root mats of Pileostegia pulcherrima Hook. (Polemoniaceae) (Scudder 1997).

Still in question is whether nymphs of C. disconotus develop on goldenrods. If so, do they feed on seed heads of their hosts and on fallen seeds, as do nymphs of a Palearc- tic oxycarenid, Metaploca origani (Kolenati), on asteraceous plants (Steřák and Vařínová 1996)? Do nymphs of C. disconotus feed on seeds of other Asteraceae or even those of other families? Further study also is needed to address other aspects of the bionomics of C. disconotus, such as volinism, as well as resolve the taxonomic status of Anomaloptera and Crophius and evaluate the biogeography of a small group that seems in need of cladistic analysis.

Acknowledgments.—I thank Thomas Henry (Systematic Entomology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, Smithsonian Institution, Washington, D.C.) for providing copies of several references and examining the nymph of C. disconotus, Patrick McMillan (Department of Biological Sciences, Clemson University) for identifying plants, Peter Adler (Department of Entomology, Soils, and Plant Sciences, Clemson University) for providing comments that improved the manuscript, and Robert Blinn (Department of Entomology, North Carolina State University, Raleigh) and Cecil Smith (Department of Entomology, University of Georgia, Athens) for checking for specimens of C. disconotus at NCSU and UGCA, respectively.

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The nymphalid genus Adelpha is sufficiently speciose and abundant throughout the Neotropical realm, from sea-level to 3000 meters and across a wide range of habitats, ranging from degraded scrubland to primary forest, that not even the most inexperienced ecotourist could fail to notice these striking, orange, white and black butterflies. Anyone who has actually collected Neotropical butterflies can also attest to the bewildering array of wing pattern subtleties exhibited by Adelpha, and the enormous difficulty in sorting them to morphospecies, let alone trying to correctly identify them. Indeed, in his treatment of the Costa Rican butterfly fauna, DeVries (1997) echoed earlier authors in saying “the butterflies that compose the genus Adelpha . . . are the most difficult and trying taxonomically of all the nymphalids”. But help is now at hand, with the first comprehensive revision of the genus since the Seitz volumes nearly 90 years ago (Fruhstorfer 1913–20). At a time when most monographs of aesthetically pleasing Nymphalidae are little more than the lepidopterological equivalent of stamp albums, Keith Willmott’s Adelpha revision is refreshingly modern and intellectually rigorous, broad and thorough in scope, and well written and illustrated.

The early portion of the book is divided into five chapters, an Introduction, Methods, Systematics, Biology, and Biogeography and Conservation, the last of which is the longest and most detailed. The Methods chapter quickly reveals the magnitude of the effort that was required to produce this book. Nearly 21,000 Adelpha specimens were examined, including all known extant types, from numerous museums and private collections across Europe and the Americas, and nearly two years of field work was conducted across the Neotropics (mainly in Ecuador) to gather precisely labeled material, record ecological observations, and assess the limits of intraspecific variation. The Systematics chapter covers the history of classification of Adelpha, and provides diagnoses for the genus and the newly proposed species groups, and a key to all species. It is important to note that an exhaustive study of morphology and character evolution in the genus, with the generation of reasonably well-resolved phylogenetic hypotheses, has been published separately (Willmott 2003). Willmott recognizes 85 species in Adelpha, five of which were described as a part of the project, although only one species (and several subspecies) is actually described in the book. His synonymic checklist of 366 described names and 209 taxa includes 127 taxonomic changes, and thus represents a substantially revised classification, built for the first time on clearly elucidated, modern concepts of species and subspecies. In cases where phenotypically similar, closely related taxa occupy allopatric geographic ranges, Willmott almost always lumps them together to create often large polytypic species, dubbed “biogeographical species” in the clearly influential treatment by Tyler et al. (1994) of the American swallowtail butterflies. This approach has had the effect of slightly decreasing the number of Adelpha species recognized compared to the arrangements of previous authors. When treating mimetic butterflies, I agree that recognizing subspecies is necessary and useful, for the reasons outlined by the author, but I personally would not have taken quite such a fine-
grained approach to their division, which is here often based on only slight differences in generally non-mimicry related ventral wing pattern elements.

The highlights of the Biology chapter include in-depth discussions on rarity, mate location, and mimicry, which is an all-pervasive underlying theme to the study of Adelpha biology and taxonomy. Detailed morphological descriptions of the immature stages are accompanied by two and a half pages of very nice line drawings, and at the end of the color plates is half a page of larval and pupal photographs. The amply illustrated Biogeography chapter, which could undoubtedly have been broken up into several separate papers, is what elevates this revision to the extraordinary. This is the intellectual heart of the book, and covers four main themes: spatial and elevational patterns of species richness, areas of species and subspecies endemism, speciation in montane regions, and conservation. While analyzing his distributional data for Adelpha from many different angles, Willmott challenges several biogeographical and ecological hypotheses based on the study of other invertebrate and vertebrate groups, and develops some of his own. Unfortunately, without a very well resolved cladogram, there is no cladistic biogeography here. My only main criticisms of these excellent introductory chapters is that certain sections might have been dealt with a little more succinctly, and a large chunk of the Biogeography chapter is really community ecology that would probably have been better placed in the Biology chapter.

The species accounts, which run to about 180 pages, form the meat of the book. The layout of the species accounts is fairly traditional, and consists of a very detailed listing of synonyms and type data, followed by a lengthy identification, taxonomy and variation section, a concise description of the taxon’s range, and detailed sections on the immature stages (if known), and habitat and adult ecology. The taxonomy sections provide an amazing amount of detail, but I did notice some repetition, with full lectotype label data being repeated in the type section and the body of the text. On this subject, it might have been a good idea to designate lectotypes for taxa described from multiple countries and/or localities. This would have restricted the type locality and removed the need to reproduce reams of syntype label data. I was glad to see that the lists of specimens examined were included in the book rather than placed on a CD rom or an internet website, as both of these increasingly commonly used options can be inaccessible to some at home, and all in the field. Being picky, I would prefer to have seen provinces as well as countries listed in geographic instead of alphabetical order, for the same reasons that we curate collections systematically instead of alphabetically. Also, I do not see the need to have burdened this section with elevational data for certain localities when this information is already summarized in the habitat and adult ecology section.

Fifteen color plates beautifully illustrate both sexes (where known) of all Adelpha taxa, largely in the composite half-wing format. The color reproduction is generally very good, although, as explained in an inserted corrigenda, there is some black graininess within the dorsal orange of a few specimens, and some of the plates are also slightly over-cropped. However, the effect of these small printing flaws on the aesthetic and taxonomic value of the plates is negligible. Good quality drawings of both the male and female genitalia (where known) of all species are followed by excellent dot maps for all taxa. The book concludes with a lengthy bibliography, a detailed index, and nine appendices, of which those summarizing the known hostplant and immature stage information are particularly impressive for their level of detail. The most eye-catching and innovative of the appendices is a three page pictorial key. Each key for the four main dorsal wing patterns uses beautifully rendered computer-generated wings, complete with arrows indicat-
ing salient features, to guide the uninitiated through the minefield of Adelpha wing pattern subtleties.

Looking back on this review, an inordinate amount of ink seems to have been given over to critical commentary, but I should stress that these criticisms range from the minor to the very minor. Put simply, this book is the best revision of a Neotropical nymphalid genus ever written. When combined with the companion phylogenetics paper, there is no doubt that this is one of the very best treatments to date of any butterfly group. Without any technical or artistic assistance, every word and image is also the author’s own. It is extremely gratifying to see the bar for butterfly monographic work continuing to be raised.

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<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATHIS, WAYNE N. and TADEUSZ ZATWARNICKI</td>
<td>Description of a new species of Hyadina Haliday (Diptera: Ephydridae) from southern California</td>
</tr>
<tr>
<td>NEUNZIG, H. H. and M. A. SOLIS</td>
<td>Exguiana, a new genus of Neotropical phycitines (Lepidoptera: Pyralidae)</td>
</tr>
<tr>
<td>PEREDO, LUIS CERVANTES, ILIANA PACHECO, and AARON SANCHEZ</td>
<td>Immature stages and life cycles of five species of Ozophora Uhler (Hemiptera: Rhyparochromidae: Ozophorini) associated with figs in Mexico</td>
</tr>
<tr>
<td>PINTO, JOHN D. and JEREMIAH GEORGE</td>
<td>Kyuwa, a new genus of Trichogrammatidae (Hymenoptera) from Africa</td>
</tr>
<tr>
<td>POINAR, GEORGE, JR.</td>
<td>Palaeomyia burnitis (Diptera: Phlebotomidae), a new genus and species of Cretaceous sand flies with evidence of blood-sucking habits</td>
</tr>
<tr>
<td>POOLOCK, DARREN A. and MICHAEL A. IVIE</td>
<td>Description of the larva of Phaeogala rufa Abdullah (Coleoptera: Mycteridae: Lacconotinae), with nomenclatural notes for the genus Phaeogala</td>
</tr>
<tr>
<td>SMITH, DAVID R.</td>
<td>The Nematus &quot;magus group&quot; (Hymenoptera: Tenthredinidae) in North America</td>
</tr>
<tr>
<td>SMITH, DAVID R.</td>
<td>A new species of Derecyrta Smith (Hymenoptera: Xiphydriidae) from Colombia and Ecuador</td>
</tr>
<tr>
<td>TENNESSEN, K. J. and T. E. VOGT</td>
<td>Ophiogomphus smithi, n. sp. (Odonata: Gomphidae) from Wisconsin and Iowa</td>
</tr>
<tr>
<td>VANDENBERG, NATALIA J.</td>
<td>Contributions to the knowledge of Olla Casey (Coleoptera: Coccinellidae: Coccinellini): New species from the Galapagos Islands, updates on the distribution of O. v-nigrum (Mulsant)</td>
</tr>
<tr>
<td>WANG, YI-KUANG and JAMES H. KENNEDY</td>
<td>Life history of Mayatrixia ponta Ross (Trichoptera: Hydroptilidae) in Honey Creek, Oklahoma</td>
</tr>
<tr>
<td>WHEELER, A. G., JR.</td>
<td>Keltonia rubrofemorata Knight and K. wheeleri Henry (Hemiptera: Miridae): Distributions, host plants, habitats, and seasonality of specialists on Polygonella spp. (Polygonaceae)</td>
</tr>
<tr>
<td>WHEELER, A. G., JR. and W. K. REEVES</td>
<td>New distribution records and moss associations for the lace bugs Acalypta duryi Drake and A. lillianis Torre-Bueno (Hemiptera: Tingidae)</td>
</tr>
<tr>
<td>LATTIN, JOHN D.</td>
<td>Solenonotus angustatus Poppius, a synonym of Dufouriellus ater Fieber (Hemiptera: Heteroptera: Anthocoridae)</td>
</tr>
<tr>
<td>WHEELER, A. G., JR.</td>
<td>Crophius discnotus (Say) (Hemiptera: Lygaeoidae: Oxycarenidae): Southeastern extension of the U. S. range, with rectification of an old Alabama record</td>
</tr>
<tr>
<td>HALL, JASON P. W.</td>
<td>The Genus Adelpha: Its Systematics, Biology, and Biogeography (Lepidoptera: Nymphalidae: Limenitidini), by Keith R. Willmott</td>
</tr>
<tr>
<td>INSTRUCTIONS FOR AUTHORS</td>
<td></td>
</tr>
</tbody>
</table>
CONTENTS

ARCE-PÉREZ, ROBERTO—A new species of Psephenotarsis Arce-Pérez (Coleoptera: Byrrhoidea: Psephenidae) from Guatemala ................................................................. 826

BICKEL, DANIEL J.—Maipomyia (Diptera: Dolichopodidae), a new genus from Chile .......... 844

BYERS, GEORGE W and DOUGLAS A. ROSSMAN—Preliminary survey of the crane flies of Louisiana (Diptera: Tipulidae: Ptychopteridae) ................................................................. 884

CANDAN, S., Z. SULUDERE, A. HASBENLI, R. LAVIGNE, and A. SCARBOURGH—Ultrastructure of the chorion of Dioctria flavipennis Meigen, 1820 (Diptera: Asilidae: Stenopogoninae) compared with those of fourteen asilid species from the mid-Atlantic region of North America ................................................................. 811

ÇILBİROĞLU, EBRU GÜL, and ALİ GÖK—Flea Beetles (Coleoptera: Chrysomelidae) of Isparta, Turkey, with habitat use and host plant associations ......................................................... 858

CLINE, ANDREW R.—A new species of Psilotus Fischer von Waldheim (Coleoptera: Nitidulidae: Nitidulinae) from Peru, with new distribution records for other Psilotus species ...................... 891

GONZALEZ, VICTOR H. and CHARLES D. MICHENER—Application of specific names and association of sexes in Cadegualina Michener (Hymenoptera: Colleidae: Diphaglossini) .... 851

GRUBBS, SCOTT A.—Studies on Indiana stoneflies (Plecoptera), with an annotated and revised state checklist ................................................................. 865

GRUBBS, SCOTT A. and BILL P. STARK—Acroneuria covelli (Plecoptera: Perlidae), a new stonefly species from eastern North America ................................................................. 797

HALL, JASON P.W. and GERARDO LAMAS—A new cloud forest species of Calydna (Lepidoptera: Riodinidae) from Peru, with a revised phylogeny for the C. hiria group .......... 733

HASTRITER, MICHAEL W., KARL FRAJFORD, and MICHAEL F. WHITING—A collection of Norwegian fleas (Siphonaptera) north of the Arctic Circle ................................................................. 877

HEIMDAL, DENNIS P., R. EDWARD DEWALT, and THOMAS F. WILTON—Annotated checklist of the stoneflies (Plecoptera) of Iowa ................................................................. 761

(Continued on back cover)
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This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).
A NEW CLOUD FOREST SPECIES OF CALYDNA (LEPIDOPTERA: RIODINIDAE) FROM PERU, WITH A REVISED PHYLOGENY FOR THE C. HIRIA GROUP

JASON P. W. HALL AND GERARDO LAMAS

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Abstract.—A new rheidinid species in the Calydna hiria group, Calydna pichita, n. sp., is described and illustrated from east Andean cloud forest in the central Peruvian department of Junín. A revised phylogeny for the Calydna hiria group is presented based on an analysis of twenty-one characters of adult morphology.

Key Words: Andes, Calydna, cladogram, cloud forest, Peru

The genus Calydna Doubleday, 1847, currently placed in the incertae sedis section (Harvey 1987) of the Riodininae, was recently characterized and revised by Hall (2002). It contains eighteen described species of small to medium-sized rheidinids with intricately marbled wing patterns that occur in a wide range of predominantly lowland habitats from northern Mexico to northern Argentina and southeastern Brazil. The existence of an additional undescribed species was noted by Hall (2002), but because the species was then known from only a single female, with damaged genital structures, it was not named. The recent collection of additional material of this new species, including males, from the same locality in the Peruvian Andes, now enables us to adequately describe and name it, and to determine more precisely its phylogenetic placement within the Calydna hiria group. A significant number of new rheidinid species continue to be discovered in montane and cloud forest habitats in the Andes (Salazar and Constantino 1993; Hall and Willmott 1995a, b, c, in press; Callaghan and Salazar 1997; Callaghan 1999; Hall and Lamas 2001; Hall and Harvey 2001, in press), but the new Calydna species described here is notable for being the only member of the genus to occur in such habitats.

Calydna pichita Hall and Lamas, new species
(Figs. 1; 2A, B)

Description.—Male: Forewing length 14 mm. Forewing costal margin approximately straight, distal margin slightly convex, apex slightly falcate; hindwing rounded, apex strongly falcate. Dorsal surface: Ground color of both wings black, with a widespread scattering of bluish gray scaling; discal cell of forewing with one small white spot in middle and one large white rectangle at end, with one small white spot at costa immediately distal to it, discal cell of hindwing with one large white rectangle at end that is medially indented ventrally, with a single small white spot above and below it; two vertical bands of black spots surrounded with reddish brown below discal
cell of forewing, and one such band postdiscal on both wings; two small white spots in subapex of forewing, one in subapex of hindwing; entire costal margin and middle of anal margin of hindwing reddish brown; submarginal spots on both wings black and fringed proximally with a narrow line of bluish gray; fringe on both wings checkered black and white. 

**Ventral surface:** Differs from dorsal surface as follows: ground color of both wings brown, with a more prominent scattering of pale gray scaling, black submarginal spots on both wings fringed proximally with a narrow line of pale gray and distally with a similar line of red, reddish scaling at costal and anal margins of hindwing absent.

**Head:** Eyes brown and bare, marginal scaling black and white; frons black with two broken horizontal white bands; first and second palpal segments black, third segment black with a few white scales; antenanal segments black with prominent white scaling at base, clubs black with orange tips.

**Body:** Dorsal surface of thorax and abdomen black, ventral surface brown with some whitish scaling, ventral tip of abdomen orange; all legs with alternating brown and whitish bands.

**Genitalia** (Fig. 2A): Uncus moderately elongate and rounded, falces relatively long and narrow; vinculum broadly continuous at anterior margin of tegumen, posteriorly swollen medially, and formed into a small saccus ventrally; aedeagus long and narrow, with a pointed tip and no cornuti, pedicel short and strap-like; valvae with a small rectangular basal section, a flat dorsum, a relatively weakly sclerotized transtilla, a posteriorly elongate and rectangular dorsal posterior section, and a ventral posterior corner that forms an approximately 90° angle.

**Female:** Differs from male as follows: forewing length 14.5 mm. Distal margin of forewing more convex. **Dorsal surface:** Ground color of both wings pale brown, with scattered yellow instead of bluish gray scaling; reddish brown on both wings slightly paler and more prominent, and visible around submarginal spots; pale markings on forewing cream instead of white, pale markings on hindwing pale yellow instead of white, and greatly expanded to form an almost continuous patch that includes an additional broad postdiscal area between cells Cu₂ and M₁; white fringe elements less prominent. **Ventral surface:** Same as dorsal surface except ground color of both wings paler brown, with a more prominent scattering of yellow scaling, some submarginal spots fringed proximally with yellow scaling, reddish scaling at costal and anal margins of hindwing absent.

**Head:** Scaling at eye margins yellowish; two broken horizontal bands on frons yellow instead of white; second and third palpal segments slightly more elongate, all segments a mixture of brown and yellow scaling.
Body: Thorax and abdomen dark brown dorsally and pale yellow ventrally, all legs with alternating brown and pale yellow bands.

Genitalia (Fig. 2B): Corpus bursae round, spinelike signa covered with raised nodules, asymmetrically positioned at wall of corpus bursae and different in shape, one with a narrow constriction before an upturned tip and one with an abruptly downturned tip; ductus bursae narrow and membranous except for a small, sclerotized, ventral, rectangular plate immediately before ostium bursae; membranous ductus seminalis exits ductus bursae dorsally near anterior margin of sclerotized rectangle; ostium bursae consists of a membranous pouch with a narrow band of sclerotization along dorsal posterior margin.

Type material.—Holotype, ♀, PERU: Junín, 0–1 km S of Mina Pichita, 11°05′S 75°25′W, 2100 m, 12 Sept 2001 (G. Lamas) (Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru [MUSM]).

Paratypes, PERU: Junín. 1 ♂: same data as HT (MUSM); 1 ♀: 0–1 km. E. of Mina Pichita, Hacienda Naranjal, 2000 m, 18 Nov 1984 (G. Lamas & J. E. Pérez) (deposited in National Museum of Natural History, Smithsonian Institution, Washington, DC).

No additional specimens have been located in the major museums of Europe and North America (as listed in Hall 1999, 2002).

Etymology.—The species name is a feminine noun derived from the name of the type locality.

Diagnosis.—The male of Calydna pichita is very similar to that of the hiria group species C. sturmula (Geyer 1837), but it differs in its slightly larger size, and by having a slightly more rounded wing shape and a less falcate forewing apex. The male of the east Andean C. pichita additionally differs from males of the geographically variable C. sturmula from the neighboring western Amazon by having a more prominent scat-tering of bluish gray scaling on both dorsal wings and pale gray scaling on both ventral wings, more prominent reddish brown scaling surrounding all black spots on both the dorsal and ventral wings, and a white rectangle in the discal cell of the hindwing that is medially indented ventrally. The male genitalia of C. pichita also differ little from

Fig. 2. Male genitalia of Calydna pichita in lateral view (A), and female genitalia in dorsal view (B).
those of *C. sternula*, but, in the single male genital example of *C. pichita* examined, the medial posterior projection of the vinctulum is considerably larger.

The female of *C. pichita* is externally most similar to the females of the *hiria* group species *C. cea* Hewitson, 1859, and *C. sternula*, but is readily distinguished by its larger size, rounded instead of falcate forewing tips, cream instead of white forewing markings, prominent scattering of yellow scaling on both ventral wings, and by the very large pale yellow patch occupying the middle of the hindwing. This last striking character is unique in *Calydna*, with no other species having a sizeable, pale hindwing patch. The female genitalia of *C. pichita* are essentially identical to those of *C. cea*.

Systematic position.—With the addition of *C. pichita* to *Calydna*, we take this opportunity to revise the phylogenetic hypothesis for the *Calydna hiria* group originally presented by Hall (2002). The monophyly of the *hiria* group, which now contains nine species, is well supported by the presence of well-defined dark and pale banding on the male hindlegs, crescent-shaped submarginal ocelli that have round black pupils, and patches of dense black androconial scales at the anterior margins of abdominal tergites six and seven, and the absence of the distal white element to the submarginal markings on both dorsal wings. A phylogenetic analysis, performed using the methods given by Hall (2002), included only the nine *hiria* group species, with *C. thersander* (Stoll 1780), from the very homogeneous, sister *thersander* group, as the outgroup taxon. Twenty-one characters of adult morphology were used from the appendages, wing shape and pattern, and male and female genitalia (see Tables 1 and 2). These predominantly consist of those characters in Hall (2002) (some of which have been slightly modified here) that were relevant to resolving *hiria* group relationships, but a small number of new characters were also included.

The heuristic search generated two most parsimonious cladograms with a length of 32 steps (consistency index = 0.75; retention index = 0.84). The strict consensus cladogram is shown in Fig. 3. This phylogenetic hypothesis differs from that presented by Hall (2002) in three ways. First, *C. carneia* Hewitson, 1859, now appears as the sister taxon to *C. catana* Hewitson, 1859 + *C. cabira* Hewitson, 1854, instead of forming part of an unresolved trichotomy with those two species and the clade *C. candace* Hewitson, 1859 + *C. hiria* (Godart [1824]). This is the result of character 16 in Hall (2002) being divided into two characters here (7 and 8), to allow the absence/presence of a particular wing pattern trait to be coded for each sex separately. Second, the added *C. pichita* is positioned as the sister species to *C. cea*, because both species uniquely possess female genital signa that are of different shapes (character 20) and positioned asymmetrically at the wall of the corpus bursae (character 19). The great similarities between the males of *C. pichita* and *C. sternula* appear to be synapomorphies. Third, as a result of adding *C. pichita*, the phylogenetic position of *C. sternula* has become uncertain. Although *C. sternula* shares several symplesiomorphies with *C. pichita* and *C. cea* (characters 11, 13 and 14), no synapomorphies of adult morphology could be found to unite *C. sternula* either with these two species or the remaining *hiria* group clade. It is possible that *C. sternula* is the most basal species in the *hiria* group.

Biology.—*Calydna pichita* is unique within the genus in being confined to cloud forest, where it is currently known from about 2000 to 2100 m. This is near the upper elevational limit of the Riodinidae, and 600 m above the highest elevation of any other *Calydna* species (*sternula*). The male was collected at mid-morning perching on top of a leaf ca. 2.5 m above the ground in a sunny area inside a patch of cloud forest. The female holotype was captured in mid-
Table 1. List of characters used in the phylogenetic analysis of the Calyptra hiria group. Most characters are from Hall (2002), but with many modified for a hiria group only analysis; new characters are marked with an asterisk.

Appendages

1. Scaling at eye margins: (0) mottled black and white; (1) entirely black. CI = 1; RI = 1.
2. Male frons: (0) black with one or two pale, broken, horizontal bands; (1) black. CI = 1; RI = 1.
3. Male forelegs: (0) with multiple pale and dark bands; (1) black. CI = 0.5; RI = 0.67.

Wing shape and pattern

4. Falcate forewing apex in male: (0) present; (1) absent. CI = 1; RI = 1.
5. A pale bar extending across entire width of forewing discal cell end in male: (0) present; (1) absent. CI = 1; RI = 1.
6. Two prominent white spots immediately distal to forewing discal cell end in male: (0) present; (1) absent. CI = 0.5; RI = 0.5.

Note that although the vast majority of male C. cee specimens exhibit character state (1), a very few exhibit character state (0).
7. A large pale block in forewing Cu1 of male: (0) absent; (1) present. CI = 1; RI = 1.
8. A large pale block in forewing Cu2 of female: (0) absent; (1) present. CI = 1; RI = 1.
9. Two prominent white subapical spots on forewing of male: (0) present; (1) absent. CI = 0.5; RI = 0.75.
10. White fringe element in forewing M1 of male: (0) considerably longer than fringe elements in adjacent cells; (1) approximately same length as fringe elements in adjacent cells. CI = 0.5; RI = 0.67.
11. Reddish brown at costal and anal margins of dorsal hindwing in male: (0) present; (1) absent. CI = 1; RI = 1.
12. A large white block in discal cell of hindwing in male: (0) absent; (1) present. CI = 0.25; RI = 0.
13. Variably prominent blue to bluish-gray scaling at distal margin of dorsal hindwing in male: (0) present; (1) absent. CI = 1; RI = 1.
14. White fringe elements in hindwing cells M2 and M1 in male: (0) considerably longer than intervening black section; (1) approximately same length as intervening black section. CI = 1; RI = 1.

Male genitalia

15. Medial upward kink in pedicel, which recontacts aedeagus: (0) absent; (1) present. CI = 0.5; RI = 0.67.
16. Dorsal portion of valvae: (0) straight to convex; (1) concave. CI = 1; RI = 1.

Female genitalia

17. Signae: (0) long, narrow and spinelike; (1) large and approximately rectangular; (2) very long, wide and spinelike; (3) small and triangular; (4) short, narrow and spinelike. CI = 1; RI = 1.
18. Nodules or spines over surface of signal invagination: (0) present; (1) absent. CI = 1; RI = 1.
19. *Signa positioned: (0) symmetrically; (1) asymmetrically. CI = 1; RI = 1.
20. *Shape of signa: (0) same; (1) different. CI = 1; RI = 1.
21. Region between eighth tergite and papillae anales: (0) short; (1) elongate. CI = 1; RI = 1.

Table 2. Character matrix for the phylogenetic analysis.

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afternoon of the same day at almost the same spot, while resting under a leaf.

Distribution.—This species is currently known only from the type locality in the central-eastern Peruvian Andes, but it is presumably more widespread along the central Andes.

ACKNOWLEDGMENTS

JPWH thanks the many curators in Europe and the Americas who kindly allowed him to examine the riodinid collections under their care (see list in Hall 1999, 2002), and The National Science Foundation (Biodiversity Surveys & Inventories Grant #0103746) for research support.

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———. In press. Four new species of Symmachini from Ecuador (Lepidoptera: Riodinidae). Tropical Lepidoptera 12.


NEW DISTRIBUTION RECORDS AND RECENT SPREAD OF HYMENORUS FARRI CAMPBELL (COLEOPTERA: TENEBRIONIDAE: ALLECULINAEE) TO FLORIDA AND IN THE CARIBBEAN REGION

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Abstract.—Hymenor us farri Campbell (Coleoptera: Tenebrionidae: Alleculinae) appears to be spreading as a “weed species” in the Caribbean region. The beetle is diagnosed and illustrated. New country distribution records are reported for the Bahamas, Belize, Guatemala, Mexico, Puerto Rico, Turks and Caicos Islands, U.S.A. (Florida), and the Virgin Islands, and additional collections from the Cayman Islands are noted. The occurrences, habitats, biogeography, and uncertain origin of the insect are discussed.

Key Words: adventive insects, Antillean fauna, Caribbean biogeography, comb-clawed beetles, disturbed habitats

Species of Hymenorus, a large, monotonous genus of “comb-clawed beetles,” are difficult to identify, but males of H. farri Campbell (1971) are distinctive. The species was described and reported from Jamaica, Cuba, and the Cayman Islands (Campbell 1971, 1978) and appeared to be indigenous to those islands. While collecting Tenebrionidae on Grand Cayman in 1993, I became familiar with this beetle and was able to compare specimens with para-types of H. farri. This led to the identification of this Hymenorus from earlier and more recent collections from widely scattered localities, reported and discussed below. The beetle is far more widespread than previous records have indicated, and evidence suggests that this species is adventive in some areas, spreading with the aid of anthropogenic activities.

Diagnosis

Hymenorus farri (Figs. 1, 2) is unique among its congener s in having dense median patches of fine setae and punctures on basal abdominal sternites in males (Fig. 3). Other species have punctures more evenly distributed over these surfaces. This character and the combination of the relatively small and widely separated eyes, robust yellowish legs and tarsi, and finely, densely punctate pronotum with short, fine, erect pubescence, allow its separation from other species of similar size (4.5–5.5 mm). The apical two abdominal sternites are very dark brown, in contrast to the rest of the venter, which is reddish brown. The male genitalia are also distinct (Campbell 1971) and were of used to confirm the identifications made in this study. In the United States, the genus contains nearly 100 described species (Aalbu et al. 2002).

New Material and Collection Records

All specimens reported here are deposited in the collection of the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM), except those listed as “SBPC,” which are in the collection of Stewart Peck, Ottawa, Canada.
"MSU," the collection of Montana State University, Bozeman, Montana, and "ABS," the Archbold Biological Station, Lake Placid, Florida. I did not search other collections for additional records of *H. farri*; the purpose of this study is to simply call attention to the presence of this species in the United States and other new records at hand. Recently, however, I examined the Florida State Collection of Arthropods, Gainesville, and found no specimens of this species. Following the quoted label data for most collections, field observations and other information on the occurrences are given. Specimens in SBPC were identified by J. M. Campbell and S. B. Peck.

Central American and Mexico.— "BELIZE: Stann Creek Dist., Dangriga, 13–15 June 1981, W. E. Steiner (17); field notes describe (14 June) a series of "alleculines" taken at lights on walls of a hotel on the beach front; a few other specimens (13 and 15 June) were found near the building under leaf litter on sand during the day. These were identified by J. M. Campbell shortly thereafter. Because they represented the only known occurrence of *H. farri* in Middle American mainland, I then searched through several hundred undetermined *Hymenorus* in the USNM collection, finding only these additional two: "B. HONDURAS, Belize, ix 1959, N. L. H. Krauss" (1); "MEXICO, Veracruz, VI.1975" (1, no other data). Most recently, the following specimen was sent to the Systematic Entomology Laboratory, USDA, for urgent identification: "GUATEMALA (origin) at Long Beach, CA, USA, with bananas, 19 March 2003, P. Butsook, Inspector" (1).

Bahamas and Turks and Caicos Islands.— "Bahamas, Andros Island, Stafford Creek, Marks Place, 24.vii.1987, J. Browne, mangrove blk lt. 87-121J" (1, SBPC); same data except "BARC. 28.vii.1987, pasture
Fig. 3. *Hymenorus farri*, ventral surface of abdomen of male with median patches of setae. Scale line = 1 mm.

edge blk lt. 87-133J’’ (1, SBPC); same data except “Fresh Creek, Andros Twn, Androsia, 15–06.viii.1987, coppice interior. blk. lt. 87-163J” (1, SBPC); “GRAND BAHAMA ISLAND. Freeport, 20–26 June 1987, W. E. Steiner, M. J. & R. Molineaux”’’ (9); “BAHAMA ISLS., San Salvador, Gerace Research Ctr., 24°07’N, 74°26’W, 26 January 1998/At light in sandy scrub forest: W. E. Steiner & J. M. Swearingen collectors” (1); same data except “21 June” (4) and “22 June” (3); “TURKS AND CAICOS ISLANDS. Providenciales. Grace Bay Beach, 21°48’N, 72°13’W, 26 January 1998/At light in sandy scrub forest: W. E. Steiner & J. M. Swearingen collectors” (1); same data except: “On palm leaf at dusk” (1); “CAYMAN ISLANDS: Grand Cayman, 3 km W Colliers, 19°21’N, 81°07’W, 21 February 1993/At black light in cut-over forest near ponds; coll. W. E. Steiner & J. M. Swearingen” (12); same data except “On palm leaf at dusk” (1); “CAYMAN ISLANDS: Grand Cayman, Hell, 19°23’N, 81°24’W, 19 February 1993/W. E. Steiner & J. M. Swearingen collectors/Under leaf litter on sandy soil, weedy roadside” (1);
same data except “North Side, 19°21’N, 81°12’W, 22 February 1993/At black light in forest clearing near coast” (2); same data except “Rum Point, 19°22’N, 81°16’W, 22 February 1993/Under leaf litter beneath Cakile plants on sand, open edge of dune and pavement” (13) and “24 February 1993/Under dry palm fronds and litter on sandy soil, open mowed flat area near dune and beach” (1). These collections do not represent new island records, but associated notes on the captures add to the knowledge of the insect’s habitat. Hymenorus farri was collected on all three of the Cayman Islands during a faunal survey in 1938 (Campbell 1978).

Puerto Rico.—“PUERTO RICO, Isla Verde, 27-II-63/A. B. Cochran, on walls & ceilings/San Juan 18388/63-6853” (6); “Isla Verde, P. R., host unknown, A. B. Cochran, 27 Feb. 1963/San Juan 18388, 63-6853” (4); “PUERTO RICO: Isla Verde Airport, 1-III-63. A. B. Cochran/San Juan 18458, 63-10499” (1); “P. R., San Juan, Airport, II-15-63, L. T. Sanders/On airport windows, San Juan # 18989, 63-19346” (1); “PUERTO RICO, Naguabo, Playa de Naguabo, 18°11’N, 65°43’W, 17 February 1996, colls. W. E. Steiner & J. M. Swearingen” (3). Label data on the San Juan Airport collections, all made within a two-week period in 1963, suggest an artificial introduction. Except for the few specimens from Naguabo, no other records for Puerto Rico have been found; this is the only collection made “in the wild” on the island, but it indicates that the beetle is established or indigenous there. Notes made at the Naguabo site indicate specimens were found among beach strand vegetation, in dead leaves on sand among trailing vines in an open sunlit roadside area.

Virgin Islands.—“VIRGIN IS., St. Croix, Est. Mount Fancy, S.E. of Great Pond, 12 JAN 1993, D. S. Sikes, beating mangroves” (2, MSU); same data except “R. S. Miller, beating veget.” (1, MSU); “BR. VIRGIN IS: Guana Is., The Flats, nr. Orchard, 13 July 1994, S. A. Bucklin colr., leaf & bark litter” (1, MSU); “BR. VIRGIN IS: Guana, Hotel to gardens, 16 OCT 2002, M. A. Ivie colr” (1, MSU); “BR. VIRGIN IS: Guana Is., White Beach, 18°29’N, 64°34’W, 01–17 JUL 1993, R. R. Snelling, CoccoColoba coppice” (1, MSU).

United States.—“FLORIDA: Broward Co., Deerfield Beach, North 3rd St., November 5, 1990, Vince Golia, sweeping” [site described (V. Golia, personal communication) as a “vacant trashy lot”] (1, ABS); “FLORIDA: Broward Co., Fort Lauderdale, near Conference Ctr., 26°06’N, 80°07’W, 19 November 2002/W. E. Steiner, N. J. Vandenberg, J. M. Swearingen collectors” [in field notes: “... rough, trashy ground between a hedge & the asphalt, with scattered cabbage palms—bases of these had thick layers of coarse thatch from repeated mowing of weedy strip—more Blapstinus fortis under the matted debris, & a few Hymenorus sp. poss. farri ...”] (3); “FLORIDA: Dade County, Homestead/1 May 1986, W. E. Steiner & D. S. Bogar/Under leaf litter near sidewalk, open turf area” (1); “FLORIDA: Monroe County, Dry Tortugas, Garden Key, 13–15 February 1989/W. E. Steiner, J. M. Hill & J. M. Swearingen collectors” [in field notes (15 Feb. 1989): “Another Blapstinus fortis, series of the small pale Phaleria, & a few Hymenorus sp. under wind-deposited plant debris caught under spreading, isolated plants of the semi-succulent crucifer “sea rocket,” Cakile sp.”] (3); “FLORIDA: Monroe Co., Lower Matecumbe Key, 17 February 1989/W. E. Steiner, J. M. Hill & J. M. Swearingen collectors” [in field notes: “Series of Hymenorus under dry leaf litter under trailing ‘ice plant’ on loose sand beneath shrubs. Not much of a beach here in terms of sand build-up and almost no areas of elevated exposed sand. Probably semi-artificial anyway, being between tidal flats & bank of highway”] (6); “FLORIDA: Monroe County, Lower Matecumbe Key, ocean beach, 24°51′15″N, 80°44′10″W; 21 May 2000, coll. W. E. Steiner & J. M. Swearingen/Under leaf lit-

**FURTHER OBSERVATIONS AND DISCUSSION**

Habits and habitats.—The label data and noted observations show that the beetle occurs primarily at or near the coast in open weedy areas on sand or sandy soil. The larvae probably inhabit sandy substrates, as has been observed for some other species of the genus (Steiner 1995). Adults hide during the day under matted leaf litter, in open areas, but often shaded by shrubs, or at the base of trees. They were especially common in sites of human disturbance—near buildings, weedy roadsides, edges of garden plantings, and areas of coarse turf that receive occasional mowing and where layers of thatch accumulate.

Beetles are fully winged and rapidly take flight when exposed to sunlight on removal of plant debris cover. Nocturnal dispersal by flight is probably typical, however, as supported by the series collected at lights. Feeding has not been observed in *H. farri*, but a single Jamaican specimen is labeled “eating coccids on Agave” (Campbell 1971) with some question as to verity—no predaceous habits have been observed in alleculines, and this needs further investigation. Adults and larvae are likely to be scavengers on dead plant material and probably fungi on its surfaces; adults of two Panamanian species apparently feed on lichens (Campbell 1962), and some eastern U.S. species chew at lichens on tree trunks at night (WES pers. obs.; in litt.).

Biogeography and detection.—“That the genus *Hymenopus* enjoys but a slight measure of popularity with collectors is undeniable” (Fall 1931). In the many localities newly added above, this may have contributed to the lack of detection of *H. farri* before now. In addition, it seems to “thrive” in habitats that are generally ignored and even avoided by collectors. The distribution of *H. farri* is much wider than originally reported, spanning the northwestern Caribbean and Bahaman regions. Campbell (1971) noted that the *Hymenopus* species of coastal areas tended to be more widespread. This species could be indigenous across its wide range, but because of the greater number of recent collections (very few records prior to 1960) and other characteristics considered here, I believe that the beetle is expanding its range.

Its appearance in Florida is especially telling: it is often common where found, but collection records are unknown prior to 1968. This rather distinct member of the genus likely would not have avoided detection until now, given the historical interest and work done on Florida Coleoptera, as summarized by Peck and Thomas (1998). Had the beetle been present much earlier, the diligent collecting of coleopterists such as E. A. Schwarz and W. S. Blatchley, when the Florida biota was in a pristine condition (Blatchley 1932), followed by the monographic works of Fall (1931) and Campbell (1971) on this genus, should have resulted in its detection. Therefore, it appears to be a recent addition to the U.S. fauna. However, determining native versus immigrant status for insects in southern Florida is particularly problematic (Whitehead and
Wheeler 1990), especially with a species of Antillean distribution. A similar situation involving several species of lygaeoid bugs that are probably recent arrivals to southern Florida in roadside habitats has been noted (Slater 1988). For the more vagile components of the circum-Caribbean lowland insect fauna, over-water dispersal from tropical America to Florida is most likely and accounts for the majority of such species in southern Florida (Peck 1989).

Similarly, *H. farri* seems to be new to Puerto Rico, the Virgin Islands, and Bahamas. *Hymenorus wolcottii* Campbell (1971) has been the only *Hymenorus* species previously known on Puerto Rico: it is abundant in many coastal localities and habitats (Wolcott 1950). A continuing survey of the Coleoptera of the Virgin Islands (Ivie 1996) has accumulated specimens of *H. farri* only during the last decade. Also, no Bahamian specimens were found during Campbell’s (1971) detailed study of material collected primarily from 1950 to 1965 on many islands, including the Turks and Caicos. The independent discoveries in 1987 on Andros and Grand Bahama, followed by other collections spanning the Bahamian archipelago, suggest a recent arrival and spread, possibly from Florida and/or Cuba.

The occurrence of *H. farri* on the Central American mainland raises several questions. Does this represent part of its natural range, or has it been recently introduced from the Greater Antilles, where it was first collected and recognized? The earliest collection record (Campbell 1971) is that of a specimen taken by E. A. Schwarz at Cayamas, Cuba; no year is given on Schwarz’s specimen label, but his letters (Sherman 1929) indicate he worked there in 1903–1904. The few records from Belize, Guatemala, and Mexico are all based on relatively recent captures. That this species is often common, but not among those described by Champion (1885), suggests a possible spread from the Antilles to Central America in recent decades. However, with so few collection records, this suggestion is tenuous. In addition, dispersal from islands to mainland is atypical—in fact, the opposite is a more likely scenario, with islands being colonized from mainland populations (Darlington 1938).

The genus *Hymenorus* is Holarctic (Campbell 1971, Papp 1958), but the numerous species treated by Champion (1885) and Fall (1931) indicate that its center of diversity and speciation is by far the arid parts of Mexico and the southwestern United States. A few species are known from Panama (Campbell 1962, 1982) and Brazil, but Campbell (1971) doubted that the latter were *Hymenorus*. Phylogeny among species is unknown; assuming that the genus is monophyletic, it displays mostly a “North American-Caribbean track” (Rosen 1976) of distribution, as does the known distribution of *H. farri* alone. Examples of other insect taxa that inhabit the soil surface also show this pattern, such as the carabid genus *Platynus* (Liebherr 1988) and many Lygaeoidea (Slater 1988). This perhaps supports the idea that *H. farri* is a mainland species that has spread to the Caribbean region. Two other species of *Hymenorus*, both of which also inhabit coastal sands, are nearly as widely distributed as *H. farri* and overlap with much of its range: *H. densus* LeConte, from North Carolina to Florida and the Bahamas (Campbell 1971) and Mexico (Champion 1885; recent collection records in USNM), and *H. convexus* Casey, from southern Florida, Bahamas, Turks and Caicos Islands, Cuba, and Cayman Islands (Campbell 1971, 1978). The latter, however, is not known from mainland Central America and appears to be of Antillean origin: Campbell (1971) stated that it “has spread into Florida from the Bahamas.” Other *Hymenorus* species, including mainland ones, are known from relatively few records and appear to be more precinctive or endemic to one or a few islands (but this could be due to the “collectors’ neglect” mentioned above). *Hymenorus farri* might be naturally widespread and has simply escaped detection across its range until now, but it ap-
pears more likely to be a “weed species” that is spreading (from an uncertain origin, possibly Cuba) with the aid of human activities.

In addition to being an active flier, H. farri has characteristics of insects that are likely to be introduced to new regions (Whitehead and Wheeler 1990). Some other adventive tenebrionids inhabit coastal sands and seem prone to accidental introduction (Steiner 1996, 2003, in press). Hymenorus farri lives in open, disturbed habitats and is found in the same microsites with other adventive or invasive species (e.g., turf weeds, imported fire ants). It also commonly co-occurs with Blapstinus foris LeConte, a widespread native tenebrionid with a distribution (Davis 1970; WES unpublished data) similar to that of H. farri. Natural dispersal via flight and storm winds could have occurred, or arrival at new lands via commerce, e.g., in soil with ornamental plant stock, is possible, as demonstrated by the recent U.S. port interception of the beetle in a fruit shipment from Central America.

Anthropogenically altered, maintained, open habitats are more easily colonized by species of coastal sandy localities and open scrub, regardless of dispersal method. Removal of native vegetation offers such a species a much greater chance of successful colonization, and the open ground of roadsides provides corridors of dispersal to other areas. Roadside habitats have provided corridors for fire ant dispersal (Taber 2000, Tschinkel 1986). Even some native, flightless species, e.g., the tenebrionid Opatrius minimus (Beauv.), have “weedy” characteristics and may be spreading to new areas, where they are becoming more abundant than in their previous range (Steiner 1999).

Future collecting and tracking of individual species in question will better define this continuing blending of biota.

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LITERATURE CITED


PICTETIELLA LECHLEITNERI (PLECOPTERA: PERLODIDAE), A NEW SPECIES FROM MOUNT RAINIER NATIONAL PARK, WASHINGTON, U.S.A.

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Abstract.—Pictetiella lechleitneri, new species, is described from a male, female, and nymphal specimen collected in Mt. Rainier National Park, Washington, U.S.A. The new species is compared with P. expansa (Banks), the only other Nearctic species of Pictetiella Illies.

Key Words: U.S.A., Washington, Mount Rainier National Park, stonefly, Perlodidae, Pictetiella

Pictetiella was proposed by Illies (1966) as a replacement name for Pictetia (Banks 1947), when the latter was found to be a secondary homonym. The genus was thought to be monotypic and endemic to the U.S. Rocky Mountains until Zwick and Levanidova (in Zwick et al. 1971), and Zhiltzova (in Levanidova and Zhiltzova 1976), described the Asian species, P. asiatica Zwick and Levanidova and P. zwicki Zhiltzova. The Nearctic species, P. expansa (Banks), remained poorly known until Baumann (1973) redescribed the species and clarified its nomenclature. This species is now known from scattered localities in Colorado, Idaho, Montana, Utah, and Wyoming (Baumann et al. 1977), but its full distribution is probably under reported due to its late summer adult emergence. Recently, one of us (BCK) and a colleague, Jason P. Schmidt, collected nymphs of a second Nearctic Pictetiella from Mount Rainier National Park, Washington, and reared a single male and female described below.

Pictetiella lechleitneri Stark and Kondratieff, new species
(Figs. 1–9)

Types.—Holotype ♂ (reared) from Washington, Pierce Co., Carbon River at Carbon River entrance, Mount Rainier National Park, 12 July 2003 (emerged 21 July), B.C. Kondratieff & J. Schmidt; same data 1 ♀ allotype (reared). Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Additional material.—1 nymph collected with the holotype and allotype.

Adult habitus.—Submental gills obscure. General color dark brown to black patterned with yellow. Head black over posterior region but with trilobed yellow patch covering occiput mesally and extending into ocellar triangle (Fig. 1); black patch covering area lateral to mesal yellow to antennal bases and terminating at anterior ocellus; anterior frons and clypeus yellow. Pronotum with a broad mesal yellow band and scattered dark rugosities and pale areas

on disc. Mesosternum with dark brown transverse band covering basisternum and additional brown pigment lining stem and Y-arms and partially filling area between furcal pits; mesosternal grooves typical of genus. Wing membrane transparent, veins dark brown but paler in costal region. Femora banded; dark brown in a dorsomesal patch which expands on anterior surface to femoral base; yellow patches occur distally and on dorsobasal surface. Tibiae and tarsi dark brown.

Male.—Macropterous. Forewing length 16 mm. Abdominal sterna dark brown but with broad yellow U-shaped, posteromesal patches on sterna 5–9; patches on sterna 7–8 large, covering much of segment; sterna 5–8 with small mesal lobes, that on segment 7 largest. Epiproct outline broad near apex and with a small mesoapical nipple-like process (Figs. 2–3); dorsal and ventral surfaces mostly membranous but covered with densely packed, backward directed, small sharp spines; dorsal sclerite wide at base and tapered to base of apical nipple, becoming less distinct near apex; ventral sclerite extends for ⅔ of epiproct length, unarmed. Cowl of epiproct covered with dense pile of fine setae; paragenital plates sclerotized, lateral styles absent (Fig. 2).
Hemiterga broadly rounded and sparsely armed with short, triangular sensilla basiconica.

Female (specimen with unexpanded wings).—Subgenital plate large and broadly rounded; apex almost as wide as base (Fig. 4). Sternum 9 essentially bare in mesal field, but with an irregular marginal row of short bristles.

Egg.—Crudely three sided but somewhat turtle shaped with collar covered by lid (Figs. 6–9); chorion smooth on ventral side surrounding collar but granular over rest of surface (Figs. 6–9). Axillary lateral ridges and cross poorly defined. Micropyles in irregular equatorial rows; micropylar orifices oval and set on smooth linear ridges (Fig. 9).

Nymph (male).—Preemergent body length 17 mm. Submental gills slightly longer than basal diameter. General color brown patterned with yellow. Head mostly pale on occiput and in a patch forward of median ocellus (Fig. 5); pronotum mostly brown with irregular pale areas scattered on disc. Abdominal terga 2–10 with large paired pale spots, narrowly separated by median brown band; posterior fringe includes several long setae and mixed short thick ones. Femora banded with narrow brown median band. Mandibles typical of genus, lacinia with a pair of prominent bristles near base of secondary tooth and an incomplete row of minor setae on basal third of margin.

Etymology.—The patronym honors Dr. Richard A. Lechleitner, Mount Rainier National Park, Washington. Rich has provided generous assistance and guidance in the study of the aquatic insects of Mount Rainier National Park, a remarkable pristine landscape.
Diagnosis.—The epiproct of _P. lechleitnieri_ (Figs. 2–3) is shorter and broader near the apex than in _P. expansa_, and the color pattern is more striking with conspicuous femoral bands and broad U-shaped postero-omesal sternal patches on abdominal segments 5–8. The female subgenital plate structure (Fig. 4) is very similar to _P. expansa_, but the female can probably be separated by the banded femoral character. Eggs are distinctive in collar form. Those of _P. expansa_ have the lid expanded into a hoodlike structure (Baumann 1973, figs. E–H), that is much smaller in _P. lechleitnieri_. In addition, the ventral concavity around the collar orifice is completely smooth in the new species (Fig. 7), but has a cluster of irregular ridges in _P. expansa_. The nymph differs from _P. expansa_ most conspicuously by the paired pale tergal patches on abdominal segments 2–10.

Discussion.—Kondratieff and Lechleitner (2002) listed 82 species of stoneflies from Mount Rainier National Park, but no specimens of _Pictetiella_ were available for study despite relatively intensive collecting of adult Plecoptera. Typically, _Pictetiella_ emerges late in the season, often as late as October (Baumann and Gauffin 1969), and adults are difficult to find in the field. Recent collecting of immature aquatic insects in July revealed a striking perlodine nymph occurring in the Carbon River, a large drainage on the west side of the Park. Despite much effort only a few nymphs were collected and returned to Colorado State University for rearing.

Other perlodine stoneflies collected and reared with _P. lechleitnieri_ included _Megarcys irregularis_ (Banks) and _Kogotus nonus_ (Needham and Claassen), with the former being especially abundant.

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**Literature Cited**


TWO NEW SPECIES OF MEGASELIA RONDANI (DIPTERA: PHORIDAE) FROM COSTA RICA

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Abstract.—Two new species, Megaselia prolixfurca and M. tanypalpis, are described from mid- to high elevations in Costa Rica.

Key Words: Diptera, Phoridae, Megaselia, Neotropical, Costa Rica, taxonomy

The Phoridae is a large group of poorly-known flies, found worldwide in nearly all terrestrial habitats. Larvae have a tremendous range of food sources, with various species being scavengers, predators, herbivores, parasitoids, or true parasites (summarized by Disney 1994), although the lifestyle of the great majority of species is unknown. There are approximately 3,400 described species of phorids, but this is generally considered to be as little as one-tenth of the actual diversity of the family, with estimates of the total ranging from 20,000–50,000 species (Disney 1983, Gaston 1991).

The giant genus Megaselia Rondani includes at present 1,452 species and accounts for about one-half of the described species of Phoridae. Of these, only about 340 species are described from the Neotropical Region, the area of probable greatest species richness for these flies. In comparison, the better studied, but presumably less diverse Palearctic Region has 420 described Megaselia, which is still of course a great underestimation of the true fauna. All regions of the world are poorly-known, as clearly demonstrated for the Australasian Region by Disney (2003) and the majority of species remain undescribed. The dauntingly large number of (mostly undescribed) species, small size, and apparent uniformity of these flies has contributed to a situation where Megaselia are essentially unidentifiable, outside of England, for which a good handbook to the species exists (Disney 1989), and nearby parts of Europe.

The most recent keys to Neotropical species of Megaselia are those of Borgmeier (1962, 1969, 1971), but they are virtually worthless for identifying most specimens. A new synthesis of the Neotropical Megaselia is required, although this would be a huge task that would be the work of a lifetime. Consequently, we herein describe two distinctive new species of Megaselia that are reasonably common at middle and high elevations in Costa Rica, and that might be noticed by a general collector.

Materials and Methods

Specimens belong to the following institutions (codens from Arnett et al. 1993):

CMNH Carnegie Museum of Natural History, Pittsburgh, PA, USA.
INBC Instituto Nacional de Biodiversidad, Santo Domingo, Heredia, Costa Rica.
LACM Natural History Museum of Los Angeles County, Los Angeles, CA, USA.
Barcoded labels are placed on the pin of each specimen. Those of holotypes are given in square brackets.

Costal sector ratios are the distance between the humeral crossvein and R₁ (= sector 1): distance between R₁ and R₂+₃ (= sector 2): distance between R₂+₃ and R₄+₅ (= sector 3). All costal sector measurements are divided by the value of sector 3.

**TAXONOMY**

*Megaselia prolizifurca* Kung and Brown, new species

(Figs. 1–3)

Diagnosis.—The unusually long wing vein fork (composed of R₂+₃ and R₄+₅) easily distinguishes this species from all other described Neotropical *Megaselia*.

Description.—Body length 2.0 to 3.2 mm. Frons dark brown, broader than high. Ventral interfrontal setae about halfway between ventral fronto-orbital and dorsal supra-antennal setae. Two pairs of supra-antennal setae present, ventral pair approximately three-fifths length and slightly thinner than dorsal pair. Flagellomere 1 brown, round. Palpus yellowish brown with long, thick setae, apical setae nearly as long as palpus. Scutum and scutellum both yellowish brown. Anterior scutellar setae one-tenth length and thickness of posterior, similar in length and thickness to setae on scutum. Pleuron mostly yellowish brown, except for anepimeron which is almost entirely dark brown. Proepisternum bordered from dorsal margin posteriorly to ventral margin with sparse, long setae. Setae at dorsal margin and ventral margin at least twice as thick as setae along posterior margin; ventral setae much longer than dorsal setae. Anepisternum bare. Legs uniformly light brown. Mid- and hind tibiae both with anterodorsal, longitudinal setal palisade, although setal palisade only extends about halfway on midtibia. Mid- and hind tibiae both with posterodorsal row of widely spaced, thicker setae. Wing (Fig. 1) 2.4 to 3.5 mm. Costa 0.61 to 0.68 wing length. Mean costal sector ratio 2.8:3.3:1: range 2.1–3.4: 2.1–4.1:1. Costal setae 0.15 to 0.22 mm. Vein R₂+₃ present; fork greatly elongate, originating from only slightly posterior to apex of R₁ to originating from midway between R₁ and R₂+₃. Wing membrane darkened along thin veins, two specimens with darkened membrane also along wing margin. Halter yellow to light brown.

**Female abdomen:** Tergites (Fig. 2) with sparse, short, thin setae; yellow, except one specimen from Villa Mills dark brown. Tergite 1 lighter in color than other tergites; rectangular, anteromedially and posteromedially shortened. Tergite 2 rectangular, almost width of abdomen, with long, thick lateral setae. Tergite 3 triangular, narrowed posteriorly with truncate posterior apex. Tergite 4 similar in shape to tergite 3, except broader and narrowed anteriorly instead of posteriorly. Tergites 3 and 4 form hourglass-shape. Abdominal segment 5 laterally with eversible glands; tergite short, linear, rounded laterally. Tergite 6 crescent shaped. Tergite 7 elongate, triangular, narrowed posteriorly. Sternite 7 narrow, elongate, slightly thickened posteriorly. Tergite 8 rectangular with anterior notch. Apex of segment 8 ventrally without large sclerites, with denser posterolateral setae.

**Male abdomen:** Tergites brown to dark brown, not reduced, with sparse, thin setae. Terminalia (Fig. 3) with scattered, thin setae. Right side of epandrium with posteroventral notch. Process on left hypandrial lobe large and broad; process on right hypandrial lobe smaller, about one-half length and width of left.

**Type material.—**Holotype ♂: COSTA RICA: San José: 20 km S Empalme, 9.63°N, 83.85°W, iv.1989. P. Hanson, Malaise trap, 2800 m [LACM ENT 063327] (LACM). Paratypes: COSTA


Etymology.—The name is a combination of the Latin words *prolixus*, meaning stretched out in length, and *furca*, fork, referring to the elongate fork in the wing.

*Megaselia tanypalpis* Kung and Brown, new species

(Figs. 4–5)

Diagnosis.—This species is most easily recognized by its elongate palpus, and the long, dense setae on the epandrium. *Megaselia tanypalpis* is also distinguished by its single pair of supra-antennal setae and the presence of one long seta in addition to short, thin setae on the anepisternum.

*Megaselia tanypalpis* can be considered as having two or four scutellar setae in Borgmeier’s terminology, so we attempted to key out this species both directions. *Megaselia tanypalpis* keys to *M. rhabdopalpis* Borgmeier in Borgmeier’s 1962 key to Neotropical *Megaselia* when treated as having 4 scutellar bristles. It differs from *M. rhabdopalpis* in its larger size and more elongate palpus: *M. rhabdopalpis* has a broader, shorter, more cylindrical palpus. This species also differs from *M. rhabdopalpis* by the presence of long, dense setae on the genitalia, and a stalked proctiger. When the scutellum is considered to have 2 bristles in the same key, *M. tanypalpis* keys to *M. seticlasper* Borgmeier, but the setae on the epandrium are much denser in *M. tanypalpis* than in this species. In Borgmeier (1969), *M. tanypalpis* keys to couplet
6 when “scutellum with 4 bristles” is used (in couplet 2), but does not fit either species. *Megaselia tanypalpis* keys to *M. subinflata* Borgmeier in couplet 7 when “scutellum with 2 bristles” is used, but differs from *M. subinflata* by a much longer costal ratio and enlarged palpus. *Megaselia tanypalpis* keys to *M. spiniceps* Borgmeier in Borgmeier’s 1971 key when “scutellum with 4 bristles” is used (in couplet 2), but is easily differentiated by its elongate palpus. When keyed using “scutellum with 2 bristles,“ *M. tanypalpis* keys to the female of *M. laevigata* Borgmeier, but does not resemble the description.

Description.—Body length 2.0 to 2.8 mm. Frons dark brown, approximately twice as broad as high. Ventral interfrontal seta approximately halfway between ventral fronto-orbital and supra-antennal setae, slightly closer to eye margin than midline. One pair of supra-antennal setae present, slightly thinner and shorter than ventral interfrontal seta. Flagellomere 1 and palpus light brown. Flagellomere 1 round. Palpus (Fig. 4) greatly enlarged, one and one-half to almost twice length of head, inflated, with sparse, thin setae. Scutum brown, scutellum darker. Anterior scutellar seta approximately one-third to one-half length and one-third thickness of posterior. Pleuron mostly light brown to brown; propisternum, anepisternum, and anepimeron always darker. In some specimens pleuron also darkened ventrally. Proepisternum ventrally with one long seta and few shorter setae; dorsally with sparse thin setae, or bare. Anepisternum with short, thick setae and one long, thick seta. Legs uniformly light brown. Mid tibia and hind tibia both with anterodorsal, longitudinal setal palisade, plus posterodorsal row of widely spaced, thicker setae. Wing 2.4 to 3.0 mm. Costa 0.60 to 0.64 wing length. Mean costal sector ratio 2.4:1.6:1: range 1.7—3.2:1.1—2.0:1. Costal setae 0.08 to 0.12 mm. Vein R_{2+3} present. Halter dark brown.

**Male abdomen:** Abdominal tergites dark brown, matte. Venter of abdominal segments 3–6 with with long, thickened setae; on each segment the setae being slightly longer posteriorly. Posterior row of setae on venter of abdominal segment 6 dorsally pointed, about one and one-half to two times longer and thicker than those of other segments. Both sides of epandrium (Fig. 5) with long, thick, dense setae. Hypandrium without large projections. Proctiger stalked, with ventral lobe.

**Female:** Unknown.

**Type material.**—Holotype ♂: COSTA RICA: San José: Zurquí de Moravia, 10.05°N, 84.02°W, iv.1989, P. Hanson, Malaise trap, 1600 m [LACM ENT 062307] (LACM). Paratypes: COSTA RICA: San José: Braulio Carillo National Park, 10.12°N, 83.97°W, 1 ♂, iv—v.1990, P. Hanson, Malaise trap, 1000 m; Zurquí de Moravia, 10.05°N, 84.02°W, 2 ♂, 2—8.iii.1995, B. Brown. Malaise trap, 1600 m; 1 ♂, iii.1989, 8 ♂, iv.1989, 4 ♂, v.1989, 1 ♂, vi.1995, 1 ♂, i.1996, 1 ♂, vi.1996, P. Hanson, Malaise trap, 1600 m (INBC, LACM, MCZC, MUCR, USNM).

**Etymology.**—The name is from the Greek word for long and outstretched, referring to the long palpus of the species.

**ACKNOWLEDGMENTS**

We thank Lai Shan Mui for skillfully preparing the illustrations, Vladimir Bereczvskii for technical assistance, and Paul Hanson for sending us Costa Rican Malaise trap samples. This work was supported in part by National Science Foundation grant DEB-0090031 to B. Brown.

**LITERATURE CITED**


——. 1971. Further studies on phorid flies, mainly
A NEW SPECIES OF HYSTRICHOPSyllA TASCHENBERG, 1880
(SIPHONAPTERA: HYSTRICHOPSyllIDAE) FROM GUATEMALA

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Abstract.—Hystrichopsylla guatemalensis, n. sp., is described from Guatemala. collected from the shrew, Sorex veraepacis Alston, 1877. A tentative key is constructed for the four Mexican and Central American members of the genus, although two of these species are known only from one sex. Members of the genus occur at higher Central American elevations (2100–3100 m). It is hypothesized that worldwide, members of Hystrichopsylla display primitive morphological characteristics and frequently parasitize primitive mammalian hosts, such as moles and shrews. This association suggests coevolution of parasite and host.

Key Words: Hystrichopsylla, distribution, host, shrew

There are currently three named members of the genus Hystrichopsylla from Mexico. Unfortunately two of these are known from single specimens. Hystrichopsylla orophila Barrera, 1952, was described from a single male specimen taken from Microtus mexicanus (Saussure, 1861) from the slopes of Popocatepetl volcano, Edo. Mexico, at an altitude of ~3100 m. Later that year Hystrichopsylls kris was described by Traub and Johnson from a single female taken on Neotomodon alstoni Merriam, 1898, from Mt. Tancitaro, Michoacán, altitude not given. The third, H. llorenteí Ayala and Morales, 1990, was based on one male and five females from Puerto del Gallo, Municipio de Atoyac de Alvarez, Guerrero, from Peromyscus thomasi Merriam, 1898 (holotype) and P. megalops Merriam, 1898 (allotype, 4 paratype females). Collections came from elevations between 2100–2400 m. In this case, the authors theorize that this species is probably restricted to the higher parts of the Sierra Madre del Sur in Guerrero, an area of high endemism with clear Nearctic and Andean affinities. Following is a description of a fourth species, this one from Guatemala.

Hystrichopsylla guatemalensis Lewis and Eckerlin, new species
(Figs. 1–4)

Diagnosis.—This species differs from those mentioned above in that both sexes have only 5 spines in the genital ctenidium, the exception being 1 male and 1 female with 5 on one side and 6 on the other. With 12 of the 14 specimens possessing 5 spines per side it seems that this is probably the normal pattern for the species. Further, it differs from H. orophila in the shape and chaetotaxy of the male fixed process, st VIII and st IX (Figs. 2, 3). It differs from H. kris in that the fossa of the spiracle on t VIII is tubular and extends to the posterior margin of the tergite. Finally, it differs from H. llorenteí in lacking the cluster of fine setae near the apex of male st VIII and in
the contours of the caudal margin of st VII in the female.

Description.—Large fleas; females 4.9 ± 0.3 mm (n = 11) and males 4.4 ± 0.1 mm (n = 3).

Head: Frontal tubercle present but not pronounced. Frontal setal row of 6–7 bristles, no well defined ocular row, but a preoc- cular row in front of vestigial eye. Remaining preantennal chaetotaxy of 15–20 fine setulae arranged in no particular pattern. Trabealina centralis conspicuous, ovate. Dor- sal margin of antennal fossa lined with ~12–15 setulae, 2 preoccipital setal rows of 2 and 5–6 setae per side. Occipital row of 7–8 setae per side. Usually with five spines in genal comb per side except as noted in diagnosis.

Thorax: Pronotum with 2 well defined rows of ~8 long setae per side. Total spines in pronotal comb in male: 25(1), 26(1) and 27(1); female 24(2), 25(1), 26(4), 27(2) and 28(2). Main setal row on mesonotum ~6 per side in male, ~8 per side in female. Remainder of surface covered with 5–6 irregular rows of short setae. One pseudoseta per side high up under mesonotal collar. Outer surface of mesepisternum-epimeron with ~25 setae in ~5 irregular rows. Main setal row of metanotum 5 per side. Re- mainder of surface with ~20 setae per side arranged in 3 rows. Metepisternum with 1 long bristle, metepimeron with ~15–18 setae per side arranged in 4 irregular rows. No marginal spinelets on metanotum.

Legs: Forefemur with a false comb on caudal margin. Tarsal segment V of all legs with 5 pairs of lateral plantar setae, none shifted on to plantar surface.

Abdomen: Setae in main row on male tergites I–VII: I 15, II 8, III 8, IV 8, V 7, VI 7, and VII 6–7; female I 5, II 8–9, III 8–9, IV 7–9, V 6–9, VI 6–8, and VII 4–5. Margi- nal spinelets on male tergites II–IV: II 3– 5, III 2–4, and IV 2–3; female II 3–8, III 2–4, and IV 2–4. Three antensensial setae in both sexes. In male lateral setae ~½ the length of median, in female laterals closer to ½ length of medial, lower seta somewhat longer than upper seta. Spiracular fossa cy- lindrical in both sexes, straight in female, somewhat bent dorsad in male. Six to 8 small setulae per side above spiracle. Three long setae in main row on sternites III–VII preceded by a few shorter bristles in male, 4 in main row on sternites I–V in female, 5 on VI, 6 on VII and ~4 on VIII. Sternites VI–VII with 10–18 shorter bristles arranged in irregular rows.

Modified abdominal segments: Male (Figs. 1–3) with apex of movable process extending ~¼ its length beyond apex of fixed process. Apical 3 spiniforms of st IX paired, remainder unpaired. Apex of st VIII tapered to a point bearing a cluster of setae on its caudal margin. Female, (Fig. 4) with spermathecae and variation in caudal margin of st VII as illustrated.

Types.—Holotype ♀: Ex Sorex varae- pacis Alston. 1877, Guatemala, El Progreso Department, San Agustin Acasaguastlan, Reserva Biosfera de la Sierra de las Minas, Montaña Pinalon 15°04’54”N 89°55’59”W, 2700 m, 4-V-1998, R. Eckerlin leg. Allo- type ♂: Ex same host species but Guate- mala. Zacapa Department, Rio Hondo, 6 km NNW of San Lorenzo, Reserva Bios- fera de la Sierra de las Minas. 15°08’26”N 89°40’36”W, 2200 m, 4-VI-1996, S. G. Perez leg. Paratypes: Same data as holotype but 15-II-1996, S. G. Perez leg. 1 ♀; same data as holotype but 8-V-1998. R. Eckerlin leg. 1 ♂: same data as allotype but 2200 m, 15-IV-1998, 1 ♀; same data as ho- lotype but 3–8-V-1998, 7 ♀.

Type deposition.—Holotype, allotype and 1 ♂ and 4 ♀ paratypes deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC. Paratype deposition includes; 1 ♂ and 4 ♀ in NMNH, 1 ♂ 3 ♀ in the Carnegie Mu- seum of Natural History, 1 ♀ in the Museo de Historia Natural, Universidad de San Carlos de Guatemala, and 1 ♀ each in each author’s collection.

Remarks.—The prevalence of infestation of the shrews was 4 of 45 (8.9%) at the San Lorenzo site and 8 of 28 (28.6%) at the
Pinalon site. Overall prevalence was 16.4%. Three Cryptotis goodwini Jackson, 1933, from the same sites were not infested.

The genus Hystrichopsylla is generally thought to be among the most primitive of all fleas. One argument used to support this hypothesis is that primitive fleas tend to infest primitive hosts, and this is buttressed by the preference of the European H. talpae for insectivores. This appears to be less the case with Asian and Nearctic members of the genus and none of the Mexican or Central American species until now have been taken on moles or shrews (Insectivores) but rather have come from rodents (Rodentia).

Other characters that suggest primitivity are the retention of two spermathecae in the female, the dense vestiture of setae covering the body in both sexes, the similarity of the male genitalia among different species and the relative simplicity of the aedeagus. In truth, very little is known of the phylogenetic relationships within the order Siphonaptera. Perhaps molecular studies will unlock some of these secrets in the future, but to date little has been published on the matter. However, although few in number, it is possible to construct a simple key to the Mexican and Central American species using mostly somatic characters. The following is an effort to do so.

1. Five teeth per side in genal comb, 24–28 teeth in pronotal comb .......... guatemalensis
   − Six or 8 teeth per side in genal comb, more than 32 teeth in pronotal comb .......... 2
2. Eight teeth per side in genal comb, 46 teeth in pronotal comb (cluster of small setae near apex of st VIII in male) .......... florentiae
   − Six teeth per side in genal comb, 32 or 42 teeth in pronotal comb .......... 3
3. Thirty-two teeth in pronotal comb; fossa of spiracle on 18 cylindrical and extending to margin of tergite (only male known) .......... orophila
   − Forty-two teeth in the pronotal comb; fossa of spiracle on 18 tapering caudally and not extending to margin of tergite (only female known) ..........  kris

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Literature Cited


ANNOTATED CHECKLIST OF THE STONEFLIES (PLECOPTERA) OF IOWA

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Abstract.—Forty-three stonefly species including ten species from literature records are reported from Iowa. Stoneflies were present in all Iowa ecoregions. The Paleozoic Plateau/Coulee Section contained the greatest number of species (30) along with the most unique species (8). Allocapnia pygmaea (Burmeister), Leuctra tenmis (Pictet), Amphinemura linda (Ricker), Nemoura trispinosa Claassen, and Soyedina vallicularia (Wu) were confined to the Paleozoic Plateau/Coulee Section and should be considered for state protection. Western and southern Iowa have been poorly surveyed. Few species have been produced in these areas, presumably due to poor habitat conditions.

Key Words: stoneflies, Plecoptera, Iowa, ecoregion, imperiled species

Stoneflies (Plecoptera) are among the most environmentally sensitive group of aquatic insects (Hilsenhoff 1987, Lenat 1993). Recently, the Nature Conservancy and Association for Biodiversity Information ranked stoneflies as being one of the three most imperiled freshwater groups in the United States, with 43% of more than 600 species classified as “Vulnerable,” “Imperiled,” “Critically Imperiled,” or “Presumed or Possibly Extinct” (Stein et al. 2000). According to total number of species imperiled, stoneflies were second only to fish in freshwater habitats and third across all habitats combined.

There is currently a gap in our knowledge of the distribution patterns and geographic affinities of stoneflies in Iowa. Stark (2001) listed only ten species from the state: Allocapnia granulata (Claassen), A. rickeri Frison, A. vivipara (Claassen), Taeniopteryx burksi Ricker and Ross, Acroneuria abnormis (Newman), Attaneuria ruralis (Hagen), Perlesta cinctipes (Banks), Perlinella drymo (Newman), Isoperla longiseta Banks, and Isogenoides doratus (Rison). This number of species is far less than adjacent states’ records: Illinois (76 species), Minnesota (54), Missouri (69), South Dakota (33), and Wisconsin (62) (Hustman et al. 2001, Stark 2001, DeWalt et al. 2002). The low diversity of stoneflies in Iowa is probably the result of historically low collection effort.

Iowa is located in a transition zone of two major biotic provinces, the Eastern Deciduous Forest and the Prairie (Houghton et al. 2001). Nearly 85% of Iowa’s 14,500,307 hectares were prairie prior to Euro-American settlement with the other 15% being forest and savanna (Thompson 1992). Over 30,577 kilometers of interior rivers and streams flow throughout the state with nearly 70% of the streams draining eastward to
the Mississippi River and the other 30% southwest towards the Missouri River (Larimer 1957). Griffith et al. (1994) classified the state into four level III ecoregions, the Central Irregular Plains, the Western Corn Belt Plains, the Driftless Area, and the Interior River Valleys and Hills. Chapman et al. (2002) further refined these classifications by creating ten level IV ecoregions. The Iowan Surface (47c) and Paleozoic Plateau/Coulee Section (52b) (Fig. 1) have streams that occupy old valleys with high gradients, cool waters, and rocky substrates (Eckblad and Coon 1984). Bedrock outcrops, boreal microhabitats, and karst geologic features are attributes largely unique to these areas. The Rolling Loess Prairies (47f) and Loess Flats and Till Plains (40a) are most representative of the Iowa landscape (Prior 1991). These regions are well drained and flow through rolling hills of row crops, grasslands, and woodlands. The Northwest Iowa Loess Prairies (47a), Des Moines Lobe (47b), Western Loess Hills (47m), and Steeply Rolling Loess Prairies (47e) were once tallgrass prairie that has since been converted to agriculture dominated and hydrologically modified landscape. These alterations have adversely impacted stream condition. The rivers of the Upper Mississippi Alluvial Plain (72d) and Missouri Alluvial Plain (47d) receive the drainage of most of Iowa’s surface area prior to their entering the Mississippi and Missouri rivers (Prior 1991). Many rivers in these ecoregions have been dammed or channelized.

The objectives of this study were to document the stonefly fauna of Iowa, associate this fauna with the ten level IV ecoregions, and discuss the need for protection of habitats that support species rare to Iowa. We
hope the distribution information produced by this study also will add to the knowledge of post-glacial dispersal of several species, as there are presently vast disjunctions between taxa found in Minnesota, to the north, and the Interior Highlands, to the south (Poulton and Stewart 1991).

**Materials and Methods**

Since 1991 the University of Iowa Hygienic Laboratory (UHL) and the Iowa Department of Natural Resources (Iowa DNR) have performed aquatic macroinvertebrate surveys at 337 stream and river locations as part of a statewide biological assessment project. The surveys used Hester-Dendy multiplate samplers, a modified Hess sampler, and hand picking from aquatic substrates. The bioassessment project provided many stonefly nymphs for the current project. Adults were collected using ultra-violet light trapping, sweep netting, and hand picking to augment this source and to confirm nympha1 identifications. The majority of the specimens reside in the Illinois Natural History Survey (INHS) collection, the information for which may be viewed at http://ctap.inhs.uiuc.edu/insect/search_inhs.asp. Collection data from UHL and the other institutions that provided material, Brigham Young University (BYU), Iowa State University (ISU), Colorado State University (CSU), University of Northern Iowa, Okoboji Lakeside Laboratory (OLL), and Mississippi College, can be obtained by contacting the senior author.

**Results**

Stoneflies were collected from 274 of the 337 stream locations surveyed. A total of 43 species in 20 genera and seven families were either collected or found in museum holdings (Table 1). Thirty-three of these were new state records and some represented significant range extensions.

Perlidae (15), Perlodidae (12), and Nemouridae (7) contributed the greatest number of species. Peltoperlidae and Chloroperlidae were not found, although the latter taxon may yet be discovered. The greatest generic species richness were Isoperla (8), Perlesta (6), and Allocapnia (4). Nymphal Perlesta, Neoperla, and Pteronarcy were unidentifiable to species, but have been included in Table 1 as they represented important location information at the generic level.

Stoneflies were present within each level IV ecoregion (Table 1). The Paleozoic Plateau/Coulee Section (30 species) had the highest diversity, followed by the Iowan Surface (26), Rolling Loess Prairies (22), and Des Moines Lobe (19). The other six ecoregions had a combined 14 species among them. The Paleozoic Plateau/Coulee Section also had the greatest number of unique species at eight (Table 1). Other ecoregions had no more than two unique species (Table 1).

The following discussions summarize Iowa distributions, habitat requirement observations, and known North American range for all stoneflies found within the state, both historically and contemporarily.

**Family Capniidae**

*Allocapnia granulata* (Claassen)

*Allocapnia granulata* occurred throughout four ecoregions (Table 1) and was most common in the small, cobble-bottomed creeks of the Iowan Surface and Paleozoic Plateau/Coulee Section. Poulton and Stewart (1991) reported it from Arkansas, Missouri, Oklahoma, and Illinois, and associated with a variety of stream conditions. This species has been previously reported from Iowa (Ross and Ricker 1971) and is known from 26 other states/provinces (Stark 2001) including neighboring Minnesota and Wisconsin (Ross and Ricker 1971).

*Allocapnia pygmaea* (Burmeister)

*Allocapnia pygmaea* occurred in the large, cool-water rivers of the Paleozoic
Table 1. Iowa stoneflies distributed among ecoregions (see Fig. 1 for key to codes). Number of species within each family in parentheses after family names. New state records are in boldface.

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Plateau/Coulee Section (Fig. 2). Ross and Ricker (1971) found this species in similar habitats. *Allocapnia pygmaea* is a new state record and is known from 24 states/provinces (Stark 2001) including adjacent Minnesota, Missouri, and Wisconsin (Ross and Ricker 1971).

Records.—Clayton Co., Volga River, 1 km N Elkport, Co. Rd. X3C, 23 Feb 2000, 1 ♀ (INHS); Fayette Co., Turkey River, Eldorado, State Hwy. 150, 20 Mar 2000, 3 ♀ (INHS); 14 Feb 2002, 12 ♀, 13 ♂ (INHS).

*Allocapnia rickeri* Frison

*Allocapnia rickeri* was found in several, small, cold-water creeks of the Paleozoic Plateau/Coulee Section (Table 1). Ross and Ricker (1971) have previously reported *A. rickeri* from Iowa and it is known from 23 other states/provinces (Stark 2001) including adjacent Illinois, Minnesota, Missouri, and Wisconsin (Ross and Ricker 1971).

*Allocapnia vivipara* (Claassen)

This species occurred in six ecoregions (Table 1). Collection sites varied from small, rapid creeks to large, turbid rivers. Poulton and Stewart (1991) found it in similar habitats in the Missouri Ozarks. Ross and Ricker (1971) previously reported *A. vivipara* from Iowa and Stark (2001) listed it from 20 other states/provinces, including adjacent Illinois, Minnesota, and Wisconsin (Ross and Ricker 1971).

Family Leuctridae

*Leuctra tenius* (Pictet)

Adults of this species were collected from a single small cold-water creek of the Paleozoic Plateau/Coulee Section (Fig. 2). Several unidentifiable nymphs were also found in June and October from the same stream. Poulton and Stewart (1991) reported that *L. tenius* was almost exclusively found in permanent spring streams in Missouri. *Leuctra tenius* is a new state record and has been reported from 21 states/provinces (Stark 2001), including adjacent Illinois (Frison 1942), Minnesota (Harden and Mickel 1952), and Wisconsin (Hilsenhoff and Narf 1972).

Records.—Clayton Co., West Fork Sny Magill Creek, 6.6 km SW McGregor, Justice Rd., 2 Sept 2003, 1 ♀ (UHL); 17 Sept 2003, 1 ♂, 1 ♀ (INHS).

Family Nemouridae

*Amphinemura delosa* (Ricker)

Adults of this species were collected from a single cold-water stream in the Paleozoic Plateau/Coulee Section (Fig. 3). *Amphinemura delosa* will likely be found throughout this region because Illinois reports it as common in the streams along the Mississippi River (DeWalt, unpublished data). Poulton and Stewart (1991) also report *A. delosa* as the most common nemourid in the Ozarks of Missouri. *Amphinemura delosa* is a new state record and has been reported from 19 states/provinces (Stark 2001), including adjacent Wisconsin (Hilsenhoff 1975).

Records.—Allamakee Co., Unnamed trib. to Waterloo Creek (INHS, UHL).

*Amphinemura linda* (Ricker)

This is one of Iowa’s autumn emerging stoneflies. Adults were collected from a sin-
Figs. 2-7. Distribution of new state record stoneflies in Iowa. 2. Allocapnia pygmaea (circle), Leuctra tenax (square), Prostoia completa (open triangle), Shipsa rotunda (open circle), Soyedina vallicularia (triangle). 3. Amphinemura delosa (square), A. linda (circle), A. varshava (triangle), Nemoura trispinosa (open circle). 4. Strophopteryx fasciata (triangle), Taeniopteryx nivalis (open circle). 5. Acroneuria lycorias (circle), Perlinella ephyre (open circle), Neoperla clymene (square), N. osage (triangle). 6. Perlesta decipiens (circle), P. lagoi (open circle). 7. Perlesta golconda (open circle), P. shubuta (square), P. xube (triangle).
gle, large-volume springbrook in the Upper Iowa River watershed of the Paleozoic Plateau/Coulee Section (Fig. 3). Huntsman et al. (2001) reported this species from a similar relict habitat in South Dakota. This is a new state record and has been reported from 14 states/provinces including adjacent Wisconsin (Stark 2001).

Records.—Winnesheick Co., Dunning’s Spring, Decorah, Ice Cave Rd., 30 Sept 1999, 3 ♂, 12 ♀, 1 N (INHS); 19 Sept 2000, 8 ♂, 3 ♀ (INHS).

Amphinemura varshava (Ricker)

This species represents a new state record and was collected from five eastern and central Iowa ecoregions (Fig. 3). This species occurred in small, wooded streams with abundant cobble and was abundant along the bluff streams of the Mississippi and Rock rivers in Illinois (DeWalt, unpublished data). Stark (2001) reported A. varshava from four states including adjacent Wisconsin.

Records.—Boone Co., Ledges St. Park (BYU); Clayton Co., Brownfield Creek (INHS), Unnamed trib. Sny Magill Creek (INHS); Johnson Co., Turkey Creek (INHS); Lee Co., Atman Creek (INHS); Linn Co., Horseshoe Falls Creek (UHL).

Nemoura trispinosa Claassen

This species is restricted to the springbrooks of the Paleozoic Plateau/Coulee Section (Fig. 3). Harden and Mickel (1952) reported N. trispinosa from bluff springbrooks in southeastern Minnesota. This is a new state record and is also known from 15 states/provinces including adjacent Illinois (Frison 1942), South Dakota (Huntsman et al. 2001), and Wisconsin (Stark 2001).

Records.—Allamakee Co., Unnamed spring of Waterloo Creek, Dorchester, State Hwy. 76 and Steinbach Rd., 13 Apr 1996, 13 N (BYU); 3 June 2003, 1 ♂, 1 ♀ (UHL); Clayton Co., West Fork Sny Magill Creek, 6.6 km SW McGregor, Justice Rd., 10 June 1999, 1 ♀ (UHL); Bridal Veil Falls, 3 km S McGregor, Pikes Peak State Park, 7 June 2001, 1 ♂, 1 N (UHL); Delaware Co., Unnamed spring of Grimes Hollow, 3.5 km E Colesburg, Voyager Rd., 1 May 2004, 1 N (UHL); Dubuque Co., Unnamed spring of Catfish Creek, 5 km SW Key West, Swiss Valley County Park, 28 Apr 2004, 1 N (UHL); Fayette Co., Unnamed spring of Grannis Creek, 5.2 km W Wadena, 19 June 2000, 1 ♀ (INHS); Winnesheick Co., Twin Springs, Decorah, Twin Springs City Park, 13 Apr 1996, 3 ♂, 4 ♀, 9 N (BYU); 19 Sept 2000, 6 ♂, 14 ♀ (INHS); Malanaphy Springs, 7.2 km NW Decorah, Co. Rd. W20, 10 May 2000, 6 N (INHS); 8 June 2000, 1 ♂, 3 ♀ (INHS); Dunning’s Spring, Decorah, Ice Cave Rd., 30 Sept 1999, 1 ♂, 11 ♀ (INHS); 22 June 2000, 2 ♂, 5 ♀ (INHS); 19 Sept 2000, 1 ♂ (INHS).

Prostoia completa (Walker)

Prostoia completa is a spring-emerging species found in the Iowan Surface and Paleozoic Plateau/Coulee Section (Fig. 2), occurring in medium-to-large streams with clean, rock riffles. Harden and Mickel (1952) reported P. completa from similarly sized streams in Minnesota. This species is a new state record and has been reported from 22 states/provinces (Stark 2001) including adjacent Illinois (Harris and Webb 1995), Missouri (Poulton and Stewart 1991), and Wisconsin (Hilsenhoff and Narf 1972).

Records.—Allamakee Co., Upper Iowa River (INHS); Delaware Co., Maquoketa River (INHS); South Fork Maquoketa River (BYU, CSU); Fayette Co., Turkey River (INHS, UHL); Winnesheick Co., Upper Iowa River (INHS).

Shipsa rotunda (Claassen)

Shipsa rotunda was rare in Iowa, with records from three streams in the Iowan Surface and one stream in the Paleozoic Plateau/Coulee Section (Fig. 2). This species occurred in medium-to-large rivers with sandy substrates. This species is a new state record and is known from 18 states/provinces (Stark 2001), including adjacent
Minnesota (Harden and Mickel 1952), Wisconsin (Hilsenhoff and Narf 1972), and Illinois (Webb and Harris 1993).

**Ricker & Ross**

Eight of the ten ecoregions provided specimens of this commonly collected taeniopterygid (Table 1). Mature nymphs and adults were collected from logjams and overhanging brush along medium-to-large rivers with slow moving water. *Taeniopteryx burksi* was previously reported from Iowa by Ricker and Ross (1968) and is known from 27 other states/provinces (Stark 2001), including adjacent Illinois (Frison 1935), Minnesota (Harden and Mickel 1952), Missouri (Poulton and Stewart 1991), and Wisconsin (Hilsenhoff and Narf 1972). Webb (2002) reported that this species is still the most common taeniopterygid in Illinois streams.

**Taeniopteryx nivalis** (Fitch)

*Taeniopteryx nivalis* was collected with greatest frequency in small, clean streams in five ecoregions, but was also taken from some of the same rivers as *T. burksi* (Fig. 4). This is a new state record and has been reported from 19 states/provinces (Stark 2001) including adjacent Illinois (Ricker and Ross 1968), Minnesota (Harden and Mickel 1952), and Wisconsin (Hilsenhoff and Narf 1972). Webb (2002) reported that this species was increasing its range in Illinois to the extent that it is now common in the northern third of the state.

**Records**

- Allamakee Co., Upper Iowa River (INHS); Benton Co., Spring Creek (UHL); Bremer Co., Cedar River (BYU, CSU); Buchanan Co., Lime Creek (INHS); Butler Co., Shell Rock River (BYU, CSU); Cedar Co., Cedar River (INHS); Cerro Gordo Co., Winnebago River (INHS); Chickasaw Co., Little Cedar River (BYU); Wapsipinicon River (INHS, UHL); Clayton Co., Hewitt Creek (UHL); Turkey River (BYU); Volga River (BYU, INHS, UHL); Delaware Co., Ma-

**Soyedina vallicularia** (Wu)

Nymphs and adults of *S. vallicularia* were collected from a small hillside seep within the Paleozoic Plateau/Coulee Section (Fig. 2). This species was also found from similar habitats in Wisconsin (Hilsenhoff 1975), where it is critically imperiled (Wisconsin Natural Heritage Inventory 2004). *Soyedina vallicularia* is a new state record and is known from 14 states/provinces (Stark 2001), including adjacent Illinois (Harris and Webb 1995).

**Family Taeniopterygidae**

**Strophopteryx fasciata** (Burmeister)

*Strophopteryx fasciata* was collected in eastern Iowa across three ecoregions (Fig. 4). Specimens were most commonly collected along medium-sized streams with abundant cobbles. Webb (2002) reported that Illinois populations of this species experienced a drastic range reduction throughout the twentieth century. This species is a new state record and is known from 23 states/provinces (Stark 2001), including adjacent Minnesota (Harden and Mickel 1952), Missouri (Poulton and Stewart 1991), and Wisconsin (Hilsenhoff and Narf 1972).

**Records**

- Allamakee Co., Upper Iowa River (INHS); Yellow River (INHS); Chickasaw Co., Little Cedar River (BYU, UHL); Clayton Co., Turkey River (BYU); Volga River (BYU, UHL); Fayette Co., Turkey River (INHS); Floyd Co., Cedar River (BYU, CSU); Linn Co., Big Creek (INHS); Buffalo Creek (INHS); Winneshiek Co., Upper Iowa River (INHS).
quoketa River (UHL); Fayette Co., Turkey River (INHS); Volga River (INHS); Floyd Co., Cedar River (BYU, CSU, INHS); Little Cedar River (UHL); Hamilton Co., White Fox Creek (UHL); Howard Co., Crane Creek (BYU); Linn Co., Big Creek (INHS); Buffalo Creek (INHS); West Otter Creek (UHL); Mitchell Co., Burr Oak Creek (UHL); Deer Creek (UHL); Rock Creek (UHL); Sioux Co., Rock River (CSU); Tama Co., Iowa River (UHL); Winneshiek Co., Upper Iowa River (BYU, INHS); Worth Co., Willow Creek (UHL).

Family Perlidae

Acroneuria abnormis (Newman)

This species was collected from nine of ten ecoregions (Table 1). The Missouri Aluvial Plain was the only region not to have A. abnormis. Specimens were found in small, rocky creeks to large, meandering rivers. This species appeared to tolerate moderate levels of organic pollution, as evidenced by its occurrence in the degraded streams of western Iowa. Stark and Gaufin (1976) previously reported A. abnormis from Iowa and it is known from 40 other states/provinces (Stark 2001) including all adjacent states (Frison 1935, Harden and Mickel 1952, Stark and Gaufin 1976, Huntsman et al. 2001).

Acroneuria lycorias (Newman)

Acroneuria lycorias occurs within the Paleozoic Plateau/Coulee Section, Iowan Surface, and Des Moines Lobe ecoregions (Fig. 5). Specimens were collected from small, cobble-bottomed creeks and the upper reaches of large, rocky rivers. Harden and Mickel (1952) reported it as widespread in Minnesota and as one of the few stoneflies collected in western prairie counties. Acroneuria lycorias is a new state record and was reported from 20 states/provinces (Stark 2001) including adjacent Wisconsin (Hilsenhoff and Narf 1972).

Records.—Cerro Gordo Co., Calamus Creek (UHL); Winnebago River (INHS, UHL); Fayette Co., Little Turkey River (UHL); Floyd Co., Cedar River (BYU); Howard Co., Upper Iowa River (UHL); Mitchell Co., Rock Creek (UHL); Worth Co., Willow Creek (UHL).

Attaneuria ruralis (Hagen)

This species was collected in several interior rivers across six ecoregions (Table 1). Attaneuria ruralis typically occurred in large rivers on woody debris or boulders in slower current. This species has been previously reported from Iowa and 22 other states/provinces (Stark 2001) including adjacent Illinois (Frison 1935), Minnesota (Harden and Mickel 1952), Missouri (Poulton and Stewart 1991), and Wisconsin (Hilsenhoff 1975).

Perlesta cinctipes (Banks)

This species was recently found from a small, sometimes intermittent stream from the Loess Flats and Till Plains and Stark (1989) reported it from Story County in the Des Moines Lobe (Table 1). DeWalt et al. (2001) also collected this species from a similar stream in Illinois. Perlesta cinctipes has been reported from six other states (Stark 2001) including adjacent Missouri (Stark 1989) and Nebraska (Rhodes and Kondratieff 1996).

Perlesta decipiens (Walsh)

Perlesta decipiens was collected from a wide range of stream sizes and qualities in four ecoregions (Fig. 6), and was the most common Perlesta in the state. DeWalt et al. (2001) also reported it as the most widespread Perlesta in Illinois. Perlesta decipiens is a new state record and has been reported from 14 states including adjacent Missouri (Poulton and Stewart 1991), Nebraska (Stark 1989), South Dakota (Huntsman et al. 2001), and Wisconsin (Stark 1989).

Records.—Allamakee Co., Upper Iowa River (INHS); Boone Co., Ledges St. Park (ISU); Cerro Gordo Co., Winnebago River (INHS); Clayton Co., Volga River (INHS);
Fayette Co., Little Turkey River (INHS); Turkey River (INHS, UHL); Volga River (INHS); Jasper Co., North Skunk River (BYU, INHS); Linn Co., Big Creek (INHS); Buffalo Creek (INHS); Story Co., possibly South Skunk River (ISU); Winnesheik Co., Canoe Creek (INHS); Dunning’s Spring (INHS); Upper Iowa River (INHS).

*Perlesta golconda* DeWalt and Stark

This species occurred in the Rolling Loess Prairies, Loess Flats and Till Plains, and Des Moines Lobe ecoregions (Fig. 7). Collection sites are medium to large rivers with sand bottoms. DeWalt et al. (1998) described this species from the Ohio River in southern Illinois and has since been found in smaller rivers in Illinois and Nebraska (DeWalt et al. 2001). *Perlesta golconda* is a new state record and is also known from adjacent Missouri (Stark 2001).

Records.—Cedar Co., Cedar River (INHS); Dickinson Co., possibly Little Sioux River (OLL); Van Buren Co., Des Moines River (INHS, UHL).

*Perlesta lagoi* Stark

*Perlesta lagoi* was collected from four ecoregions (Fig. 6). Collection sites varied from clear running creeks with rocky substrates to channelized drainage ditches with silt bottoms. This species appears to tolerate a wide range of stream habitats. *Perlesta lagoi* is a new state record and is known from three states including adjacent Illinois, but it is probably more widespread throughout the midwestern United States (DeWalt et al. 2001).

Records.—Buchanan Co., South Fork Maquoketa River (INHS); Henry Co., Cedar Creek (INHS, UHL); Johnson Co., Clear Creek (INHS); Lee Co., Lick Creek (INHS); Worth Co., Beaver Creek (INHS).

*Perlesta shubuta* Stark

*Perlesta shubuta* occurred within the Iowa Surface and Rolling Loess Prairies (Fig. 7). This species was found in small creeks to large rivers with sand bottoms. Currently, this species is the only *Perlesta* recognizable in the nymphal stage due to its freckled head mask. All other known nymphs have head masks of solid pigment. Poulton and Stewart (1991) reported that *P. shubuta* was restricted to the larger, permanent streams in Missouri. This species is a new state record and has been reported from five states (Stark 1989, Stark 2001), including adjacent Illinois (DeWalt et al. 2001).

Records.—Buchanan Co., Lime Creek (INHS, UHL); Butler Co., Beaver Creek (UHL); Fayette Co., Little Turkey River (INHS); Jackson Co., Maquoketa River (INHS); Jasper Co., North Skunk River (INHS); Poweshiek Co., North Skunk River (INHS).

*Perlesta xube* Stark and Rhodes

*Perlesta xube* is a new state record and was found in Loess Flats and Till Plains and Rolling Loess Prairie streams (Fig. 7). This species was collected from heavily shaded, cobble-bottomed creeks and open canopied, sand-bottomed streams. Stark and Rhodes (1997) described *P. xube* from a channelized stream in northern Nebraska. This species occurs in adjacent Illinois in habitats similar to that noted for Iowa (DeWalt et al. 2001) and in North Dakota (Kondratieff and Baumann 1999).

Records.—Johnson Co., Clear Creek (INHS); Lee Co., Lick Creek (INHS).

*Perlinella drymo* (Newman)

This species occurred in small-to-large rivers of four ecoregions (Table 1). Nymphs inhabited fine gravel substrates, often with abundant coarse organic material overlaid. Poulton and Stewart (1991) reported this species from similar habitats in Missouri. *Perlinella drymo* has been collected previously in Iowa (Stewart and Stark 2002) and 33 other states/provinces (Stark 2001) including adjacent Illinois (Frison 1935), Minnesota (Harden and Mickel 1952), and Wisconsin (Hilsenhoff 1975).
Perlinella ephyre (Newman)

*Perlinella ephyre* occurred in the Iowan Surface and Paleozoic Plateau/Coulee Section ecoregions (Fig. 5). All the collection sites were medium-to-large rivers with abundant rocky substrate. Most specimens were adults, the nymphs being rarely collected. In Missouri, *P. ephyre* nymphs occurred in fine gravel of shallow runs (Poulton and Stewart 1991). This species is a new state record and has been reported from 28 states (Stark 2001) including adjacent Illinois (Frison 1935), Minnesota (Harden and Mickel 1952), and Wisconsin (Hilsenhoff 1975).

Records.—Allamakee Co., Upper Iowa River (INHS); Bremer Co., Cedar River (UHL); Fayette Co., Little Turkey River (INHS); Turkey River (UHL); Volga River (INHS); Franklin Co., Baily Creek (UHL); Linn Co., Buffalo Creek (UHL); Cedar River (INHS); Wapsipinicon River (INHS); Winneshiek Co., Upper Iowa River (INHS).

**Neoperla clymene** (Newman)

Adult *N. clymene* were collected recently from the Loess Flats and Till Plains and the Rolling Loess Prairies (Fig. 5). *Neoperla* nymphs have been collected from five additional ecoregions (Table 1), but species determination was not possible. DeWalt et al. (2002) found that this species had undergone a dramatic range reduction in Illinois and is now limited to large rivers. This is a new state record and is known from 12 states (Stark 2001).

Records.—Keokuk Co., North Skunk River (INHS); Van Buren Co., Des Moines River (INHS, UHL).

**Neoperla osage** Stark and Lentz

One specimen from the INHS represents this new state record collected within the Des Moines Lobe (Fig. 5). There are no contemporary records for this species. Poulton and Stewart (1991) reported *N. osage* as endemic to the Ozark and Quachita mountain regions of Missouri and Arkansas, but it was also collected from large rivers of the Gulf Coastal Plain. This species has been reported from three states (Stark 2001).

Records.—Story Co., possibly South Skunk River (INHS).

**Agnetina capitata** (Pictet)

*Agnetina capitata* is a new state record and was collected from several localities across five ecoregions (Fig. 8), but most prevalent in eastern regions of the state. Poulton and Stewart (1991) found *A. capitata* to be indicative of large groundwater inputs in Missouri Ozark streams. This species has been reported from 20 states/provinces (Stark 2001) including adjacent Minnesota (Harden and Mickel 1952) and Wisconsin (Hilsenhoff and Narf 1972).

Records.—Allamakee Co., Upper Iowa River (UHL); Yellow River (UHL); Cerro Gordo Co., Calmus Creek (UHL); Winnabago River (INHS, UHL); Clayton Co., Volga River (UHL); Fayette Co., Little Turkey River (UHL); North Branch Volga River (UHL); Turkey River (INHS, UHL); Volga River (INHS); Floyd Co., Cedar River (UHL); Shell Rock River (INHS); Hamilton Co., Boone River (UHL); White Fox Creek (UHL); Howard Co., Crane Creek (UHL); Upper Iowa River (UHL); Linn Co., Big Creek (INHS); Buffalo Creek (INHS); Wapsipinicon River (UHL); Mitchell Co., Cedar River (UHL); Deer Creek (UHL); Rock Creek (UHL); O’Brien Co., Waterman Creek (UHL); Pocahontas Co., Little Cedar Creek (UHL); Story Co., South Skunk River (ISU, UHL); Webster Co., Prairie Creek (UHL); Winneshiek Co., Canoe Creek (UHL).

**Paragnetina media** (Walker)

This species was confined to small creeks and medium-sized rivers of the Paleozoic Plateau/Coulee Section and Iowan Surface (Fig. 9). Nymphs and adults were collected from shaded, cool streams. Poulton and Stewart (1991) often found *P. media* in spring-fed streams in the Missouri Ozarks.
This is a new state record and was reported from 23 states/provinces including adjacent Illinois (Frison 1935), Minnesota (Harden and Mickel 1952), and Wisconsin (Hilsenhoff and Narf 1972).

Records.—Allamakee Co., Upper Iowa
River (INHS); Yellow River (UHL); Black Hawk Co., Buck Creek (UHL); Bremer Co., East Branch Wapsipinicon River (UHL); Chickasaw Co., Little Cedar River (UHL); Wapsipinicon River (UHL); Clayton Co., Volga River (UHL); Fayette Co., Brush Creek (INHS); Deep Creek (UHL); Little Turkey River (UHL); North Branch Volga River (UHL); Turkey River (INHS); Volga River (INHS); Floyd Co., Cedar River (UHL); Little Cedar River (UHL); Howard Co., Crane Creek (UHL); Upper Iowa River (UHL); Mitchell Co., Deer Creek (UHL); Rock Creek (UHL); Winneshiek Co., Canoe Creek (UHL).

Family Perlodidae

*Isoperla* *clio* (Newman)

*Isoperla clio* is a new state record and was limited to the Paleozoic Plateau/Coulee Section (Fig. 10). The collection sites were small, cold-water creeks in Clayton and Dubuque counties. Hilsenhoff and Billmyer (1973) also found *C. clio* in similar streams in Wisconsin. This species has been reported from 24 states (Stark 2001) including adjacent Illinois (Frison 1935) and Missouri (Poulton and Stewart 1991).

Records.—Clayton Co., North Cedar Creek (UHL); Mossy Glen St. Preserve (UHL); Unnamed trib. to Sny Magill Creek (UHL); West Fork Sny Magill Creek (INHS, UHL); Delaware Co., Grimes Hollow (UHL); Dubuque Co., White Pine Hollow Creek (UHL).

*Isoperla* *bilineata* (Say)

*Isoperla bilineata* was collected in medium-to-large rivers in six ecoregions (Fig. 10). This is a new state record and has been reported from 28 states/provinces (Stark 2001) including adjacent Illinois (Frison 1935), Minnesota (Harden and Mickel 1952), Missouri (Poulton and Stewart 1991), Nebraska (Rhodes and Kondratieff 1996), South Dakota (Huntsman et al. 2001), and Wisconsin (Hilsenhoff and Billmyer 1973).

Records.—Allamakee Co., Upper Iowa River (UHL); Waterloo Creek (INHS); Black Hawk Co., Wolf Creek (UHL); Boone Co., stream unknown (ISU); Cedar Co., Cedar River (INHS); Cerro Gordo Co., stream unknown (ISU); Chickasaw Co., Little Cedar River (UHL); Clayton Co., Bridal Veil Falls (INHS); Turkey River (UHL); Volga River (INHS); Delaware Co., Maquoketa River (INHS); Des Moines Co., Mississippi River (INHS); Fayette Co., Turkey River (UHL); Volga River (INHS); Guthrie Co., stream unknown (ISU); Hamilton Co., Boone River (UHL); Henry Co., Skunk River (BYU); Iowa Co., Iowa River (UHL); Johnson Co., Iowa River (UHL); Keokuk Co., North Skunk River (INHS); Linn Co., Buffalo Creek (INHS, UHL); Cedar River (INHS, UHL); Wapsipinicon River (INHS); Mahaska Co., South Skunk River (INHS); Polk Co., Des Moines River (ISU, UHL); Story Co., possibly South Skunk River (ISU); Tama Co., Iowa River (UHL); Van Buren Co., Des Moines River (UHL).

*Isoperla* *dicala* Frison

This species was collected from Iowan Surface and Paleozoic Plateau/Coulee Section streams (Fig. 11). *Isoperla dicala* was confined to medium-sized streams in Wisconsin and usually smaller streams than that inhabited by *I. bilineata* (Hilsenhoff and Billmyer 1973). *Isoperla dicala* is a new state record and has been reported from 22 states/provinces (Stark 2001) including adjacent Minnesota (Harden and Mickel 1952) and Missouri (Poulton and Stewart 1991).

Records.—Allamakee Co., Upper Iowa River (INHS); Waterloo Creek (UHL); Yellow River (INHS, UHL); Clayton Co., Volga River (UHL); Delaware Co., Maquoketa River (INHS); Fayette Co., Turkey River (UHL).

*Isoperla* *longiseta* Banks

Stark et al. (1986) previously reported this species from Iowa and historical re-
Isoperla marlynia (Needham and Claassen)

Isoperla marlynia was collected from medium-sized rivers in three ecoregions (Fig. 11). Specimens were found in leaf packs and on woody debris in slow current. This is a new state record and has been previously reported from 22 states/provinces (Stark 2001), including adjacent Illinois (Frison 1942), Minnesota (Harden and Mickel 1952), Nebraska (Rhodes and Kondratieff 1996), and Wisconsin (Hilsenhoff and Billmyer 1973), although it has possibly been extirpated from Illinois (Webb and Harris 1993).

Records.—Allamakee Co., Upper Iowa River (UHL); Chickasaw Co., Little Cedar River (UHL); Wapsipinicon River (INHS); Clayton Co., Volga River (UHL); Jackson Co., North Fork Maquoketa River (INHS).

Isoperla richardsoni Frison

Isoperla richardsoni was collected from small creeks to medium-sized rivers within the Iowan Surface, Paleozoic Plateau/Coulee Section, and Rolling Loess Prairies (Fig. 12). Harden and Mickel (1952) and Hilsenhoff and Billmyer (1973) found that this species was most common in medium and larger rivers of Minnesota and Wisconsin, respectively. This species is a new state record and has been reported from eight states (Stark 2001), including adjacent Illinois (Frison 1935) and Missouri (Stark 2001).

Records.—Allamakee Co., Upper Iowa River (INHS); Benton Co., Spring Creek (UHL); Chickasaw Co., Little Cedar River (UHL); Fayette Co., Turkey River (UHL); Volga River (INHS); Linn Co., Big Creek (INHS).

Isoperla signata (Banks)

Isoperla signata was collected from the Iowan Surface and Paleozoic Plateau/Coulee Section (Fig. 12). This species occurred in small, cold-water streams and medium-sized rivers that were strongly influenced by ground water. Hilsenhoff and Billmyer (1973) found that I. signata was the least habitat specific of the Wisconsin perlodids, occurring in small and large streams. However, Poulton and Stewart (1991) reported that this species inhabited permanent, spring-fed streams, an assessment supported by Harden and Mickel's (1952) work in Minnesota. Isoperla signata is a new state record and has been reported from 17 states/provinces (Stark 2001).

Records.—Allamakee Co., French Creek (UHL); Hickory Creek (UHL); Upper Iowa River (UHL); Waterloo Creek (UHL); Williams Creek (UHL); Yellow River (INHS, UHL); Clayton Co., Bloody Run Creek (INHS); North Cedar Creek (UHL); Sny Magill Creek (UHL); Unnamed trib. to Sny Magill Creek (UHL); Volga River (UHL); West Fork Sny Magill Creek (INHS); Delaware Co., Elk Creek (UHL); Dubuque Co., White Pine Hollow Creek (UHL); Fayette Co., Otter Creek (UHL); Volga River (INHS).

Isoperla slossonae (Banks)

Isoperla slossonae is a new state record and was collected in Iowan Surface streams only (Fig. 12). This species occurred in small-to-medium-sized streams, as was found by Hilsenhoff and Billmyer (1973) in Wisconsin. Isoperla slossonae has been found in 14 states/provinces (Stark 2001) including adjacent Minnesota (Harden and Mickel 1952).

Records.—Delaware Co., possibly Maquoketa River (BYU); South Fork Maquoketa River (BYU, UHL).
Isoperla transmarina (Newman)

This species was collected from medium-sized rivers of the Iowan Surface and Paleozoic Plateau/Coulee Section (Fig. 11). Isoperla transmarina, I. dicata, and I. richardsoni were often found in the same stream. Harden and Mickel (1952) often found P. media with this species in Minnesota. Isoperla transmarina is a new state record and has been reported from 26 states/provinces (Stark 2001), including adjacent South Dakota (Huntsman et al. 2001) and Wisconsin (Hilsenhoff and Billmyer 1973).

Records.—Fayette Co., Turkey River (INHS); Volga River (INHS); Linn Co., Buffalo Creek (INHS); Winneshiek Co., Upper Iowa River (INHS).

Isogenoides doratus (Frison)

This species was collected from the Rock River, Sioux County, in the Northwest Iowa Loess Prairies and is known from several historical records in the Des Moines Lobe (Ricker 1952). Isogenoides doratus has been collected from three other states/provinces (Stark 2001) with Michigan as the only other upper midwestern state (Ricker 1952).

Isogenoides krumholzi (Ricker)

Isogenoides krumholzi was only collected in the Rolling Loess Prairies (Fig. 11). In Michigan this species was collected from the northernmost cold streams and Lake Superior (Ricker 1952). This species is a new state record and has been collected from three states/provinces including adjacent Minnesota (Stark 2001). The genus is currently under revision by John Sandberg at the University of North Texas. Consequently some nomenclature or status may change, especially as it refers to this species.

Records.—Linn Co., Cedar River (INHS).

Isogenoides varians (Walsh)

This species is a new state record and was collected from the same site as I. krumholzi (Fig. 12). Walsh (1863) described this species from neighboring Illinois at the mouth of the Rock River. Isogenoides varians is a large river species (Ricker 1952) and has been reported from eight states (Stark 2001) including adjacent Minnesota (Harden and Mickel 1952)

Records.—Linn Co., Cedar River (INHS).

Family Pteronarcyidae

Pteronarcys pictetii Hagen

Pteronarcys pictetii was collected in five ecoregions in the northern two-thirds of the state (Fig. 13). Pteronarcys nymphs were collected from three additional ecoregions (Table 1), but identification to species is not possible at this time. Some of these nymphs may represent P. dorsata since Harden and Mickel (1952) found it in Minnesota. However, there are no confirmed records of P. dorsata from neighboring states to the immediate east (Frison 1935, 1942; Harris and Webb 1995), the south (Poulton and Stewart 1991), or to the west (Rhodes and Kondratieff 1996, Kondratieff and Baumann 1991, Huntsman et al. 2001). With more adult records a pattern of P. dorsata being eastern and northern transcontinental and P. pictetii being eastern, midwestern, and central Great Plains states may be confirmed. This is a new state record and has been reported from 15 states/provinces (Stark 2001).

Records.—Allamakee Co., Yellow River (INHS); Clay Co., Ocheyedan River (BYU); Clayton Co., Volga River (UHL); Delaware Co., Maquoketa River (UHL); South Fork Maquoketa River (ISU); Emmet Co., West Fork Des Moines River (CSU); Fayette Co., Turkey River (UHL); Volga River (INHS); Iowa Co., possibly Iowa River (INHS); Linn Co., Big Creek (INHS); Story Co., possibly South Skunk River (INHS, ISU).
DISCUSSION

Streams of the Iowan Surface and the Paleozoic Plateau/Coulee Section support the greatest stonefly diversity in Iowa (Table 1). These are the only areas of the state where large, cool, rocky rivers and abundant springs and springbrooks can be found. Three stoneflies, *A. pygmaea*, *A. linda*, and *N. trispinosa*, require these conditions and are considered northern species (Ross and Ricker 1971, Huntsman et al. 2001). The collection of *A. pygmaea* in Iowa has filled a considerable disjunction between Missouri and Minnesota populations. Ross and Ricker (1971) hypothesized that this species reached the upper Midwest during the post-Pleistocene period. After glacial advances and retreats two populations occurred, one in the Missouri Ozarks and the other in the Cumberland Gap region of Tennessee and Kentucky. *Allocapnia pygmaea* then dispersed north from the Cumberland Gap into southern Canada, Michigan, Wisconsin, and Minnesota. The population in Iowa most likely came from nearby Minnesota and Wisconsin. The Loess Flats and Till Plains, which lack large, cool-water rivers, separate the Missouri and Iowa populations.

Streams of the Rolling Loess Prairies and the Des Moines Lobe harbored the second greatest number of stonefly species (Table 1). Both ecoregions cover a large area of the state, with most of Iowa’s streams and rivers flowing through them. A combined three unique species were present in these regions. *Isoperla longiseta*, *Isogenoides krumholzi*, and *Isogenoides varians*. All were found in the sandy rivers common to the regions. There appears to be a mixing zone here with *I. longiseta* being from western states and *I. krumholzi* and *I. varians* being of a more northern and eastern origin.

The six remaining ecoregions contained no unique species and supported considerably fewer species than that of previously mentioned ecoregions (Table 1). Although these western ecoregions have not been sampled as extensively as in the east, we believe that numerous stream alterations have reduced species richness from pre-settlement times. All species present, *Allocapnia vivipara*, *Taeniopteryx burksi*, *Acronemia abnormis*, and *Isoperla bilineata* are considered widespread and tolerant of moderate organic enrichment (Hilsenhoff 1987).

*Pteronarcyss pictettii* and nymphs of *Pteronarcyss* were found in much of Iowa, but were missing from the Loess Flats and Till Plains (Table 1). This species should occur in the largest rivers, but frequent summer droughts probably preclude it from maturing in smaller streams due to a documented two-year nymphal life cycle (Hilsenhoff and Narf 1972).

Seventeen of the 33 new stonefly species reported for Iowa were found in the last three years; therefore, it is conceivable that several more new state records will be discovered. Thirteen additional species are known from adjacent states (Stark 2001). These include *Paracapnia angulata* Hanson, *Leuctra ferruginea* (Walker), *Prostoa similis* (Hagen), *Taeniopteryx parvula* Banks, *Haploperla brevis* (Banks), *Acronemia internata* (Walker), *Perlesta daktota* Kondratieff and Baumann, *Neoperla stewarti* Stark and Baumann, *Agnetina flavescens* (Walsh), *Isoperla frisoni* Illies, *Hydropsyche crosbyi* (Needham and Claassen), *H. fugitans* (Needham and Claassen), and *Pteronarcyss dorsata* (Say).

Our work has greatly increased the distributary knowledge of stoneflies in Iowa. Much of eastern Iowa has been collected with regularity, but western and southern Iowa remain poorly surveyed. Nonetheless, enough distribution information exists in eastern Iowa for use by state resource organizations to protect sensitive stream habitats, and to set improvement status for some of the stoneflies whose existence is tenuous. We suggest that the state consider purchasing easements and buffers along streams to protect the following species: *Allocapnia pygmaea*, *Leuctra tenuis*, *Amphinemura linda*, *Nemoura trispinosa*, and *Soyedina val-
_Chloraria_. Much of these efforts should be focused on Paleozoic Plateau/Coulee Section and Iowan Surface ecoregions. Other species and regions may be considered when additional distribution information on Iowa stoneflies is available.

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**LITERATURE CITED**


A NEW SPECIES OF XESTOPHANES FÖRSTER (HYMENOPTERA: CYNIPIDAE) FROM AZERBAIJAN

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Abstract.—A new species of cynipid gall wasp, Xestophanes caspiana, is described from the Caspian Azerbaijan in western Asia. It differs from the two previously known species of the genus in having 12 antennal flagellomeres. The discovery of the new species indicates a much broader distribution for Xestophanes, which was previously known only from western Europe.

Key Words: new species, gall wasps, Xestophanes, Cynipidae, Aylacini, western Asia

The genus Xestophanes Förster, 1869 is of special interest to studies on the evolution of cynipid gall wasps. The genus and Diastrophus Hartig (the genus Gonaspis Ashmead has recently been synonymized with Diastrophus (Schick et al. 2003)) constitute a morphologically unique group within the cynipid tribe Aylacini. They differ from all other aylacine members in having 1) claws with a distinct basal lobe or tooth and 2) mesopleuron, mesoscutum, and vertex smooth and shining. Biologically, these two genera also differ from other aylacines in that they induce galls on host plants belonging to the family Rosaceae (the two known Xestophanes species are associated with the plant genus Potentilla, and species of Diastrophus make galls on Rubus and Potentilla (Nieves-Aldrey 1994)), in contrast to the other aylacine genera making galls on host plants of more advanced plant families, such as Apiaceae, Asteraceae, Lamiaceae, Papaveraceae, Rubiaceae, and Valerianaceae (Ronquist and Liljeblad 2001). According to recent phylogenetic studies, Xestophanes and the inquiline tribe Synergini are sister groups and they together with Diastrophus form a monophyletic clade deeply nested within the Cynipidae phylogenetic tree (Ronquist 1994, Liljeblad and Ronquist 1998).

Xestophanes comprises two known species, X. bravitarsis (Thomson) and X. potentillae (Retzius), and was previously known only from western Europe (Nieves-Aldrey 2001). Here I describe a new species from Chatshmas, Azerbaijan, in western Asia.

METHODS AND MATERIALS

The type specimen was loaned from the Cynipidae collection at the American Museum of Natural History, New York, NY (AMNH). SEM images were taken from uncoated specimen with a Hitachi S4700 Field Emission Scanning Electron Microscope (FE-SEM) at AMNH. Structural terminology follows Ronquist and Nordlander (1989) and Ronquist (1995), and sculptural terminology follows Harris (1979).

Xestophanes caspiana Liu, new species

(Figs. 1-7)

Description.—Female: Body length, measured from anterior margin of head to
posterior margin of eighth metasomal tergum: 2.3 mm. Length of forewing: 2.0 mm.
Head and mesosoma brown, legs and metasoma bright brown.

**Head:** Anterior view (Fig. 1). Lower face glabrous and not keeled medially; facial strigae present laterally, radiating from clypeus and reaching to compound eyes and lower margin of antennal sockets. Head in anterior view broader than high; lateral margin of gena smoothly rounded, height of malar space about half height of compound eye. Clypeus trapezoid. Ventral margin of clypeus broadly rounded, slightly projecting from cranial margin. Anterior tentorial pits small and distinct. Epistomal sulcus and clypeo-pleurostomal lines weak and barely detectable. Antennal sockets situated slightly above middle of compound eye; distance between antennal rim and compound eye twice as broad as distance between inner rims of antennal socket. Gena not expanded behind eyes (Fig. 1–2, 4). Dorsal view (Fig. 2). Upper face (see also Fig. 1) and vertex glabrous; median frontal carina and lateral frontal carinae absent. Ocellar plate not raised. Occiput (see Fig. 4) transversely wrinkled. Antenna (Fig. 3) with flagellum with 12 connate articles. Length of first flagellomere (F1) 1.1 times length of second (F2). F3 2.2 times as long as broad. Ultimate flagellomere 1.6 times as long as penultimate. Elongate placodeal sensilla present on all flagellomeres except F1.

**Pronotum** (Figs. 2, 4, 6): Medially long (high), ratio of median distance between anterior and posterior margins to lateral distance between these margins 0.45 (Fig. 6). Lateral pronotal carinae more or less distinct, meeting posteroventral pronotal margin. Submedian pronotal depressions oval, small and shallow, open laterally, connected by a shallow groove medially (Fig. 1). Posterior pronotal plate distinctly marked by depressed pronotal surface behind (Fig. 6). Dorsal pronotal area slightly visible laterally (Fig. 4). Lateral surface of pronotum mostly glabrous, shining, and without hair (Fig. 6).

**Mesosoma** (Fig. 4, 6): Scutum glabrous and shining. Median mesoscutal impression barely present, only weakly impressed posteriorly. Notauli present only in posterior one third, narrow, shallow, and strongly divergent anteriorly. Scutellar foveae shallow and closed posteriorly. Dorsal surface of scutellum rugulose. Posterior margin of scutellum smoothly rounded. Mesopleurites (mesopleuron including subpleuron and sternum) (Fig. 6). Mesopleuron mostly glabrous and shining, except with sparse pubescence in ventral longitudinal impression. Middle part of mesopleuron without horizontal impression or carinae. Mesopleural triangle distinctly impressed, ventral margin clearly marked.

**Metanotum:** Metapetaco-–propodeal complex (Fig. 6). Metapleural sulcus meeting anterior margin of metapetaco-–propodeal complex at about three-quarters height of latter. Metepimeron subrectangular, relatively large. Lateral propodeal carinae subparallel, narrow, not flattened above, slightly higher anteriorly. Nucha short. 2.7 times as broad as long, longitudinally carinate, posterior margin slightly incised medially.

**Legs:** Procoxa with a weak, but distinct anterolateral crest. Metacoxa elongate. Longitudinal carina absent on posterior surface of metatibia. Claws with a distinct basal lobe.

**Forewing:** Clear. Marginal cell open in distal two thirds along anterior margin. Rs+M arising from middle of basal vein. Bulla in R1+Sc distinctly present. Areolet triangular and small. Hair fringe along apical margin short.

**Metasoma** (Fig. 7): Petiolar tergum shining smooth and reduced to a small lobular structure above petiolar articulations. Postpetiolar metasoma laterally compressed, in lateral view as high as long, lenticular. Metasomal terga 3–4 fused to form a large syntergum covering almost entire metasoma; fusion between tergum 3 and 4 vaguely detectable across middle of syntergum. Ter-
gite 5–8 mostly covered by syntergum, being exposed only posteroverentral to syntergum. Syntergum with a few hairs close to base in the middle, otherwise nude. Exposed part of terga 7–8 distinctly and densely micropunctate. Eighth tergum also with a dorsal row of fine hairs. Ventral spine of hypopygium not projecting, united almost to apex with lateral flaps. Hypopygium ventrally with sparse pubescence toward apex.

Male: Unknown.

Type material.—Holotype ♀ Chatshmas, Transac., Azerbaijan. 1935-V-28, collected by Lubischew (AMNH). The specimen was remounted on a rectangular cardboard stage: metasoma and the old small triangular stage with leg parts in glue are mounted separately on the new stage.

Diagnosis.—The new species can be easily separated from the two known species by the number of antennal flagellomeres: X. caspiana has 12 flagellomeres whereas both X. potentillae and X. bravitarsis have only 11 flagellomeres. In addition, the new species has the notauli strongly divergent anteriorly and the syntergum covering the entire post-petiolar metasoma (thus no other tergum than syntergum is seen from above).

Biography.—Unknown. The two known species of Xestophanes induce galls on Potentilla. It is likely that the new species is also associated with Potentilla.

Distribution.—Chatshmas, Azerbaijan.

Taxonomical Notes

Although Xestophanes can be easily distinguished from Diastrophus by a number of features, including 1) weak tooth on tarsal claws, 2) subcosta and radius reaching to anterior margin of wing and radial cell sometimes partly closed, and 3) abdominal terga 3 and 4 fused, it can be difficult to separate it from the Synergini, particularly from Synophromorpha Ashmead, which live in Diastrophus galls on Rubus (Rosaceae). Liljeblad and Ronquist (1998) found 13 synapomorphic characters for the Synergini. Although these characters are phylogeny-informative, they are of limited practical use in distinguishing Xestophanes from Synergini. It is difficult to create a taxonomical key to separate Xestophanes from all synergine genera. In practice, it is easier to separate Xestophanes and Synophromorpha from other synergine genera than separating Xestophanes from all synergine genera including Synophromorpha: both genera have a smooth and shining vertex, pronotum, mesoscutum and mesopleuron (those of all other synergine genera are either sculptured or coriaceous). Xestophanes can be separated from Synophromorpha by the number of antennal flagellomeres: Xestophanes species have either 11 or 12 flagellomeres, whereas all known Synophromorpha species have only 10 flagellomeres. Host association data certainly will assist the separation Xestophanes from Synophromorpha, which are inquilines exploiting galls induced by Diastrophus species on Rubus host plants.

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AN INTRODUCED KNAPWEED GALL FLY, UROPHORA QUADRIFASCIATA (MEIGEN) (DIPTERA: TEPHRITIDAE), IN NORTH AMERICA: NORTHEASTERN AND SOUTHEASTERN RANGE EXTENSIONS

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Abstract.—The knapweed gall fly Urophora quadrifasciata (Meigen), native to Eurasia, was released in British Columbia, Canada, in 1970 to help control infestations of Eurasian knapweeds, Centaurea spp. (Asteraceae), in rangelands. After the tephritid had dispersed into Idaho and Montana by the early 1980s, it was approved for release in the United States as a biological control agent. Released in northeastern North America only in Quebec, Maryland, and New York, U. quadrifasciata has spread to other provinces and states. It is newly reported from New Brunswick (1 county) and Nova Scotia (3 counties) as the first records from the Canadian Maritime Provinces and from North Carolina (12 counties) as the southeasternmost records in North America. Populations in the Maritime Provinces are attributed to dispersal from established populations in Quebec or New England; in North Carolina, the fly likely dispersed from established populations in Virginia.

Key Words: Insecta, Diptera, Urophora, biocontrol, non-native species, dispersal, knapweed, Centaurea

Two Eurasian knapweeds of the genus Centaurea (Asteraceae = Compositae) were accidentally introduced with commerce into the Pacific Northwest during the late nineteenth and early twentieth century. Spotted knapweed, C. biebersteinii DC (= C. maculosa auct. non Lam.; sensu Kartesz 1999), was detected at Victoria, British Columbia, in 1893. Diffuse knapweed, C. diffusa Lam., was first collected in southern Washington in 1907 (Watson and Renney 1974). Both species have become important weeds in western pastures and rangelands. Because of their allelopathic properties and other biological attributes, these adventive plants tend to form solid stands and to displace native herbaceous plants (Fletcher and Renney 1963, Harris and Cranston 1979, Maddox 1982, Müller-Schärer and Schroeder 1993, Sheley et al. 1998). Allelopathy appears to have been particularly critical to spotted knapweed’s success as an exotic invader (Bais et al. 2003). The economic importance of C. biebersteinii and C. diffusa in western North America includes reduced forage production, decreased carrying capacity of ranges, and detrimental effects on soil and water resources, in addition to the cost of herbicide applications (Watson and Renney 1974, Harris and Cranston 1979, Maddox 1979, Sheley et al. 1998). Both knapweeds (especially C. biebersteinii) are established in eastern North America, mainly along highways and railroad rights-of-way and in abandoned fields, poorly managed pastures, and other dis-
turbed sites (Mays and Kok 2003). These species, however, are of lesser economic importance in the East than they are in western rangelands (T.A. Wheeler and Varady-Szabo 2002).

A complex of Eurasian insects has been intentionally introduced to help reduce knapweed densities (e.g., Müller-Schärer and Schroeder 1993, Lang et al. 2000, Bourchier et al. 2002). These biological control agents include the seedhead gall flies Urophora affinis Frauenfeld and *U. quadrisfasciata* (Meigen). Both tephritids were released in British Columbia in the early 1970s (Harris 1980), with *U. affinis* released in the United States in Montana and Oregon in 1973. *Urophora quadrisfasciata* was not released initially in the western United States but was recovered in Idaho in 1980 and Montana in 1981, apparently as a result of dispersal from release sites in British Columbia (Story 1985, Lang et al. 1997). In the late 1980s, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, began a national program to redistribute *U. affinis, U. quadrisfasciata,* and other knapweed biocontrol agents (Lang et al. 1997). As a result of intentional releases coupled with natural dispersal (and possibly the movement of infested knapweed seed heads in commerce), *U. quadrisfasciata* has become established in Alberta, British Columbia, Ontario, and Quebec in Canada (Bourchier et al. 2002, T.A. Wheeler and Varady-Szabo 2002) and in 25 U.S. states (Hoebeke 1993, A.G. Wheeler and Stoops 1996, Lang et al. 1997). In the central and eastern states, *U. quadrisfasciata* has been reported from New Hampshire to Virginia west to Indiana, Michigan, and Minnesota (Lang et al. 1997).

Here, we extend the known distribution of *U. quadrisfasciata* to New Brunswick and Nova Scotia in the Northeast and North Carolina in the Southeast. Specimens were collected in the Canadian Maritime Provinces on *C. nigra* L., black knapweed, by E.R.H. in 1997 and E.R.H. and A.G.W. in 2001 and 2003, and in North Carolina on *C. biebersteinii* by A.G.W. Voucher material is deposited in the Cornell University Insect Collection, Ithaca, New York.


**DISCUSSION**

Lang et al. (1997) predicted that *U. quadrisfasciata* a more rapid disperser than
U. affinis (e.g., Harris 1980, Harris and Myers 1984), will continue to spread into
knapweed-infested regions of North America. This tephritid recently was reported
new to Ontario and from several sites in Quebec, including the Gaspé Peninsula
(T.A. Wheeler and Varady-Szabo 2002). Its establishment in eastern Canada was attri-
buted to continued dispersal from populations in the central and eastern United
States rather than to the 1979 release of the gall fly in southwestern Quebec. T.A.
Wheeler and Varady-Szabo (2002) collect-
ed adults in eastern Canada by sweeping
mixed vegetation, but they assumed that the
host in eastern Quebec (Forillon National
Park) was the Old World C. nigra because
C. biebersteinii (as C. maculosa) has not
been recorded from the park.

Our collections of U. quadrifasciata in
New Brunswick and Nova Scotia are the
first for the Canadian Maritime Provinces.
This tephritid apparently has not been re-
leased in the Maritimes (Harris and Myers
1984, Bourchier et al. 2002). We collected
adults only on flower heads of black
knapweed in New Brunswick and Nova Scotia.
In Nova Scotia, C. nigra is “common
throughout the province,” whereas C. bie-
bersteinii is found only locally in Kings
County (Zinck 1998). Our experience with
U. quadrifasciata in the Maritimes supports
T.A. Wheeler and Varady-Szabo’s (2002)
suggestion that this tephritid uses black
knapweed as a host in certain areas of east-
ern Canada. Urophora quadrifasciata in
eastern North America has been collected
from C. jacea L. and C. nigrescens Willd.
(as C. dubia Suter) in addition to C. bie-
bersteinii and C. nigra (Hoebeke 1993,
Ruhren 2000).

We suggest that U. quadrifasciata has
spread to New Brunswick and Nova Scotia
from Quebec or the New England states and
that its establishment is recent. It was de-
tected in New Brunswick in 1997. While
collecting the Palearctic pteromalid wasp
Pteromalus elevatus (Walker), a parasitoid
of the accidentally introduced gall fly U.
jacea (Hering), we swept flower heads of
C. nigra in Nova Scotia during late June
and late July 1993–1995 without finding U.
quadrifasciata (Hoebeke and Wheeler
data). Our sampling included Dartmouth
and Truro, where we found this tephritid on
Fewer than 10 individuals of U. quadrifas-
ckiata were observed at all but one of our

We collected U. quadrifasciata on spot-
ted knapweed in North Carolina in the cen-
tral piedmont and mountains. The tephritid
likely dispersed to North Carolina from
populations in Virginia that have been at-
tributed to dispersal from previously estab-
lished populations in more northern states
(A.G. Wheeler and Stoops 1996, Mays and
Kok 2003). Urophora quadrifasciata was
not released in either Virginia (Mays and
Kok 2003) or North Carolina (K.A. Kidd,
personal communication). The North Car-
olina State University insect collection does
not have North Carolina material of this
species (R.L. Blinn, personal communica-
tion).

Although in North Carolina we collected
the tephritid in Cherokee County within 5
km of the Georgia line and in Henderson
County within 12 km of the South Carolina
line, its spread to those states might not be
imminent. Known hosts of U. quadrifasci-
ta in Europe and North America, mostly
species of Centaurea in the subgenera Ac-
rolaphus and Jacea (Zwölfer 1965, Sobhian
and Zwölfer 1985, White and Korneyev
1989, Rees and Story 1991, Hoebeke
1993), are not known from or are rare in
Georgia and South Carolina (Duncan and
Kartesz 1981, Jones and Coile 1988, Kar-
tesz 1999, Weakley 2002). Spotted knap-
weed, although known historically from
Greenwood County, South Carolina, is not
currently known from the state (P.D. Mc-
Millan, personal communication). It also is
not known from Georgia (Kartesz 1999).
Colonization of novel hosts in Georgia and
South Carolina, however, is possible be-
cause *U. quadrifasciata* exhibits a wider host range within the subtribe Centaureinae than do most other species of the genus (Ponisich and Brandl 1992). The atypically broad host range also suggests the possibility that a sibling complex is involved (White and Korneyev 1989).

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(Centaurea diffusa) and spotted knapweed (C. maculosa). Weed Science 30: 76–82.


A NEW SUBFAMILY OF CRETAOCEOUS ANTLIKE STONE BEETLES
(COLEOPTERA: SCYDMAENIDAE: HAPSOMELINAE) WITH AN EXTRA
LEG SEGMENT

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Abstract.—A new subfamily, genus, and species of antlike stone beetles (Coleoptera: Scydmnaenidae: Hapsomeliniae: Hapsomela burmitis) are described from Cretaceous Burmese amber. The forelegs of the fossil contain a patella, the major character on which the new subfamily is based. The patella is regarded as an example of functional morphology and probably served in the capacity of catching and/or holding down prey, probably mites, since all extant members of this family are mite predators. This character appears to have been specific to this clade of antlike stone beetles, since no other members (extinct or extant) of the family have a patella. Another unusual character of H. burmitis is the extended abdomen and elongate strongly sclerotized ovipositor, thus allowing eggs to be inserted into cracks or soft tissue. The significance and occurrence of the extra leg segment in this group of beetles is discussed in relation to Paleozoic insects and modern arthropods.

Key Words: Hapsomeliniae n. subfam., Hapsomela n. gen., Hapsomela burmitis n. sp., Burmese amber, Cretaceous, patella

Antlike stone beetles comprise a small, staphylinoid family characterized by elongate elytra, five-segmented tarsi, six visible abdominal sternites, and clavate femora (O’Keefe 1998). They are placed in the family Scydmnaenidae Le Conte of the Staphyliniformia, with two subfamilies (Mastiginae Fleming and Scydmnaeninae Leach) and 13 tribes (Newton and Thayer 1992). We describe a unique scydmnaenid from Burmese Cretaceous amber, which demonstrates fore legs with a patella.

MATERIALS AND METHODS

The amber was recut and polished in order to better view the fossil beetle. The amber piece containing the fossil is trapezoidal in outline, 1 mm in depth, with the sides measuring 5, 3, 6, 1, and 4 mm, respective-ly. Observations, drawings, and photographs were made with a Nikon Optiphot microscope (with magnifications up to 650×).

Amber from Burma occurs in lignitic seams in sandstone-limestone deposits in the Hukawng Valley. Nuclear magnetic resonance (NMR) spectra of amber samples taken from the same locality as the fossil indicated an araucarian (possibly Agathis) source of the amber (Lambert and Wu, unpublished research 2002). Palynomorphs obtained from the amber beds where the fossil piece originated have been assigned to the Upper Albian of the Early Cretaceous (100–110 mya) (Cruickshank and Ko 2003).

The amber specimen could not be placed in either of the two subfamilies since it pos-
sessed a pointed labial palpomere 3, a character of the Mastiginae, and antennomere 1 not nearly as long as antennomeres 2–4 combined and antennae not geniculate between antennomeres 1 and 2, both characters of the Scydmaeninae (O’Keefe et al. 1997). In addition, we consider the extra leg segment in the forelegs to be a significant character for the new subfamily.

**Hapsomelinae Poinar and Brown, new subfamily**

**Diagnosis.**—A patella in the forelegs separates this subfamily from the other two in the family Scydmaenidae. In addition, labial palpomere 3 pointed; antennae not geniculate; antennomere 1 only slightly longer than antennomere 2; distal antennomere only forms club.

**Hapsomela Poinar and Brown, new genus**

**Type species.**—*Hapsomela burmitis* Poinar and Brown.

**Description.**—With characters listed under subfamily description. Head approximately as broad as long; eyes large, situated behind antennal insertions, widely separated; distal antennomere longest and widest; maxillary palpomere 1 longest; maxillary palpomeres 2–4 approximately equal in length; maxillary palpomere III clavate; abdominal segments protruding beyond tips of elytra, ovipositor enlarged, strongly sclerotized.

**Etymology.**—*Hapsomela* is from the Greek “hapsos” (feminine) for juncture or joint and the Greek “melos” for limb. The gender is neuter.

**Hapsomela burmitis Poinar and Brown, new species**

(Figs. 1–8, 10)

**Description.**—Holotype female; with characters listed under subfamily and generic diagnoses. Body and legs dark brown, covered with brown setae; body length 1.13 mm. **Head:** Length, 0.38 mm; covered with short erect setae; subocular setae present; antenna longer than head and pronotum combined, with 11 segments; antennomere 1 (scape) slightly longer than first antennomere, antennomere II (pedicel) with a few long setae, all other antennomeres densely covered with setae; lengths of antennomeres: 1: 102 μm, 2: 86 μm, 3: 86 μm, 4: 86 μm, 5: 86 μm, 6: 113 μm, 7: 91 μm, 8: 91 μm, 9: 91 μm, 10: 91 μm, 11: 109 μm; head deflexed; eyes oval, protruding from head margin; mandibles strongly curved, sharply pointed, apparently lacking teeth; maxillary palpomeres elongate, maxillary palpomere I longest, 98 μm; with following three palpomeres approximately of equal length: 2: 46 μm, 3: 44 μm, 4: 41 μm; third palpomere thicker than others; labial palpomeres elongate, first palpomere longest, 49 μm; followed in size by terminal one, 37 μm, with second palpomere shortest, 32 μm; palpomere III narrow and pointed.

**Thorax:** Brown; pronotum 380 μm long, almost flat, densely pubescent; legs elongate, slender, inner tips of trochanters bear a blunt tooth; femora long, only slightly clavate; patella with a wide, triangular-shaped spur on inner margin near distal end; front tibia with inner spine and outer blunt spur; meso- and metatibiae without patella; protarsomere lengths as follows: 1: 61 μm, 2: 49 μm, 3: 37 μm, 4: 49 μm, 5: 61 μm, mesotarsomere lengths, 1: 102 μm, 2: 82 μm, 3: 48 μm, 4: 68 μm, 5: 87 μm; metatarsomere lengths: 1: 159 μm, 2: 85 μm, 3: 66 μm, 4: 54 μm, 5: 88 μm; claws straight, length, 24 μm on protarsus, 39 μm on mesotarsus, 44 μm on metatarsus.

**Abdomen:** Brown; 415 μm long; scutellum absent, elytra tapered posteriorly, punctate, partially open at apex, with elytral apices bluntly rounded, entire; pygidium exposed, vertical; ovipositor prominent, with triangular protiger, paraaprosternum and paired valvifers; paired elongate gonocoxae pointed at tip; styli not observed.

**Male.**—Unknown.

**Material examined.**—Holotype female in Burmese amber from the Hukawng Valley,
Figs. 1–2. *Hapsomela burmitis* 1. Lateral view of holotype female. Arrow shows joint separating patella and tibia in right front leg. Bar = 345 μm. 2. Lateral view of right front leg with patella (P) and tibia (T). Arrow shows truncate spur at base of patella. Bar = 77 μm.
Figs. 3–8. *Hapsomela burmitis*. 3. Lateral view of head with palps. Bar = 48 µm. 4. Lateral view of ovipositor. Bar = 48 µm. 5. Lateral view of right front leg. F = femur; P = patella; T = tibia. Bar = 48 µm. 6. Angled, dorsal (edge) view of left front leg. F = femur; P = patella; T = tibia. Same magnification as Fig. 5. 7. Right metatarsus. Same magnification as Fig. 5. 8. Right antenna. Bar = 90 µm.
deposited in the Poinar amber collection (accession # B-C-11) maintained at Oregon State University.

Etymology.—The specific epithet burmitis is for the country of origin of the fossil.

Notes.—In his phylogenetic analysis of the Scydmaenidae, O’Keefe (1998) mentioned a number of additional character states for the family. Those observable in *H. burmitis* are listed below as an addendum to the description and for the benefit of future workers conducting phylogenetic analyses on this group. 1. Vertex approximately as broad as long, with antennal bases slightly separated or vertex distinctly broader than long, with antennal bases widely separated; in *H. burmitis*, the vertex is approximately as broad as long but the antennal bases are widely separated. 2. Maxillary palpomere III subtriangular or elongate; in *H. burmitis*, it is neither of these, but clavate (club-shaped). 3. Elytra free or fused; the elytra in *H. burmitis* are free. 4. Hind wings present or absent; this is difficult to observe in *H. burmitis*, but since the elytra are slightly open at the base, it is assumed that hind wings are present. 5. Elytral punctuation deep and distinct, shallow or absent; in *H. burmitis*, the punctuation is shallow, but distinct and arranged in rows. 6. Pronotal collar present or absent; it is absent in *H. burmitis*. 7. Pronotum slightly or greatly convex; in *H. burmitis*, it is only slightly convex. 8. Profemoral setae present or absent; in *H. burmitis*, they are absent. 9. Protrochanteral setae present or absent; they are absent in *H. burmitis*, but in their place is a blunt spine. 10. Postgenal setae present or absent: they are present in *H. burmitis*. 11. Maxillary palpomere II with or without bisetose process; it is without in *H. burmitis*. 12. Antennomeres IV–VII slightly longer than wide or 3–5 times longer than wide; they are 3–5 times longer than wide in *H. burmitis*. 13. Maxillary palpomere IV broad, nearly one-third length of palpomere III or elongate, nearly same length as palpomere III; in *H. burmitis*, it is elongate and nearly the same length as palpomere III. 14. Labial palpomere II elongate, parallel-sided or widened medially; it is elongate in *H. burmitis*. 15. Labial palpomere III short or elongate and slender; it is elongate and slender in *H. burmitis*. 16. Antennal insertions widely separated or narrowly separated; they are narrowly separated in *H. burmitis*. 17. Femora strongly or weakly clavate; they are weakly clavate in *H. burmitis*. 18. Elytral striae present or absent; they are absent in *H. burmitis*. 19. Mesotosomeres I–IV subequal in length or decrease in length; they decrease in length in *H. burmitis*.

**DISCUSSION**

The main distinguishing character of *H. burmitis* is the presence of a patella on the front legs (Figs. 1, 2, 5, 6, 10). The structure of the patella and a bend at its joint with the left tibia indicates that this is a true dicondylic joint (allowing movement in only one direction) controlled by internal muscles inserted at the base of the anterior protibia, a condition occurring in the legs of most adult insects today (Adler 2003). While insects represent one of the most diverse groups of terrestrial arthropods today, their basic external morphology is fairly conservative. All extant insects possess legs with 5 basic segments, the coxa, trochanter, femur, tibia and tarsus (Fig. 11). The tarsus is usually subdivided into 2–5 additional sub-segments, but together they are still regarded as a single segment. While some extant insects possess secondary segments, such as the trochantellus in some Hymenoptera (Goulet and Huber 1993) and subdivisions of the hind tibia in some caddisfly larvae (Wiggins 1977), no modern or fossil insect from the Tertiary or Mesozoic periods is known to possess more than 5 basic leg segments. However, some insects from the Late Paleozoic do possess extra leg segments, including a patella (Kukalová-Peck 1992) (Fig. 9).

There are three possible scenarios for the presence of this character on *H. burmitis*. 


Figs. 9–11. 9, Leg of a Paleozoic paleodictyopteran with two extra joints, a prefemur and patella (modified from Kukalová-Peck 1992). C = coxa; F = femur; P = patella; PF = prefemur; T = tibia; TA = tarsus; TR = trochanter. 10, Foreleg of *Hapsomela burniitis* with patella. C = coxa; F = femur; P = patella; T = tibia; TA = tarsus; TR = trochanter. 11, Leg of extant insect (Coleoptera: Cerambycidae) showing basic 5 segments. C = coxa; F = femur; T = tibia; TA = tarsus; TR = trochanter.

First, this clade of beetles could have carried this feature with them from the Paleozoic, losing the patella in the mid- and hind legs but retaining it in the front legs. Second, the extra segment could have arisen in an early Mesozoic clade that did not have a patella, but carried the genes responsible for its formation. Or lastly, this character could have arisen as a spontaneous mutation in this particular beetle. The latter scenario seems unlikely since there is no experimental evidence indicating that insects
can spontaneously produce extra leg segments, even with the numerous spontaneous and induced mutations reported in *Drosophila melanogaster* (Lindley and Zimm 1992). If the expression of an extra leg segment is not feasible by spontaneous mutation (being beyond the possibility of genomic recombination) then it would appear that this condition is either a continual, or resurgent, expression of an ancestral character.

Since extinct Paleozoic forms belonging to the orders Paleodictyoptera, Monura, and Thyusanura (Kukalová-Peck 1986, 1992) (Fig. 9), as well as present day myriapods (Barnes 1963), mites (Krantz 1978) and spiders (Comstock 1948), possess patellae, it would appear that the expression of a patella (and other additional segments) is under early developmental control in all arthropods. Unfortunately, the legs of most Paleozoic beetles were not fossilized (Carpenter 1992), and thus it is not possible to know if they had extra leg segments. The present discovery suggests that genes controlling insect leg segments became highly conserved by the Late Cretaceous, thereafter expressing only the 5 basic segments found in extant insects.

All extant scydmaenids feed on mites and use their forelegs to manipulate the prey during feeding (Molleman and Walter 2001, Schmid 1988). The extra leg segment may have been useful in manipulating certain clades of Early Cretaceous mites and was retained for this purpose, making it an example of functional morphology. When this group of mites disappeared, the extra leg segment became useless, or even a hindrance, which would explain the disappearance of this particular beetle clade.

*Hapsomela burnitii* contains characters found in both the Scydmaeninae and the Mastiginae as well as unique characters not reported previously within the family. One such unique character is the extended abdomen containing the modified ovipositor with a sharp tipped protiger, which would allow the eggs to be inserted into cracks or soft tissue. When living in a habitat with mites and other small predators, leaving unprotected eggs exposed on the substrate would be risky. Burmese amber is dated at approximately 110–100 mya which would make this specimen the oldest described scydmaenid, some 20–30 million years older than the previously described Cretaceous specimens (O’Keefe et al. 1997).

**Acknowledgement**

We thank Roberta Poinar for comments on an early draft of the manuscript.

**Literature Cited**


ACRONEURIA COVELLI (PLECOPTERA: PERLIDAE), A NEW STONEFLY SPECIES FROM EASTERN NORTH AMERICA

SCOTT A. GRUBBS AND BILL P. STARK

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Abstract.—A new species of Nearctic Perlidae, Acroneuria covelli, is described from the Ohio River traversing the Indiana-Kentucky border, the White River in southern Indiana, and a single female from Tennessee. This new species can be assigned to the A. flinti species group based on structural characteristics of the egg, yet also placed in the A. internata species group according to aedeagal armature.

Key Words: Plecoptera, Perlidae, Acroneuria, new species

The Nearctic genus Acroneuria has been the subject of systematic restructuring during the last three decades. Stark and Gaufin (1976) revised the taxon, describing two new species and placing all the then-known twelve species into seven species groups based on aedeagal and egg characteristics. Kondratieff and Kirchner (1988, 1993) described species from Kentucky (A. hitchcocki) and Virginia (A. kosztarabi). Poulton and Stewart (1991) introduced A. ozarkensis as new to science from Arkansas and Missouri, and Stark and Kondratieff (2004) added A. kirchneri from Kentucky, Virginia, and West Virginia. Lastly, Stark and Brown (1991) synonymized A. mela Frison with the true A. evoluta Klapalek, and named A. frisoni for the species originally assigned to the old A. evoluta.

Females had been acquired by the second author from two localities, Knoxville, Tennessee, and Louisville, Kentucky, that superficially resembled A. ozarkensis, yet presented enough morphological differentiation to suggest these specimens belonged to a different species. In concordance with a study of Indiana Plecoptera by the first author, light-trapping for summer-emergent Perlidae along the Ohio River produced males and gravid females of a new species of Acroneuria that corresponded to the aforementioned females. Morphological terminology follows Stark and Gaufin (1976).

The holotype and a paratype female are deposited in the Illinois Natural History Survey. The remaining paratypes are deposited in the B. P. Stark collection at Mississippi College (BPS), the S. A. Grubbs collection at Western Kentucky University (WKU), the Illinois Natural History Survey (INHS), and at the University of Louisville (UL).

Acroneuria covelli Grubbs and Stark, new species
(Figs. 1–7)

Male.—Macropterous. Forewing length 23–24 mm. Head pattern with dark intercellar patch expanded laterally around anterior ocellus but interrupted by pale M-line; occiput pale (Fig. 1). Pronotum brown with scattered pale rugosities (Fig. 1). Wing membrane translucent brown, veins dark brown. Femora dark brown dorsally and near apex, anterior face with irregular lon-

Lateral pale and brown bands; tibiae brown except for narrow pale spot near femur. Hammer typical; paraprocts slender, recurved, apically acute (Fig. 2) and strongly hooked in lateral aspect. Abdominal terga 8–10 with well-developed patches of sensilla basiconica (Fig. 2). Apical aedeagal lobe balloon-like and broadly armed over most of dorsum and venter with a continuous patch of spinules (Figs. 3, 4); apical and basal patches separated on dorsum but continuous on venter; basal patch narrowly divided on meson. Basal aedeagal lobe expanded into apically directed lobe sparsely covered with fine setae (Fig. 5).

Female.—Macropterous. Forewing length 25–27 mm. Color similar to male. Subgenital plate with lateral margins
strongly constricted near midlength; apical margin entire or with slight medial notch; plate covering 1/2 to 1/2 of 9th sternite (Fig. 6). Abdomen with contrasting dark and yellow pigmentation, with light color extending as a wide longitudinal stripe both dorsally and ventrally. Dark pigmentation extends onto lateral margins of subgenital plate on some specimens.

Egg.—Length 0.58-0.60 mm, width 0.40-0.41 mm. Pear-shaped in outline, cross-section circular, collar button-like. Chorion coarsely pitted throughout except for smooth zone surrounding collar; smooth zone length about 0.05 mm (Fig. 7). Micropyles set in apical third of egg and surrounded by irregular rosettes of 5-6 follicle cell impressions.

Nymph.—Unknown.


Etymology.—This species is named for Dr. Charles Covell, University of Louisville, for his rich contributions to Lepidoptera systematics and biology and many collections of Kentucky stoneflies.

Diagnosis.—The placement of A. covelli in a species group as defined by Stark and Gaufin (1976) is problematic, a conundrum shared by A. kosztarabii and A. ozarkensis. If based solely on egg characteristics, A. covelli would be aligned within the A. flinti group. Both A. flinti Stark and Gaufin and A. kosztarabii possess eggs that are covered with coarse pits over the entire surface, but these are easily distinguished from the eggs of A. covelli and A. ozarkensis which each have a smooth zone surrounding the collar.
Females of *A. covelli* and *A. ozarkensis* are virtually identical except that the pronounced elevation of the collar observed in *A. ozarkensis* is absent for *A. covelli* (Fig. 7).

*Acroneuria covelli* can also be placed into the *A. internata* group according the aedeagal armature. The aedeagus of *A. covelli* is similar to that of *A. internata* (Walker) and *A. petersi* Stark and Gaufin in bearing an apically directed, basoventral lobe, but, in the latter two species, the ventral spinule patch is expanded over this lobe (Stark and Gaufin 1976), whereas in the new species this lobe is armed only with a sparse patch of long thin setae (Figs. 4, 5). Additionally, the male aedeagus of *A. ozarkensis* lacks the apically directed ventral lobe and has the ventral spinule patch distinctly narrowed near midlength. In *A. covelli*, this patch covers the entire ventral surface (Fig. 4).

The nymph of *A. covelli* is unknown. Because the type locality (Ohio River, Indiana/Kentucky) and one paratype locality (White River, Indiana) are large lowland rivers, nymphal habitat is presumably either nearshore inorganic substratum or large woody debris. Formal description of the immature stage and documentation of habitat will await successful rearing and association of nymphal and adult stages.

**Acknowledgments**

We extend thanks to John Andersland (Western Kentucky University) for assistance with SEM preparation, and Don Tarter (Marshall University), Charles Covell (University of Louisville), and the Illinois Natural History Survey for loan of specimens.

**Literature Cited**


**APHIS BOYDSTONI, N. SP., AND APHIS Ceanothi CLARKE (HEMIPTERA: APHIDIDAE: APHIDINAE) ON Ceanothus velutinus Douglas, including associated parasitoids**


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Abstract.—*Aphis boydstoni* Pike, n. sp. (Hemiptera: Aphididae: Aphidinae), is described and illustrated. The aphid, which was found in the Cascade Mountains of Washington and southern British Columbia, and the Blue Mountains of Oregon, is a monoeocious holocyclic feeder of *Ceanothus velutinus* Douglas (Rhamnaceae). Its morphology and associated parasitoids are compared with those of *Aphis ceanothi* Clarke, the only other aphid known to feed on *Ceanothus.*

Key Words: aphid, *Aphis, Ceanothus,* new species, description, parasitoids, *Aphidius, Binodoxys, Diaeretiella, Lysiphlebus, Praon, Alloxysta, Lytoxysta, Phaenoglyphis, Asaphes, Pachyneuron, Dendrocerus*

Research on parasitoids of *Aphis ceanothi* Clarke in northwestern North America (Pike et al. 2000) led to the discovery of a new species of aphid on *Ceanothus velutinus* Douglas (Rhamnaceae) in the Cascade Mountains of Washington and southern British Columbia, and the Blue Mountains of Oregon. Descriptions, illustrations, parasitoid associations, and diagnoses are provided for this aphid and for *Aphis ceanothi* Clarke, the only other aphid that feeds on *Ceanothus.*

**Material and Methods**

The new species of aphid was collected from *Ceanothus velutinus* at numerous sites along the eastern slopes of the Cascade Mountains of Washington and Canada, and at two sites in the Blue Mountains of Oregon at elevations within the range of 600 to 1200 m. The collected aphids were preserved in ethanol, and subsequently cleared and mounted on microscope slides in Canada balsam. Some specimens were processed using techniques published by Hille Ris Lambers (1950) with modifications by D. Voeglin of the Illinois Natural History Survey (See Pike et al. 1991), and some were processed using techniques by Foottit and Maw (see website, http: www.zoology.ubc.ca/~mawe/bcaphid).

The aphid description is attributed to the first author. Illustrations were hand drawn from images taken with a Nikon Coolpix 990® digital camera.

All of the aphid-parasitoids associated with the *Ceanothus*-feeding aphids were reared from field collected material held in
semi-transparent plastic containers on clipped foliage at ambient laboratory temperatures ranging from 17 to 23°C for 30 days.

**Aphis boydstoni Pike, new species** (Figs. 1–2, 5–12)

Etymology.—The species is named in honor of Leslie Boydston, former Washington State University Research Technologist, who contributed significantly for many years to the research on aphids in northwestern USA.

Description.—**Apterous vivipara** (Figs. 1–2, 5–10): Coloration in life, reddish brown to blackish. Prepared specimens: Adult: body length 1.59 to 2.86 mm. Body relatively pale, appendages pigmented. Abdominal dorsum membranous, pale, except for some sclerotic pigmentation on posterior terga. Longest setae on head and antennal segment III usually longer than basal width of antennal III. Frontal tubercles (= antennal tubercles) weakly developed, diverging, and relatively smooth. Median tubercle weakly developed, height ≤ frontal
tubercles, surface sculpturing similar to frontal tubercles. Antenna 0.6–0.9 × body length; 6-segmented without secondary rhinaria; primary rhinaria with conspicuous ciliate margins. Ultimate rostral segment tapering, rounded distad of preapical primary setae, usually with 2 secondary setae. Claws simple; empodial setae acuminate, not reaching claw apices. Abdominal segments I–VII with wide, nearly flat marginal tubercles (marginal tubercle I diameter = 0.08–0.14 mm); spiracles subcircular without opercula. Siphunculus imbricated throughout, tapering (narrower at apex than base), and weakly flanged. Cauda tapering with broadly rounded apex. For a full range of morphological measurements and comparisons, see Table 1.

**Alate vivipara:** Morphological features generally similar to alate vivipara (see Table 1). Antenna (Fig. 11) with secondary rhinaria on III, sometimes IV; abdominal dorsum largely membranous, but with post-siphuncular sclerites, slight transverse pigmentation on posterior terga, and pigmented marginals.

**Ovipara:** Morphological features generally similar to alate vivipara (see Table 1). Lateral ocelli usually absent, but sometimes a trace indicated; hind tibia with 3–22 pseudorhinaria (Fig. 12).

**Diagnosis.—**Wide, nearly flat marginal tubercles on abdominal segments I–VII [largest tubercles on segments I (0.07–0.15 mm diameter) and VII (0.04–0.12 mm)], and frequent presence of a few siphuncular setae (diagnosis applies to all known adult forms of *A. boydstoni*). *Aphis ceanothi*, the other aphid known to feed on *Ceanothus* (see Clarke 1903, Gillette and Palmer 1932, Palmer 1952, Smith and Parron 1978, Maw et al. 2000, Pike et al. 2003), in comparison with *A. boydstoni*, has smaller tubercles on abdominal segments I and VII, lacks marginal tubercles on abdominal segments II–VI, and manifests fewer caudal setae. Table 2 summarizes the morphological features of *Aphis ceanothi* for use in characterizing similarities and differences between the two *Ceanothus*-inhabiting species. Regarding other *Aphis* spp., none in North America has the wide, nearly flat marginal tubercles like *A. boydstoni*.

A European aphid with large marginal tubercles, *Aphis mammulata* Gimingham and Hille Ris Lambers (1949), which feeds on *Rhamnus*, in the same plant family as *Ceanothus*, is easily distinguishable from *A. boydstoni* by its abdominal marginals that are strongly conical as opposed to flat or nearly flat.

**Material.**—Holotype: alate viviparous ♀—USA, Washington, Klickitat Co., east of Glenwood near Klickitat River, 6-VI-2000, on *Ceanothus velutinus* Douglas (WSU Code A0K055-1), collector K. S. Pike. Paratypes (all from *Ceanothus velutinus*) [abbreviations: ap, alate viviparae; ov, oviparae]: Washington, Yakima Co.—type locality, 7-VI-95 (5 ap, 3 al, A0K055); near type locality, 19-IV-96 (1 ap, 96G580); Yakama Nation along Klickitat River, 7-VI-1995 (3 ap, 95G132), 11-VII-95 (2 ap, 1 al, 95K061), 19-IX-95 (3 ap, 7 ov, 95G627), Klickitat Canyon, 23-VI-1995, (4 ap, 4 al, 95G230); Goose Egg Mountain, 23-VII-2000 (3 ap, 1 al, A0G564); Rimrock Lake, 25-VII-2003 (18 ap, A3G311); Chelan Co., 16 km north of Blewett Pass, 8-VIII-2000 (1 ap, A0G600); Oregon—Grant Co., Hwy 7, 3.6 km east of Austin Junction, 27-VII-2000 (5 ap, A0G581), Baker Co., Hwy 7, 4.2 km west of Sumpter (3 ap, A0G583); Canada, British Columbia, northwest of Peachland along Silver Lake Road, 14-VIII-1998 (8 ap, 98EM0524). Holotype deposited in National Museum of Natural History, Smithsonian Institution, Beltsville, MD (USNM). Paratypes—2 ap, 2 al, and 1 ov, deposited in USNM; 9 ap, 2 al, and 1 ov deposited in Canadian National Collection, Ottawa. Other paratypes deposited in the Washington State University aphid collection, Prosser.

**Biology and distribution.**—*Aphis boydstoni* is holocyclic monoecious on *Ceanothus velutinus* Douglas, a shrub known as mountain balm or sticky laurel. It has been
<table>
<thead>
<tr>
<th></th>
<th>Apterous Vivipara n = 32</th>
<th>Alate vivipara n = 7</th>
<th>Ovipara n = 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body (length)</td>
<td>2.15 (1.59–2.86)</td>
<td>2.37 (2.09–2.71)</td>
<td>1.88 (1.62–2.22)</td>
</tr>
<tr>
<td>Head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head (width)</td>
<td>0.51 (0.42–0.58)</td>
<td>0.49 (0.47–0.54)</td>
<td>0.46 (0.41–0.53)</td>
</tr>
<tr>
<td>Antenna</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I–VI (length)</td>
<td>1.63 (1.33–1.92)</td>
<td>1.93 (1.84–2.03)</td>
<td>1.43 (1.34–1.59)</td>
</tr>
<tr>
<td>III (length)</td>
<td>0.38 (0.25–0.52)</td>
<td>0.49 (0.46–0.52)</td>
<td>0.29 (0.25–0.35)</td>
</tr>
<tr>
<td>III (width at base)</td>
<td>0.034 (0.027–0.041)</td>
<td>0.035 (0.031–0.037)</td>
<td>0.028 (0.024–0.032)</td>
</tr>
<tr>
<td>IV (length)</td>
<td>0.27 (0.20–0.36)</td>
<td>0.34 (0.30–0.37)</td>
<td>0.23 (0.21–0.28)</td>
</tr>
<tr>
<td>V (length)</td>
<td>0.27 (0.23–0.33)</td>
<td>0.33 (0.32–0.34)</td>
<td>0.23 (0.21–0.26)</td>
</tr>
<tr>
<td>Processus terminalis (length)</td>
<td>0.37 (0.33–0.45)</td>
<td>0.42 (0.38–0.47)</td>
<td>0.34 (0.33–0.35)</td>
</tr>
<tr>
<td>Base of antennal VI (length)</td>
<td>0.16 (0.14–0.18)</td>
<td>0.17 (0.16–0.17)</td>
<td>0.15 (0.15–0.16)</td>
</tr>
<tr>
<td>Base of antennal VI (width at base)</td>
<td>0.024 (0.018–0.030)</td>
<td>0.022 (0.021–0.024)</td>
<td>0.019 (0.017–0.022)</td>
</tr>
<tr>
<td>Antenna III secondary rhinaria</td>
<td>0 —</td>
<td>27.1 (22–31)</td>
<td>0 —</td>
</tr>
<tr>
<td>Antenna IV secondary rhinaria</td>
<td>0 —</td>
<td>6 (0–2)</td>
<td>0 —</td>
</tr>
<tr>
<td>Antenna V secondary rhinaria</td>
<td>0 —</td>
<td>—</td>
<td>0 —</td>
</tr>
<tr>
<td>Longest seta on antennal III (length)</td>
<td>0.040 (0.032–0.049)</td>
<td>0.038 (0.033–0.044)</td>
<td>0.036 (0.030–0.042)</td>
</tr>
<tr>
<td>Longest seta on vertex (length)</td>
<td>0.041 (0.032–0.046)</td>
<td>0.040 (0.035–0.043)</td>
<td>0.037 (0.034–0.045)</td>
</tr>
<tr>
<td>Ultimate rostral segment (length)</td>
<td>0.16 (0.15–0.18)</td>
<td>0.16 (0.16–0.17)</td>
<td>0.16 (0.15–0.17)</td>
</tr>
<tr>
<td>Ultimate rostral segment (width at base)</td>
<td>0.077 (0.060–0.099)</td>
<td>0.075 (0.068–0.078)</td>
<td>0.066 (0.064–0.071)</td>
</tr>
<tr>
<td>Ultimate rostral segment accessory setae</td>
<td>2.2 (1–5)</td>
<td>2.3 (2–4)</td>
<td>2.0 (2–2)</td>
</tr>
<tr>
<td>Thorax</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hind tibia (length)</td>
<td>1.16 (0.94–1.48)</td>
<td>1.44 (1.33–1.57)</td>
<td>0.99 (0.86–1.21)</td>
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<tr>
<td>Longest seta near apex of tibia (length)</td>
<td>0.040 (0.033–0.047)</td>
<td>0.039 (0.034–0.047)</td>
<td>0.036 (0.031–0.039)</td>
</tr>
<tr>
<td>Tibial rhinaria</td>
<td>0 —</td>
<td>0 —</td>
<td>13.7 (3–22)</td>
</tr>
<tr>
<td>Hind tarsus II (length)</td>
<td>0.14 (0.12–0.17)</td>
<td>0.14 (0.13–0.16)</td>
<td>0.13 (0.12–0.14)</td>
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<tr>
<td>Hind tarsus II (width at mid-segment)</td>
<td>0.027 (0.023–0.032)</td>
<td>0.027 (0.024–0.031)</td>
<td>0.026 (0.024–0.028)</td>
</tr>
<tr>
<td>Hind tarsal II accessory setae</td>
<td>4.5 (3–5)</td>
<td>4.6 (4–6)</td>
<td>3.4 (2–4)</td>
</tr>
<tr>
<td>Trochanter-femoral suture (length)</td>
<td>0.060 (0.047–0.076)</td>
<td>0.057 (0.055–0.060)</td>
<td>0.051 (0.045–0.059)</td>
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<tr>
<td>Longest seta on trochanter (length)</td>
<td>0.044 (0.038–0.054)</td>
<td>0.039 (0.032–0.045)</td>
<td>0.046 (0.042–0.052)</td>
</tr>
<tr>
<td></td>
<td>Apterous Vivipara Mean (Range)</td>
<td>Alate vivipara Mean (Range)</td>
<td>Ovipara Mean (Range)</td>
</tr>
<tr>
<td>--------------------------------</td>
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<tr>
<td>Abdomen</td>
<td></td>
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<tr>
<td>Siphunculus (length)</td>
<td>0.41 (0.25–0.57)</td>
<td>0.45 (0.40–0.49)</td>
<td>0.27 (0.21–0.43)</td>
</tr>
<tr>
<td>Siphunculus (width at base)</td>
<td>0.10 (0.06–0.15)</td>
<td>0.09 (0.07–0.11)</td>
<td>0.058 (0.050–0.083)</td>
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<tr>
<td>Siphuncular setae</td>
<td>1.4 (0.7)</td>
<td>0.3 (0.0–1.5)</td>
<td>1.3 (0.0–2.5)</td>
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<tr>
<td>Cauda (length)</td>
<td>0.19 (0.16–0.24)</td>
<td>0.21 (0.19–0.23)</td>
<td>0.19 (0.18–0.19)</td>
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<tr>
<td>Cauda (width at base)</td>
<td>0.15 (0.11–0.20)</td>
<td>0.15 (0.13–0.17)</td>
<td>0.12 (0.12–0.12)</td>
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<tr>
<td>Caudal setae</td>
<td>17.5 (13–22)</td>
<td>17.0 (11–20)</td>
<td>18.2 (15–20)</td>
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<tr>
<td>Marginal tubercle I (diameter)</td>
<td>0.10 (0.08–0.14)</td>
<td>0.13 (0.08–0.15)</td>
<td>0.09 (0.07–0.11)</td>
</tr>
<tr>
<td>Marginal tubercle VII (diameter)</td>
<td>0.08 (0.04–0.11)</td>
<td>0.09 (0.08–0.12)</td>
<td>0.05 (0.04–0.07)</td>
</tr>
<tr>
<td>Comparisons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head/antennal III (width/length)</td>
<td>1.4 (1.1–2.9)</td>
<td>1.0 (0.9–1.1)</td>
<td>1.5 (1.5–1.6)</td>
</tr>
<tr>
<td>Antenna/body (length)</td>
<td>0.77 (0.61–0.94)</td>
<td>0.84 (0.72–0.97)</td>
<td>0.73 (0.70–0.77)</td>
</tr>
<tr>
<td>Antenna III (length/width at base)</td>
<td>11.1 (8.7–14.6)</td>
<td>14.1 (12.7–15.0)</td>
<td>10.4 (9.0–11.5)</td>
</tr>
<tr>
<td>Length of longest seta on antennal III/basal width of antennal III</td>
<td>1.19 (0.98–1.46)</td>
<td>1.09 (0.91–1.21)</td>
<td>1.29 (1.04–1.57)</td>
</tr>
<tr>
<td>Antenna VI base (length/width at base)</td>
<td>6.8 (5.3–8.6)</td>
<td>7.4 (6.8–8.3)</td>
<td>8.2 (7.2–9.1)</td>
</tr>
<tr>
<td>Processus terminalis/antennal VI base (length)</td>
<td>2.4 (2.0–2.8)</td>
<td>2.5 (2.2–2.9)</td>
<td>2.2 (2.2–2.2)</td>
</tr>
<tr>
<td>Length of longest seta on vertex/basal width of antennal III</td>
<td>1.21 (0.90–1.50)</td>
<td>1.14 (0.95–1.34)</td>
<td>1.34 (1.14–1.43)</td>
</tr>
<tr>
<td>Ultimate rostral segment (length/width at base)</td>
<td>2.1 (1.6–2.5)</td>
<td>2.2 (2.1–2.4)</td>
<td>2.4 (2.3–2.4)</td>
</tr>
<tr>
<td>Ultimate rostral segment/hind tarsus II (length)</td>
<td>1.2 (1.0–1.3)</td>
<td>1.1 (1.0–1.2)</td>
<td>1.2 (1.2–1.3)</td>
</tr>
<tr>
<td>Hind tarsus II (length/width at median)</td>
<td>5.3 (4.3–6.2)</td>
<td>5.4 (4.4–6.2)</td>
<td>5.0 (4.7–5.4)</td>
</tr>
<tr>
<td>Siphunculus (length/width at base)</td>
<td>4.1 (3.0–5.1)</td>
<td>4.8 (3.7–5.7)</td>
<td>4.7 (4.1–5.1)</td>
</tr>
<tr>
<td>Siphunculus/body (length)</td>
<td>0.19 (0.13–0.23)</td>
<td>0.18 (0.15–0.24)</td>
<td>0.15 (0.12–0.19)</td>
</tr>
<tr>
<td>Siphunculus/cauda (length)</td>
<td>2.1 (1.3–2.7)</td>
<td>2.1 (1.9–2.3)</td>
<td>1.3 (1.2–1.4)</td>
</tr>
<tr>
<td>Cauda (length/width at base)</td>
<td>1.3 (1.0–1.7)</td>
<td>1.4 (1.1–1.6)</td>
<td>1.6 (1.5–1.6)</td>
</tr>
<tr>
<td>Cauda/body (length)</td>
<td>0.09 (0.06–0.12)</td>
<td>0.09 (0.07–0.11)</td>
<td>0.11 (0.10–0.11)</td>
</tr>
</tbody>
</table>
Table 2. Morphological measurements (mm) and comparisons for adult morphs of *Aphis ceanothi*.

<table>
<thead>
<tr>
<th></th>
<th>Apterous Vivipara n = 79</th>
<th>Alate Vivipara n = 11</th>
<th>Apterous Male n = 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body (length)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean (Range)</td>
<td>Mean (Range)</td>
<td>Mean (Range)</td>
</tr>
<tr>
<td>Head</td>
<td>1.70 (1.19–2.28)</td>
<td>1.90 (1.60–2.39)</td>
<td>1.37 (1.18–1.54)</td>
</tr>
<tr>
<td>Head (width)</td>
<td>0.41 (0.34–0.51)</td>
<td>0.40 (0.34–0.45)</td>
<td>0.39 (0.36–0.42)</td>
</tr>
<tr>
<td><strong>Antenna</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I–VI (length)</td>
<td>1.21 (0.95–1.53)</td>
<td>1.38 (1.13–1.70)</td>
<td>1.19 (1.05–1.27)</td>
</tr>
<tr>
<td>III (length)</td>
<td>0.31 (0.22–0.44)</td>
<td>0.37 (0.29–0.48)</td>
<td>0.32 (0.27–0.36)</td>
</tr>
<tr>
<td>III (width at base)</td>
<td>0.026 (0.021–0.030)</td>
<td>0.026 (0.023–0.030)</td>
<td>0.024 (0.021–0.026)</td>
</tr>
<tr>
<td>IV (length)</td>
<td>0.20 (0.13–0.27)</td>
<td>0.22 (0.16–0.28)</td>
<td>0.21 (0.17–0.24)</td>
</tr>
<tr>
<td>V (length)</td>
<td>0.19 (0.15–0.24)</td>
<td>0.21 (0.17–0.27)</td>
<td>0.19 (0.17–0.21)</td>
</tr>
<tr>
<td>Processus terminalis (length)</td>
<td>0.26 (0.21–0.32)</td>
<td>0.28 (0.22–0.32)</td>
<td>0.23 (0.22–0.25)</td>
</tr>
<tr>
<td>Base of antennal VI (length)</td>
<td>0.13 (0.11–0.18)</td>
<td>0.14 (0.13–0.18)</td>
<td>0.12 (0.11–0.12)</td>
</tr>
<tr>
<td>Base of antennal VI (width at base)</td>
<td>0.017 (0.014–0.022)</td>
<td>0.015 (0.013–0.018)</td>
<td>0.013 (0.013–0.014)</td>
</tr>
<tr>
<td>Antenna III secondary rhinaria</td>
<td>0</td>
<td>22.7 (16–36)</td>
<td>6.0 (3–9)</td>
</tr>
<tr>
<td>Antenna IV secondary rhinaria</td>
<td>0</td>
<td>0.8 (0–5)</td>
<td>8.5 (7–9)</td>
</tr>
<tr>
<td>Antenna V secondary rhinaria</td>
<td>0</td>
<td>0.1 (0–1)</td>
<td>7.7 (7–8)</td>
</tr>
<tr>
<td>Longest seta on antennal III (length)</td>
<td>0.035 (0.020–0.043)</td>
<td>0.034 (0.030–0.038)</td>
<td>0.025 (0.023–0.027)</td>
</tr>
<tr>
<td>Longest seta on vertex (length)</td>
<td>0.039 (0.031–0.049)</td>
<td>0.041 (0.033–0.048)</td>
<td>—</td>
</tr>
<tr>
<td>Ultimate rostral segment (length)</td>
<td>0.12 (0.11–0.13)</td>
<td>0.12 (0.11–0.13)</td>
<td>0.11 (0.10–0.11)</td>
</tr>
<tr>
<td>Ultimate rostral segment (width at base)</td>
<td>0.058 (0.043–0.076)</td>
<td>0.052 (0.045–0.060)</td>
<td>0.050 (0.048–0.052)</td>
</tr>
<tr>
<td>Ultimate rostral segment assessor setae</td>
<td>2.0 (2–3)</td>
<td>2.1 (2–3)</td>
<td>2.0 (2–2)</td>
</tr>
<tr>
<td><strong>Thorax</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hind tibia (length)</td>
<td>0.81 (0.58–1.06)</td>
<td>0.94 (0.75–1.20)</td>
<td>0.68 (0.56–0.76)</td>
</tr>
<tr>
<td>Longest seta near apex of tibia (length)</td>
<td>0.039 (0.031–0.049)</td>
<td>0.036 (0.030–0.044)</td>
<td>0.036 (0.033–0.042)</td>
</tr>
<tr>
<td>Tibial rhinaria</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hind tarsus II (length)</td>
<td>0.13 (0.10–0.15)</td>
<td>0.13 (0.11–0.14)</td>
<td>0.11 (0.10–0.12)</td>
</tr>
<tr>
<td>Hind tarsus II (width at mid-segment)</td>
<td>0.022 (0.018–0.027)</td>
<td>0.020 (0.018–0.024)</td>
<td>0.024 (0.017–0.029)</td>
</tr>
<tr>
<td>Hind tarsal II accessory setae</td>
<td>3.6</td>
<td>4.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Trochanter-femoral suture (length)</td>
<td>0.045 (0.034–0.063)</td>
<td>0.041 (0.034–0.051)</td>
<td>0.038 (0.036–0.041)</td>
</tr>
<tr>
<td>Longest seta on trochanter (length)</td>
<td>0.048 (0.035–0.062)</td>
<td>0.044 (0.033–0.050)</td>
<td>0.047 (0.042–0.053)</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Apterous Vivipara</td>
<td>Alate vivipara</td>
<td>Apterous Male</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Siphunculus (length)</td>
<td>0.42 (0.24–0.58)</td>
<td>0.39 (0.23–0.58)</td>
<td>0.21 (0.17–0.24)</td>
</tr>
<tr>
<td>Siphunculus (width at base)</td>
<td>0.118 (0.069–0.185)</td>
<td>0.092 (0.070–0.125)</td>
<td>0.047 (0.036–0.053)</td>
</tr>
<tr>
<td>Siphuncular setae</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cauda (length)</td>
<td>0.14 (0.11–0.18)</td>
<td>0.14 (0.11–0.16)</td>
<td>0.09 (0.09–0.09)</td>
</tr>
<tr>
<td>Cauda (width at base)</td>
<td>0.13 (0.09–0.17)</td>
<td>0.13 (0.11–0.18)</td>
<td>0.11 (0.11–0.11)</td>
</tr>
<tr>
<td>Caudal setae</td>
<td>8.0 (1–16)</td>
<td>7.8 (5–10)</td>
<td>5.0 (5–5)</td>
</tr>
<tr>
<td>Marginal tubercle I (diameter)</td>
<td>0.029 (0.020–0.040)</td>
<td>0.032 (0.027–0.037)</td>
<td>0.023 (0.022–0.024)</td>
</tr>
<tr>
<td>Marginal tubercle VII (diameter)</td>
<td>0.023 (0.014–0.036)</td>
<td>0.027 (0.022–0.032)</td>
<td>0.017 (0.015–0.019)</td>
</tr>
<tr>
<td>Comparisons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head/antennal III (width/length)</td>
<td>1.3 (1.0–1.8)</td>
<td>1.1 (1.0–1.3)</td>
<td>1.2 (1.1–1.3)</td>
</tr>
<tr>
<td>Antenna/body (length)</td>
<td>0.72 (0.42–0.88)</td>
<td>0.70 (0.67–0.82)</td>
<td>0.87 (0.82–0.90)</td>
</tr>
<tr>
<td>Antenna III (length/width at base)</td>
<td>11.8 (8.7–15.4)</td>
<td>14.2 (12.4–15.9)</td>
<td>13.7 (11.4–16.7)</td>
</tr>
<tr>
<td>Length of longest seta on antennal III/basal width of antennal III</td>
<td>1.34 (1.04–1.97)</td>
<td>1.32 (1.02–1.55)</td>
<td>1.05 (1.02–1.08)</td>
</tr>
<tr>
<td>Antenna VI base (length/width at base)</td>
<td>7.9 (5.5–9.4)</td>
<td>9.3 (8.5–10.4)</td>
<td>8.8 (8.4–9.3)</td>
</tr>
<tr>
<td>Processus terminalis/antennal VI base (length)</td>
<td>2.0 (1.5–2.2)</td>
<td>1.9 (1.7–2.1)</td>
<td>2.0 (1.9–2.0)</td>
</tr>
<tr>
<td>Length of longest seta on vertex/basal width of antennal III</td>
<td>1.78 (1.34–2.26)</td>
<td>1.65 (1.29–1.92)</td>
<td>—</td>
</tr>
<tr>
<td>Ultimate rostral segment (length/width at base)</td>
<td>2.1 (1.5–2.6)</td>
<td>2.3 (2.0–2.6)</td>
<td>2.2 (2.1–2.4)</td>
</tr>
<tr>
<td>Ultimate rostral segment/hind tarsus II (length)</td>
<td>0.9 (0.8–1.1)</td>
<td>0.9 (0.8–1.0)</td>
<td>1.0 (0.9–1.1)</td>
</tr>
<tr>
<td>Hind tarsus II (length/width at median)</td>
<td>5.6 (4.7–5.0)</td>
<td>6.3 (5.7–7.0)</td>
<td>4.8 (3.9–5.8)</td>
</tr>
<tr>
<td>Siphunculus (length/width at base)</td>
<td>3.6 (2.7–5.1)</td>
<td>4.2 (3.0–4.8)</td>
<td>4.5 (4.3–10.0)</td>
</tr>
<tr>
<td>Siphunculus/body (length)</td>
<td>0.25 (0.11–0.35)</td>
<td>0.20 (0.14–0.24)</td>
<td>0.15 (0.14–0.17)</td>
</tr>
<tr>
<td>Siphunculus/cauda (length)</td>
<td>3.0 (2.1–4.2)</td>
<td>2.8 (2.3–3.7)</td>
<td>2.7 (2.7–2.7)</td>
</tr>
<tr>
<td>Çauda (length/width at base)</td>
<td>1.1 (0.8–1.7)</td>
<td>1.1 (0.9–1.2)</td>
<td>0.8 (0.8–0.8)</td>
</tr>
<tr>
<td>Çauda/body (length)</td>
<td>0.08 (0.05–0.10)</td>
<td>0.07 (0.06–0.08)</td>
<td>0.06 (0.06–0.06)</td>
</tr>
</tbody>
</table>
collected in open Douglas fir and ponderosa pine forests in the Cascade Mountains of Washington and southern British Columbia, and the Blue Mountains of Oregon. Further exploration may show it to exist elsewhere in the range of _Ceanothus velutinus_ [British Columbia to California, east to Colorado and South Dakota (Hitchcock and Cronquist 1973)].

_Aphis ceanothi_ is widely scattered across western North America from British Columbia to California, and eastward to Colorado, Nebraska, and Manitoba (Palmer 1952, Smith and Parron 1978, Maw et al.
Table 3. Primary parasitoids (Hymenoptera) found attacking *Aphis boydstoni* and *Aphis ceanothi* in northwestern North America.

<table>
<thead>
<tr>
<th>Aphid</th>
<th>Collections</th>
<th>Primary Parasitoids No. Reared (% of total rears per aphid species)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(A. boydstoni)</em> (ex Ceanothus velutinus)*</td>
<td></td>
<td><strong>Aphelinidae</strong></td>
</tr>
<tr>
<td></td>
<td>Total No. %</td>
<td><strong>Aphelinus</strong></td>
</tr>
<tr>
<td><em>(A. ceanothi)</em> (ex Ceanothus spp.)</td>
<td></td>
<td><strong>Aphelinus</strong></td>
</tr>
<tr>
<td><em>A. boydstoni</em></td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td><em>A. ceanothi</em></td>
<td>58</td>
<td>47</td>
</tr>
</tbody>
</table>

1 Ap, *Aphidius polygonaphis* (Fitch); Bc, *Binodoxys carolinensis* (Smith); Dr, *Diaeretiella rapae* (McIntosh); Lt, *Lysiphlebus testaceipes*; Pr, *Praon* sp.

2 Aphid taken from *C. cuneatus* (1 collection), *C. integerrimus* (2), *C. sangineus* (8), and *C. velutinus* (47).

2000, Pike et al. 2003). In addition to feeding on *Ceanothus velutinus*, it was found on *C. cuneatus* Nuttal, *C. integerrimus* Hooker and Arnott, and *C. sangineus* Pursh.

Intermixed colonies.—Colonies of *Aphis boydstoni* and *A. ceanothi* were infrequently found intermixed. Of 65 aphid collections taken from *Ceanothus velutinus*, only five showed intermixed colonies, and even with these, *A. boydstoni* tended to be on the stems, while *A. ceanothi* tended to be on the leaves.

Relationship to other aphids.—Based on preliminary DNA microsatellite flanking sequence data, the two *Ceanothus*-feeding aphids are closely related to each other and belong to a group of *Aphis* that includes *A. helianthi* Monell, *A. neogillettei* Palmer, *A. nigratibialis* Robinson, and *A. viburniphila* Patch (unpublished data of Footit and Maw).

Parasitoids.—Tables 3 and 4 summarizes the primary and secondary parasitoids found associated with *Aphis boydstoni* and *A. ceanothi*. Between 73 and 81% of the collections were parasitized, with *Lysiphlebus testaceipes* (Cresson) (Hymenoptera: Braconidae: Aphidiidae) being the predominant parasitoid present; it comprised ≈80% of the primary parasitoids associated with *A. boydstoni*, and ≈95% of the primaries associated with *A. ceanothi*. Both species of aphids were also attacked by *Aphelinus* sp. Additionally, *A. ceanothi* was attacked by several other species of aphidiines (see Table 3). The secondary parasitoids associated with these *Ceanothus* aphids were comprised of a mix of species spanning several families of Hymenoptera (Table 4).

*Lysiphlebus testaceipes* is a rather broadly oligophagous parasitoid, especially common in its attack of *Aphis* spp. in the Pacific Northwest (Pike et al. 2000), and thus, its high parasitism of *Aphis boydstoni* and *A. ceanothi* is in accord with its typical preference. *Lysiphlebus testaceipes* is an important natural biological control agent of some of the crop-attacking aphid pests in the region. e.g., *Aphis craccivora* Koch on alfalfa; *Diuraphis noxia* (Kurdjumov), *Rhopalosiphum padi* (L.), *R. maidis* (Fitch), and *Sitobion avenae* (F.) on small grains. Although the aphids of *Ceanothus* are usually some distance from the region’s crops, the aphids are nevertheless part of the overall biodiversity that sustain the parasitoid. And although untested, the aphid-supporting *Ceanothus*, if used in landscape plantings, might prove useful in enhancing the presence and action levels of *L. testaceipes* in nearby crops.

Acknowledgments

We express thanks to D. Graf, J. Hileman, and T. Miller (Washington State Uni-
versity technical staff), L. Boydston (former Washington State University technician), and L. Pike for assistance in collecting, mounting, photography, or parasitoid rearings; G. A. P. Gibson (Agriculture and Agri-Food Canada, Ottawa) for assistance in secondary parasitoid identification; and the Yakama Nation for allowing access to their lands.

**LITERATURE CITED**


ULTRASTRUCTURE OF THE CHORION OF DIOCTRIA FLAVIPENNIS MEIGEN, 1820 (DIPTERA: ASILIDAE: STENOPOGONINAE) COMPARED WITH THOSE OF FOURTEEN ASILID SPECIES FROM THE MID-ATLANTIC REGION OF NORTH AMERICA

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(SC, ZS, AH, NC) Gazi University, Faculty of Arts and Science, Department of Biology, 06500 Teknikokullar, Ankara, Turkey (e-mail: scandan@gazi.edu.tr); (RL) P.O. Box 1010, Mt. Barker, SA 5252, Australia (e-mail: rjlavigne@netspace.net.au)

Abstract.—The fine structure of egg morphology of Dioctria flavipennis Meigen 1820 was studied utilizing both scanning electron (SEM) and transmission (TEM) microscopy. Eggs from Aksaray, Turkey, averaged 0.4 mm in length and 0.3 mm in width and had a single micropylar opening at one end. Chorions were covered with small and large circular elevated structures. A micropylar region eclosion groove is reported for the first time. Sperm flagella were present in the micropylar region of some eggs. The endochorion and exochorion were distinguished from each other in TEM micrographs, the former being slightly more dense than the latter. Lamellar sheets, minute canals, and air ducts were also found. Additionally, the exochorion of the egg of D. flavipennis was compared with those (SEMs) of 14 asilid species from the mid-Atlantic region of North America: Atomo sia puella (Wiedemann), Cerotainia albipilosa Curran, Euhodricia tibialis (Banks), Holcocephala abdominalis (Say), H. calva (Loew), Laphria divisor (Banks), L. flavicollis Say, L. ithyphigi McAtee, L. sicula McAtee, L. virginica (Banks), Leptogaster flavipes Loew, Psilonyx annulatus (Say), Tipulogaster glabrata (Wiedemann), and Tolmerus sp. Brief comments about the phylogeny of the egg chorion and its adaptation to various environmental conditions are included. Egg morphology may be useful to elucidate taxonomic and phylogenetic relationships among asilids.

Key Words: egg morphology, ultrastructure, chorion, Dioctria flavipennis, Asilidae, Diptera, SEM, TEM

The taxonomic importance of egg morphology has become increasingly significant in a wide variety of insect orders, such as Diptera (Lounibos et al. 1997), Lepidoptera (Salkeld 1983, 1984; Suludere 1988), Hemiptera (Javahery 1994), and Pleocoptera (Szczytko and Stuart 1976, Starks and Stewart 1981). The surface structure of dipteran eggs, as revealed by scanning electron microscopy (SEM), often provide reliable characters for separating species (Salkeld 1980, Kula 1988, Kuznetsov 1988, Linley and Chadee 1990, Sahlen 1990, Mouzaki et al. 1991, Feliciani et al. 1993, Greenberg and Singh 1995, Service et al. 1997, Suludere et al. 2000a, b). Although an extensive survey of respiratory and morphological structures of insect eggs have been conducted by Hinton (1981) and Margaritis (1985), little information concerning the
surface structure of eggs of Asilidae was reported by these authors. Many papers that cover robber fly reproductive behavior include a superficial description of the eggs (e.g., Dennis 1979; Lavigne 1963a, b, 1964).

Previous detailed published SEM studies of the external morphology of asilid eggs are summarized in Table 1. In this study, we examined the egg structure of Dioctria flavipennis Meigen 1820 in detail utilizing both scanning (SEM) and transmission electron (TEM) microscopy to extend our knowledge of egg surface structures that might be utilized in the taxonomy of the Asilidae in the future. Additionally, the exochorion of the egg of D. flavipennis was compared with those (SEMs) of 14 asilid species from the mid-Atlantic region of North America: 

Table 1. Summary of descriptions of asilid eggs (Diptera) using SEM microscopy.

<table>
<thead>
<tr>
<th>Subfamily and Species</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEPTOGASTRINAE</strong></td>
<td></td>
</tr>
<tr>
<td>Psilonyx annulatus (Say)</td>
<td>Castillo et al. 1994</td>
</tr>
<tr>
<td><strong>STENOPOGONIAE</strong></td>
<td></td>
</tr>
<tr>
<td>Taperigma dionitiformis Artigas and Papavero 1991</td>
<td>Castillo et al. 1994</td>
</tr>
<tr>
<td><strong>DASYPOGONIAE</strong></td>
<td></td>
</tr>
<tr>
<td>Megapoda labitata (Fabricius)</td>
<td>Castillo et al. 1994</td>
</tr>
<tr>
<td><strong>LAPHRINAE</strong></td>
<td></td>
</tr>
<tr>
<td>Atomosia dasypus (Wiedemann 1828) as Pararactia dasypus</td>
<td>Castillo et al. 1994</td>
</tr>
<tr>
<td>Dismeryngodes anticus (Wiedemann 1828)</td>
<td>Castillo et al. 1994</td>
</tr>
<tr>
<td><strong>ASILINAE</strong></td>
<td></td>
</tr>
<tr>
<td>Antipalus varipes (Meigen 1820)</td>
<td>Musso 1981</td>
</tr>
<tr>
<td>Colealomyia sp.</td>
<td>Castillo et al. 1994</td>
</tr>
<tr>
<td>Colepa abludo (Daniels 1983) as Neoaratus abludo Daniels</td>
<td>Musso 1981</td>
</tr>
<tr>
<td>Dystolmus kiesenwetteri (Loew 1854) as Eutolimus kiesenwetteri Loew</td>
<td>Musso 1981</td>
</tr>
<tr>
<td>Machimus fimbriatus (Meigen 1820)</td>
<td>Musso 1981</td>
</tr>
<tr>
<td>Machimus fimbriatus (Meigen 1820)</td>
<td>Suludere et al. 2000a</td>
</tr>
<tr>
<td>Machimus pilipes (Meigen 1820)</td>
<td>Musso 1981</td>
</tr>
<tr>
<td><strong>LAFRINAE</strong></td>
<td></td>
</tr>
<tr>
<td>Dasyopogoninae</td>
<td></td>
</tr>
<tr>
<td>Leptogaster virgina (Banks 1917), Leptogaster flavipes Loew 1862, Psilonyx annulatus (Say 1823), Tipulogaster glabrata (Wiedemann 1828), and Tolmerus sp.</td>
<td></td>
</tr>
</tbody>
</table>
sion Electron Microscope (TEM) were fixed with 2.5% glutaraldehyde in a phosphate buffer (pH 7.2) for 2 hours and post-fixed with 1% osmium tetroxide in a phosphate buffer (pH 7.2) for 1 hour. The samples were embedded in Glaucert’s araldite medium and the ultrathin sections were stained with Reynold’s lead citrate following uranyl acetate. These eggs were examined with a Zeiss EM 900 Transmission Electron Microscope at 80 kV.

RESULTS

Eggs of Dioctria flavipennis are ovoid, dull brown, and approximately 0.4 mm in length and 0.3 mm in width (Figs. 1, 2). The exochorion is covered by erect, relatively thin, oval rings of varying sizes (Figs. 3–6). The walls of these structures are curved, appearing crown or cup-shaped in lateral and dorsal views (Figs. 3, 4, 8). Aeropyles are present on the floor of these structures and occasionally outside of them (Figs. 4, 6). One end of the egg [micropylar region] is fairly smooth, contains one micropyle, and is surrounded on it outer edge by irregularly spaced, cup-like structures and a row of larger, oval rings (Figs. 1, 3, 7). An eclosion groove is visible between the two latter structures, delineating the micropylar region from the remaining exochorion (Figs. 3, 4). Larvae emerge from eggs by pressing against the micropylar region [operculum], causing it to separate along the thin, weaker eclosion line (Fig. 2). Sperm flagella are sometimes present in the micropylar area (Figs. 7, 22).

The chorion of Dioctria flavipennis is composed of two layers, each of which is composed of lamellar sheets, minute vertical canals, and small cavities that probably connect to the surface aeropyles (Fig. 8). The electron density of the endochorion, which rests on the vitelline membrane, appears more compact than that of the exochorion. The latter appears somewhat rippled or rugose in cross-section near the outer surface due to the presence of rather large horizontal chambers or grooves. The exochorion is covered externally with a thin, nonstratified material, possibly wax (Fig. 8). The broken edge of the chorion of L. divisor suggests a more complex organization of lamellar bundles, angled in a crossing pattern, which would enhance the tensile strength of the endocuticle along its inner surface (Fig. 9).

The egg morphology of the mid-Atlantic North American species differs from that of Dioctria flavipennis. Two contrasting types of exochorions were found (Figs. 9–33). One with a simple, smooth exochorion (three Leptogastrinae and one Asilinae species) without erect exochoronic rings and aeropores (Table 2, Fig. 10) and a second with complex polygon rings and numerous, widely distributed, aeropyles (Laphriinae, Dioctriinae, and Trigonomininae). Pentagon and hexagon shaped rings are most common. The polygon ridges are usually thicker and shorter than those in D. flavipennis (Figs. 8, 9, 14–21, 23, 27, 29, 33). The exceptions include Laphria ithyugi (Fig. 11–12), which has peglike tubercles connected at angles to unusually low ridges and Holcocephala calva (Figs. 13, 24), which has taller, thinner-walled rings. In most species, ridges are solid, either as a raised exochorion surface or formed of fused surface processes. Those of Laphria flavicollis, Cerotainia albipilosa and Atamosia puella are composed of loosely organized hairlike or thicker digitate processes (Figs. 17–19, 25).

The broad interridge areas are usually much shorter than the surrounding ridges and covered by erect processes. However, the interridge processes on eggs of C. albipilosa and A. puella are only slightly shorter than those that form the ridges (Figs. 17, 18). The interridge areas are sometimes bare (Figs. 15, 21), especially near the micropylar region (Fig. 23), but most are covered with various processes, of which some are fused whereas others are thin and hairlike or thicker and digitate (Figs. 16–20, 22, 23, 25).

Aeropyles are widespread across the ex-
Figs. 1–7. Egg morphology of *Dioctria flavipes*. 1. SEM micrograph of an unhatched egg. 2. SEM micrograph of an egg and emerging first instar larva. 3. SEM micrograph of the micropylar region [Ma] showing a micropyle, distribution of circular rings. Also note an eclosion groove and a row of ovoid rings surrounding the micropylar region. 4. SEM micrograph of an eclosion line and distribution of circular and ovoid rings. Note aeropyles on the floor of the ringed walls. 5. SEM micrograph showing the distribution of ovoid rings on the surface of the exochorion. 6. SEM micrograph showing the aeropyles on the floor of oval rings and on the general surface of the exochorion. 7. SEM micrograph of the micropylar region with a micropyle and a sperm flagellum.
ochorion surface, including both ridges and interridge areas, and are more numerous than those in *D. flavipennis* (Figs. 6, 17, 19–24, 30–32). They usually occur as single surface pores on flat surfaces, at the top of processes or cone-shaped elevations (Figs. 17, 19, 21–23, 25). Additionally, one to two clusters of aeropyles are present in each interridge area on the eggs of *Laphria sicula* (Fig. 20).

The micropylar area is largely smooth with ridges becoming shorter and flattened toward the center (Figs. 11, 27–29, 31–32). However, it is somewhat floral-like (Fig. 30) in *Holcocephala abdominalis* and weakly ridged in *Laphria flavicollis* (Fig. 33). An eclosion groove delineating the micropylar area is absent on eggs of all mid-Atlantic species in this study. Duel aeropyles were found only in *Psilonyx annulatus* (Figs. 10–11, 26, 27–33, Table 2).

**DISCUSSION**

With the exception of the micropylar region, the surface of the chorion of *D. flavipennis* is covered with both small and large oval rings. Similar patterns were observed on the surface of eggs of certain *Dioctria* and *Laphria* species by Melin (1923) using a standard ocular microscope.

Scarborough (1978) reported finding “characteristic elevated ridges forming 4–7 sided rings with 6-sided rings being the most common” on the surface of eggs of *Ceratonia albipilosa* Curran at 550X magnification, while Dennis (1979) illustrated hexagon rings on the surface of *Holcocephala fuscans* eggs at 740X magnification. Dennis and Lavigne (1975) reported a “chorion smooth, without ornamentation” in six North American genera.

Musso (1981) studied the morphology and development of the immature stages of some European robber flies and classified the eggs into three groups: pigmented eggs, non-pigmented ones (ornamented and non-ornamented), and eggs covered with sand grains. He defined pigmented eggs as those, such as *Andrenosoma atrum* and *A. bayardi*, which are colored and have a thick chorion composed of irregular juxtaposed polygon rings (pentagon and hexagon shaped). Unpigmented ornamented eggs, usually whitish, had a thick chorion covered by “nipples and tubercles surrounding numerous small cavities, crypts or crevices” as found in *Machimus fimbriatus*, and *Dystolmus kiesewetteri*. He provided an SEM of *Machimus pilipes* to illustrate unpigmented non-ornamented egg and commented that Mach-
Table 2. Four egg characters present on 14 asilid species (Diptera) from the mid-Atlantic region of North America listed by subfamily.

<table>
<thead>
<tr>
<th>Subfamily and Species</th>
<th>Chorion Surface</th>
<th>Aeropyles</th>
<th>Micropyle</th>
<th>Micropyle Area</th>
<th>Egg Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEPTOGASTRINAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leptogaster flavipes Loew*</td>
<td>thin, smooth w/o ridges</td>
<td>absent</td>
<td>one</td>
<td>smooth</td>
<td>oval</td>
</tr>
<tr>
<td>Psilomyx annulatus (Say)*</td>
<td>thin, smooth w/o ridges</td>
<td>absent</td>
<td>two</td>
<td>smooth</td>
<td>oval</td>
</tr>
<tr>
<td>Tipulogaster glabrata (Wiedemann)*</td>
<td>thin, smooth w/o ridges</td>
<td>absent</td>
<td>one</td>
<td>smooth</td>
<td>oval</td>
</tr>
<tr>
<td><strong>TRIGONOMIMINAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holcocephala abdominalis (Say)</td>
<td>thick, with thick, low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, floral-like</td>
<td>oval</td>
</tr>
<tr>
<td>Holcocephala calva (Loew)</td>
<td>thick, with tall thin uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>oval</td>
</tr>
<tr>
<td><strong>DIOCTRINAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eudiciea tibialis (Banks)</td>
<td>thick, with thick low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>oval</td>
</tr>
<tr>
<td><strong>LAPHRINAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atomosia puella (Wiedemann)</td>
<td>thick, with low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>oval</td>
</tr>
<tr>
<td>Cerotainia albipilosa Curran</td>
<td>thick, with low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>oval</td>
</tr>
<tr>
<td>Laphria divisor (Banks)</td>
<td>thick, with thick low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>oval</td>
</tr>
<tr>
<td>Laphria flavicollis (Say)</td>
<td>thick, with thick low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>narrow with low ridges</td>
<td>oval</td>
</tr>
<tr>
<td>Laphria thyopi McAtee</td>
<td>tuberculate corners, low interconnecting ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>elongate, ends bluntly rounded</td>
</tr>
<tr>
<td>Laphria sicula McAtee</td>
<td>thick, with thick low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>oval</td>
</tr>
<tr>
<td>Laphria virginica (Banks)</td>
<td>thick, with thick low uniform ridges</td>
<td>present</td>
<td>one</td>
<td>broad, smooth</td>
<td>oval</td>
</tr>
<tr>
<td><strong>ASILINAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tolmerus sp.*</td>
<td>thin, smooth w/o ridges</td>
<td>absent</td>
<td>one</td>
<td>smooth</td>
<td>elongate, narrow</td>
</tr>
</tbody>
</table>

* Chorion surface smooth and without obvious aeropyles as in *Psilomyx annulatus* (Say).
**im us rusticus** had the same surface characters. SEMs of the latter species taken by Suludere et al. (2000a) confirmed Musso’s statement. Interestingly, the same exochorionic pattern is found on the eggs of *Asilus crabroniformis* (Clements and Skidmore 1998), being made up of globular masses of varying size. None of the eggs in our paper fall into Musso’s third grouping: exochorion “entirely covered with a thin pellicle made of tiny (10–150 μm) sand grains.” The egg of *Antipalus varipes* is the only species that is known to have this type of exochorionic pattern.

Eggs of *Dioctria flavipennis* do not fall into any of these groups. Neither do their chorionic reticulations resemble any of those reported by Castillo et al. (1994). Only two species in the latter study can be placed in Musso’s pigmented eggs category (*Dismeryngodes anticus* and *Taperigna diognitiformis*). Lastly, the chorionic structures on the eggs of *Colepia abludo* (Lawson and Lavigne 1984) also do not conform to any of Musso’s groupings, nor do they equate with those of *D. flavipennis*. However, eggs of the mid-Atlantic North American species of Dioctria, Laphriinae, and Trigonomiminae can be placed in Musso’s first grouping of pigmented eggs with thick chori- ons and juxtaposed polygons.

The micropylar area of an asilid egg is usually smooth and flattened around the micropyle. This study reports the first finding of a distinct single row of similar sized oval rings surrounding the micropylar region and an eclosion groove in *Dioctria flavipennis*. Both of the structures are absent in the American and Europeans species thus far studied.

Our study also reports a single micropylar opening at the apex of the *D. flavipennis* egg. Lawson and Lavigne (1984) also reported sperm flagella in the micropylar opening of an egg of *Colepia abludo*. Sperm flagella are also reported near the entrance to the micropy of *Holcocephala abdominalis* eggs (Fig. 30). That the micropylar opening is a central canal for the passage of sperm is also suggested by the presence of a single micropy in the eggs of *Cnudolomyia* sp., *Archilestroides guimareaensis* and *Megapoda labiata* (Castillo et al. 1994) and most mid-Atlantic North American species, (Table 2, Figs. 19–24) with one exception. Interestingly, the eggs of *Atomosia dasyxus* (Castillo et al. 1994) and *Psilonyx annulatus* (Table 2, Figs. 19–24) have two micropyles. Castillo et al. (1994) record dual micropyles for *Taperigna diognitiformis*, but this is not apparent in their Figure 24, which shows only a single micropy.

Conversely, no micropyle was found in *Machimus rusticus* eggs (Suludere et al. 2000a), nor was any noted on the exochorion of the eggs of *Asilus crabroniformis* (Clements and Skidmore 1998). Note, too, that Castillo et al. (1994) did not observe a micropylar opening in eggs of *Dismeryngodes anticus*.

Suludere et al. (2000a) referred to the area at the end of eggs of *Machimus rusticus* as a micropylar region (anterior pole). She postulated that the openings of dome-like projections might be aeromicropylar openings through which sperm enter the egg. Similar multiple openings [aeropyles of Castillo et al. (1994)] are also seen in the exochorionic structures of *Holcocephala abdominalis* (Fig. 30), *Holcocephala calva* (Fig. 31), and *Eudioctria tibialis* (Fig. 32). However, the latter species have a single, large micropy as well and much smaller pores which probably function as openings for gas exchange.

Insect eggs require a large surface area in order to supply adequate quantities of oxygen for the developing embryo. Because of the presence of air spaces, as seen in cross section under TEM, the eggs of *D. flavipennis* are able to perform plastron respiration thus supplying enough oxygen without significant moisture loss. Hinton (1969) suggested that the chorion is so structured to minimize water loss.

It is of interest taxonomically, then, that the exochorion of most Laphriine eggs have
Figs. 10–15. SEM micrographs of unhatched eggs of five asilid species from the mid-Atlantic region of North America. 10. Psihonyx annulatus showing a smooth chorion and micropyles [arrow]. 11–12. Laphria tithypgi showing tuberculate pattern and unusually low interconnecting ridges and single micropyle. 13. Holoccephala calva showing tall, thin hexagon pattern. 14. Eudioctha tibialis showing hexagon ornamentation on the exochorion. 15. Laphria divisor showing hexagonal ornamentation on the exochorion.

pentagon-hexagon rings: Laphriinae—Ato-
mosiini [Atomosia puella (Fig. 18), Cerotainia albiptiosa, (Fig. 17) Dissmeryngodes anticus (Castillo et al. 1994)]; Laphriinae—Andrenosomini [Andrenosoma atra (Musso 1981), Andrenosoma bayardi (Musso 1981)]; Laphriinae—Laphriini [Laphria di-
visor (Fig. 15), Laphria flavicollis (Fig. 19), Laphria sicula (Fig. 20), Laphria virginica (Fig. 23)]. The exception is the egg of La-
Figs. 16–21. SEM micrographs of polygon patterns on the exochorion of six asilid species from the mid-Atlantic region of North America. 16. *Holcocephala abdominalis* showing thick, solid ridges. 17. *Ceratania albipilosa* Curran showing low ridges formed from digitate processes and scattered aeropyles. 18. *Atomosia puella* showing unusually low polygon ridges. 19. *Laphria flavicollis* showing tall ridges formed from hair-like tubercles and distribution of aeropyles. 20. *Laphria sicula* showing thick ridges with the distribution of minute aeropyles on the general chorion surface, including ridges, and clusters of aeropyles in the interridge areas. 21. *Eudioctria tibialis* showing thick ridges and distribution of aeropyles. Note slightly elevated surface surrounding aeropyles.
*Philia ithyphi* (Figs. 11–12) that has rows of tubercles that appear to form slightly spiral rows at some angles, but corners of a pentagon or hexagon when viewed at a greater magnification. Hexagon rings also occur on the eggs of some Asilinae [Cnodalomyia sp. (Castillo et al. 1994)], on the eggs of some Dioctriinae—Ethchodopini [*Euioctria tibialis* (Fig. 14)] and on the eggs of some Trigonomininae [*Holcocephala abdominalis* (Fig. 16), *H. calva* (Fig. 13)]. Conversely, the eggs of the Leptogastriines [*Psilonyx annulatus* (Fig. 10), *Leptogaster flavipes* and *Tipulogaster badius* (Table 2)] are smooth, lacking any surface rings.

In this connection it is of interest to look at the phylogeny of the subfamilies of Asilidae, as portrayed by various authors. Hull (1962) considered that the Asilinae and Ommatinae were the oldest with the Dasypogoninae (including the Stenopogoninae) being the youngest; whereas Lehr (1969) considered Dasypogoninae/Atomosiinae/Ommatinae to be the oldest with Laphriinae and Megapodinae being the youngest. More recently, Papavero (1973) and Artigas and Papavero (1988) placed the Atomosiinae at the tribal rank (Atomosiini) in the Laphriinae and proposed that Ommatinae, Apocleinae, Laphriinae and Laphystiinae were the youngest subfamilies, having been derived from the ancestor of the Asilinae, with the Leptogastriinae as an outgroup. However, Lehr (1991) maintained that Atomosiinae is a subfamily and suggests that it is the “most archaic group in the family” whereas Dasypogoninae/Trigonomininae and Stichopogoninae/Stenopogoninae evolved about the same time as the Asilinae. It is therefore not surprising to find polygon exochorionic patterns occurring in only some Asilinae if the Laphriinae are indeed derived from the ancestor of Asilinae. The question is why did they disappear in some Asilinae species. It will be of considerable interest to look for exochorionic patterns on Dasypogoninae and Stichopogoninae/Stenopogoninae eggs.

Many asilids are forest-edge species whereas few occur deep in forests. Species concentrated in this narrow, moist ecotone are subjected to intense competition for larval and adult food, developmental sites and predation from vertebrates that occupy or traverse this ecological zone. Further, most Asilinae+Apocleinae+Dasypogoninae and Stichopogoninae/Stenopogoninae species occupy a much wider ecotone, e.g. open grassy areas near forests, grasslands, savannas, and deserts-dunes. Here species possibly exploit a broader, seasonally abundant food while reducing competition for developmental sites and larval food by dispersing eggs over wider areas. Further, vertebrate predators are likely less abundant and more widely dispersed which would reduce interactions between predators and larval and adult populations, e.g. reduce losses.

Asilid egg chorions are either thin-walled, smooth externally, and without aeropyles or thick-walled, sculptured externally, and with aeropyles. Each type can be associated with physiographic conditions of the environment, ovipositor type, and oviposition behavior. The transition from forest-edge to arid conditions ranges from moist to extremely dry, the deserts and sandy dunes being quite harsh. The forest-edge species have simple ovipositors and behaviorally drop their eggs at random [some Laphriinae being exceptions in that they drop eggs on or in cavities of decaying trees stumps and logs]. Eggs deposited in this manner are frequently, but temporally, inundated with water. Sculptured chorions with aeropyles trap gas bubbles on their surfaces that facilitates gas exchange [plastron respiration, e.g. the Laphriinae, Ommatinae, Dioctriinae—Ethchodopini *Euioctria tibialis* and the eggs of some Trigonomininae such as *Holcocephala abdominalis* and *H. calva*]. Additionally, North American *Dioctria* [including *D. baumbaueri* which presumably has been introduced from Europe], *Eudioctria*, and some Oriental *Damalis* species (Scarborough, unpublished data) have hexagon
chorionic rings readily visible with light microscopy.

A second group has smooth chorions without aeropyles, e.g. Leptogastrinae, some Asilinae + Apoecilinae + Dasyopogoninae and Stichopogoninae/ Stenopogoninae. Species of Leptogastrinae also drop their eggs at random (Dennis and Lavigne 1976), whereas those remaining groups have more selective oviposition habits. Interestingly, the latter (Martin 1968) are found within the grass zone of forest-edges in eastern North America and scrub vegetation in the Caribbean Islands (Scarbrough, unpublished data) and in open grassland in western N. A. (Lavigne, unpublished data). Bybee et al. (2004), based on a molecular study, suggest that Leptogastrines are basal to all other asilid subfamilies.

Those asilids that have adapted to drier habitats also have thin-walled eggs with smooth surfaces and specialized behaviors and/or ovipositors. The latter have spines for digging and placing eggs in the soil or flattened ovipositors for inserting eggs into plant tissues or behind plant parts. Sand grains readily adhere to the chorions of Proctacanthus and Ospriceros (Dennis and Lavigne 1975) when excavated, suggesting a sticky material is present. Many grassland and desert Mallophora, Megaphorus and Promachus (Apoecilinae) females deposit their eggs on desert scrub, then cover them with a frothy material which hardens and protects them from desiccation. Thus, the thin-walled chorion in certain Asilinae, Apoecilinae, Dasyopogoninae and Stichopogoninae/ Stenopogoninae is derived, being adaptive in these environments because they are secondarily surrounded by moisture barriers (soil, plant, froth). Presumably, hatching here is delayed by the embryo entering dormancy, only to emerge during the rainy season. Alternatively, a thin-walled, smooth choronic surface is pleiomorphic, with the Leptogastrine being the archaic group. The thick-shelled egg with an ornamented surface of 'forest' species would then be a derived character state.

Though factors influencing hatching of asilid eggs have yet to be studied, some environmental factors have been determined for lower Diptera, especially Aedes mosquitoes (Livdahl and Koenee koop 1985, Roberts 2001). Mature larvae hatch only when inundated with water in combination with rapid decreasing/increasing [oxygen and carbon dioxide] gas pressures. Thus, a critical change in gas pressures is probably a significant factor in hatching of eggs. Possibly asilid larvae in eggs, as well as pupae, respond similarly to changes in gas pressures when temporarily submerged by water and may also explain the sudden emergence of adults in desert environments following the onset of the rainy season.

These results suggest that egg morphology may be useful to elucidate taxonomic and possibly phylogenetic relationships among asilids. The eggs of asilids may have a smooth or sculptured chorion. The specific pattern on the surface of egg chorions are imprints of the ovarian folliclar cells which produce it (Chapman 1971). Significant differences in egg morphology of Palaearctic Dioctria flavipennis and Nearctic Eu dioc tria tibialis, two related genera, are evident, especially in the oval and polygon patterns on the exochorion, the presence or absence of an eclosion line, construction of the ridges, presence or absence of interridge processes, and the distribution, abundance, and the structural configuration of aeropyles. Similarly, conspecific choronic differences are also evident on the eggs of Holoccephala abdominalis and H. calva, several Laphria species, and those of Cerotainia albipilosa and Atomosia puella. Further studies on egg morphology of other species of Dioctria are anticipated and we hope those data will lend themselves to taxonomic separation of Dioctria species.

ACKNOWLEDGMENTS

We thank Dr. Candan Ozogul for her skilled technical assistance on the TEM at
Figs. 28–33. SEM micrographs of the micropylar area with a single micropyle on eggs of six asilid species from the mid-Atlantic region of North America. 28. *Atomostia puella*. 29. *Laphria virginica*. 30. *Holcocephala abdominalis* showing floral-like micropylar region, sperm flagellum, and distribution of minute aeropyles. 31. *Holcocephala calva* showing minute aeropyles scattered around the micropyle. 32. *Endioctria tibialis* showing several minute aeropyles above the micropyle. 33. *Laphria flavicollis* showing low ridges surrounding the micropyle.

Gazi University. We also thank Kirikkale University and Towson University for the use of SEM facilities. The work at Gazi University and Towson University was supported by Research Grant 05/99-11 and by Faculty Research Grants, respectively. We, also, express our grateful appreciation to AS for sharing his unpublished data on the chorionic structure of eggs of asilids occurring in the mid-Atlantic region of North
America. We also thank two anonymous reviewers for providing valuable comments on the manuscript.

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Martin, C. H. 1968. The new family Leptogastridae (the grass flies) compared with the Asilidae (Rob-


A NEW SPECIES OF PSEPHENOTARSIS ARCE-PÉREZ (COLEOPTERA: BYRRHOIDEA: PSEPHENIDAE) FROM GUATEMALA

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Abstract.—Psephenotarsis shepardi, new species, is described and illustrated from specimens collected in Purulha (1798 m), Baja Verapaz State, Guatemala. Psephenotarsis shepardi can be distinguished from Psephenotarsis triangularis Arce-Pérez, by the following characteristics: total body length, antenna type and length; pronotal carina; type and disposition of elytral vestiture; and length and shape of the male genital structure.

Resumen.—Psephenotarsis shepardi nueva especie es descrita e ilustrada con especímenes colectados en Purulha (1798 m) estado de Baja Verapaz, Guatemala. Psephenotarsis shepardi puede diferenciarse de Psephenotarsis triangularis por la siguiente combinación caracteres: longitud total del cuerpo; tipo y longitud de las antenas; la carina pronotal; tipo y disposición de la vestidura elítral; longitud y forma de la estructura genital del macho.

Key Words: Psephenidae, Psepheninae, Psephenotarsis, new species, Guatemala

The family Psephenidae is represented in Central America by three genera and five species, two of which are known from Guatemala: Dicranopselaphus venosus Champion, 1897, from a town called Zapote, and Psephenops grouvelli Champion, 1913, from Lanquin, Alta Verapaz (Arce-Pérez and Shepard 2001). The genus Psephenotarsis Arce-Pérez has been known from a single species, P. triangularis Arce-Pérez, occurring in Mexico (Arce-Pérez and Novelo-Gutiérrez 2001). A second species is herein described from four specimens from Guatemala, the first record of the genus from Central America.

Psephenotarsis shepardi Arce-Pérez, new species
(Figs. 1-3)

Holotype male.—Body oval, elongate, and depressed; integument reddish black, dorsally completely covered with dense vestiture of short and long reddish yellow setae with golden highlights; ventrally with dense vestiture of only long setae with same color. Head, pronotum, and scutellum black; antenna and elytra reddish black, elytra without striae, with light yellow marking in mid basal region; legs with reddish black coxae, tibiae, and tarsi; trochanters and femora reddish yellow, covered with vestiture of long reddish-yellow setae with golden highlights; total length 4.45 mm, maximum humeral width 1.85 mm.

Head: Black, short, transverse; eyes spherical, very prominent, dark reddish, with postocular area yellow; clypeus sub-rectangular, wider than long, declivous at an angle of less than 90 degrees from plane of frons, distal margin widely emarginate; labrum like clypeus but shorter; fronto clypeal surface with long, robust, stiff setae; an-
tenna long, filiform, 11-segmented, reaching apex of scutellum; scape and pedicel yellowish, 9 flagellar segments reddish black; scape larger than all other segments, slightly curved, pedicel half as long as scape, covered with short reddish setae; maxillary palp 4-segmented, slightly longer than first three antennomeres combined; three basal palpomeres subcylindric, first one shortest, second one three times longer than first one and wider, third palpomere 0.75 as long as second but wider, fourth one 0.80 shorter than second but stouter and acuminate, laterally compressed and truncate at apex, all palpomeres dark reddish and covered with dark reddish setae; labial palp small, 3-segmented, extending beyond basal margin of second maxillary palpomere; basal two labial palpomeres subcylindric, larger than subspherical third one, all of them dark reddish with reddish setae.

Thorax: Pronotum subtrapezoidal (basal width 1.65 mm, apical width 0.70 mm), wider than long (width 1.65 mm, apical length 0.90 mm), its anterior margin arcuate, posterior margin bisinuate and slightly narrower than elytral base, lateral margins straight and convergent at anterior half, then suddenly expanding at posterior half, posterolateral angles rounded, ending with a acute apex; with a longitudinal carina weakly developed at distal half, with wide, shallow, long depression at each side of carina; in lateral view, pronotal disc (except for posterolateral expansions) convex; prosternum short, neither raised nor carinate at its mid basal portion, prosternal process long, parallel-sided at middle, then gradually diverging to form a lanceolate apex, with a weak longitudinal carina on its apex, which reaches anterior half of mesosternum. Mesonotum with scutellum short, triangular, its apex rounded. Elytra 3.1 mm long (from base to apex of internal suture), 1.85 mm wide (measured over calla humeralis), surface without striae; gradually widening caudad, reaching its maximum width at middle, then narrowing toward apex, not covering abdomen entirely, lateral margins expanded; mesosternum short, clearly grooved for reception of prosternal process. Metasternum bulky with longitudinal, shallow, wide groove at middle that ends in a semi-triangular cavity between metacoxae.

Legs: Procoxa conical-transverse, mesocoxa conical-transverse, metacoxa completely transverse; trochanters long and subtriangular; femora ovate and robust, with dark yellowish setae; tibiae slender; protibia with distinct apical posterolateral denticle, metatibia as long as femur; tarsi 5-segmented, the first four short and notably triangular shaped, flattened and widely emarginate at apex, beset with short reddish setae, tarsomeres 1 and 2 slightly lobed ventrally, with spongy vestiture; setae on first tarsomere reaching basal half of second, setae on second tarsomere extending to base of fourth segment; fifth tarsomere longest, slightly longer than all preceding ones together (0.34 mm compared to 0.24 mm), subcylindrical and smooth, tarsomere proportions 0.10, 0.18, 0.06, 0.07, 0.34 mm; with claws entire, long, curved, without denticles or accessory membranes.

Abdomen: Vestiture long, fine, and dense, reddish yellow with golden highlights. Seven sterna visible, usually segment 6 hidden under segment 5. Sternum 2 largest. Posterior margins of sterna 1 and 2 slightly sinuate at middle. Sterna 6 and 7 reddish yellow; sternum 6 short, posterior margin widely concave; sternum 7 very short and oval. Pygidium oval, convex, with long dark reddish setae.

Genitalia: Short, wide, subrectangular, trilobate, total length 0.60 mm. Paramere slightly shorter than median lobe, robust; in dorsal view (Fig. 1) its basal half subrectangular with internal margin in close contact with that of other paramere, its apical half parsimoniously narrow at 0.80 of paramere’s length ending in a apex rounded; its internal margin straight; length 0.30 mm; in ventral and ventrolateral view (Fig. 2–3) wide, curved and with a small tooth in internal margin near apex; a translucent mem-
brane at lateroapical part. Median lobe long, fingerlike, membranous (Fig. 2), length 0.32 mm, bearing a longitudinal sub-triangular sclerite along base which measures 0.20 in length; ventrolateral view with truncated apex (Fig. 3); dorsal area of phallobase concave (Fig. 1); ventral portion very bulky, subrectangular; length 0.28 mm, width 0.18 mm (Fig. 2).

Female.—Unknown (females of this group appear to be less frequently collected).

Variation in paratype series.—Two specimens have clear elytra, so that the yellow marking is less intense; another specimen has reddish-gray ventral integument. Measurements: total body length 4.35-4.45 mm; maximum humeral width 1.75-1.85 mm; pronotum length 0.80-0.90 mm, basal width 1.50-1.65 mm; elytral length 3.00-3.10 mm.

Discussion.—Psephenotarsis shepardi is similar to Psephenotarsis triangularis, but the two are distinguishable by the following combination of characteristics (those of P. triangularis in parentheses): Total length 4.35-4.45 mm (4.20 mm), maximum humeral width 1.75-1.85 mm (2.05 mm); antennae filiform, reaching scutellum apex (moniliform, not reaching scutellum apex); pronotum with longitudinal carina weakly developed (pronotum without carina); pronotum with posterolateral angles rounded, ending in an acute apex (posterolateral angles obtuse); elytra completely covered with dense vestiture of short and long reddish-yellow setae (elytra beset with four longitudinal bands of short and long reddish-yellow setae); paramere with apical half parsimoniously narrowing (Fig. 1) (paramere with apical half abruptly and markedly narrowing (Fig. 4)); paramere with small tooth in the internal margin near apex (Fig. 3) (paramere without tooth (Fig. 6)); paramere with internal margin straight (Fig. 1) (paramere with internal margin sigmoid (Fig. 4)); median lobe long, fingerlike, membranous (Fig. 2) (median lobe long, subcylindrical, sclerotized (Fig. 5)).

Type material.—Holotype ♂ labeled: GUATEMALA, Baja Verapaz, 0.3 km sur de Purulha, stream at the bridge on Hwy 14, 1798 m, 14-VII-2001, W. Shepard col. Paratypes: same data as holotype (3 ♀♂). Holotype and one paratype deposited in Essig Museum of Entomology, University of California, Berkeley, USA; two paratypes deposited in Coleccion Entomológica (IEKA), Instituto de Ecologia, A.C., Xalapa, Veracruz, México.

Etymology.—It is with pleasure that I dedicate this species to Dr. William D. Shepard, who kindly provided the specimens that support this work.

Habitat.—In the stream, the water was cool and ran over a substrate of sand, gravel and rocks. The current was slow to moderate in speed. There were a few submerged leaves on the rocks. Associated taxa included: Anchytarsis palpalis Champion, Macrelmis sp., Heterelmis sp., and Neoelmis sp.

ACKNOWLEDGMENTS

Thanks are due to Dr. William D. Shepard (California, USA) and Biól. Leonardo Delgado (Xalapa, México) for their invaluable criticism of the final manuscript as well as for the English corrections. Finally I thank J. A. Gómez-Anaya for the illustrations.

LITERATURE CITED

CORDULEGASTER TALARIA, N. SP. (ODONATA: CORDULEGASTRIDAE) FROM WEST-CENTRAL ARKANSAS

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Abstract.—A new species of Cordulegastridae, Cordulegaster talaria, is described from specimens collected in the Ouachita Mountains in western Arkansas. The new species is related to C. bilineata (Carle) and C. diastatops (Selys). The ventral teeth of the male cerci are separated by a larger gap in C. talaria (0.77–0.89 mm) than in the other species (0.52–0.73 mm). The anterolateral yellow mark on abdominal segment 4 is elongate and extends to the anterior margin whereas in C. diastatops it usually does not reach the anterior margin and in C. bilineata it is abbreviated to absent.

Key Words: Odonata, Cordulegastridae, new species, Arkansas

While searching for Odonata in the Ouachita Mountains of western Arkansas in 1990, I collected a relatively small black and yellow cordulegastrid that I could not positively identify in the field. The color pattern was reminiscent of C. diastatops (Selys), a species that ranges from northeastern Canada south to Virginia and west to Illinois and Wisconsin. Subsequent examination with a microscope and comparisons with known species convinced me that the specimens represented an undescribed species. The discovery was surprising as this family of large dragonflies is well studied.

Lohmann (1992) resurrected Zoraena Kirby 1890 for C. bilineata (Carle) and C. diastatops and erected a new genus, Arche-gaster, for C. sayi Selys. He also erected a new subfamily, Zoraeninae, for this species group. Prior to Lohmann, Carle (1983), in describing C. bilineata, had resurrected the generic name Zoraena for these species (bilineata, diastatops and sayi). Many of the distinctions used by the above authors to split Cordulegaster into various genera appear to be characters of degree (e.g., mid-dorsal carinae of abdomen slightly more developed) or are intermediate character states. Needham et al. (2000) opted for the more traditional, conservative usage and placed all North American species in Cordulegaster, with which I concur. The four species, bilineata, diastatops, sayi and talaria, are obviously closely related and for convenience can be referred to as the diastatops group.

Specimens of the new species I collected were dried in acetone and stored in cellophane envelopes. Wing vein terminology and other morphological terms follow Needham et al. (2000). Illustrations were made with aid of a camera lucida and measurements were made using an ocular micrometer on a Wild M-8 Stereomicroscope.

Cordulegaster talaria Tennessen, new species
(Figs. 1–6, 12, 14)

Specimens examined.—Holotype ♂: ARKANSAS, Montgomery County, first-order tributary of Caddo River, Caddo Gap, N34.389° W93.626°, 28 May 1990, K. J. Tennessen; allotype ♀: same locality as ho-

Holotype. 26 May 1990: both deposited in Florida State Collection of Arthropods, Gainesville, Florida (FSCA). Paratypes (15 ♂, 4 ♀): ARKANSAS, Montgomery County, same locality. 28 May 1990, 2 ♂, K. J. Tennessen (FSCA); 3 ♂, J. J. Daigle (JJD, Tallahassee, Florida); 1 ♀, 29 May 1990, J. J. Daigle (JJD); 17 May 1992, 4 ♂, 2 ♀, K. J. Tennessen (1♂ 1♀ in National Museum of Natural History, Smithsonian Institution, 3♂ 1♀ in FSCA); 23 May 1992, 2♂, T. E. Vogt (TEV, Hillsboro, Illinois);

Etymology.—From talaria (Latin) liberally translated meaning “wings about the ankles,” referring to the habit of males flying low over the shallow water of small seeps in search of females.

Holotype.—Head: Eyes green in life. Labium, maxilla, base of mandible tan white; apical half of mandible dark brown, teeth black; labrum bone white, anterior margin brown; anteclypeus mostly black brown except green tan laterally; postclypeus bone white with slight yellow green cast, except lower margin black brown; antefrons same color as postclypeus; antenna and vertex dark brown to black; occiput bone white, crest black with thick fringe of long black setae; postocular border with black stripe 0.2 mm wide; rear of head off-white. Gap between compound eyes 0.28 mm.

Thorax: Prothorax brown; ground color of pterothorax dark brown; dorsal carina black; yellow, tear-drop shaped dorsal stripe on each side of dorsal carina (Fig. 1) with slight bluish cast, maximum width (1.35 mm at upper end) 0.4 its length; anterior ends of these stripes 0.5 mm from collar; mesinfraepisternum brown with elongate black spot in center and dull yellow spot ventrally; two lateral yellow stripes, maximum width of mesepimeral stripe less than maximum width of metepimeral stripe (1.23 mm vs. 1.48 mm; Fig. 2). Wing veins black to brown, except anterior edge of costa yellow; pterostigma dark brown.

Abdomen: Ground color black to black brown with conspicuous yellow markings as follows: segments (AbS) 2 and 3 with dorsolateral stripes full length of segment; AbS 4 with anterior dorsolateral rectangular markings each followed by an elongate triangle; AbS 5 and 6 with small circle anterior to shorter, almost trapezoidal, triangle; AbS 7 with larger circular spot anterior to larger triangle; AbS 8 with roughly triangular dorsolateral spots not as acute at tips as triangles on preceding segments; AbS 9 with very small, anterolateral yellow spots; AbS 10 black dorsally (Fig. 3). Cercus dark brown, 1.61 mm long, with two ventral teeth and an apical, ventromesally directed flat lobe (Fig. 4); epiproct light brown dorsally, tips black dorsally with 2 small black teeth, apical margin slightly sinuate (Fig. 5), 1.87 mm wide (maximum width at tips, measured in ventral view). Ratio of epiproct width to cercus length 1.16.

Measurements (mm): Total length 62, abdomen length 47, hind wing length 39.5, pterostigma (h.w.) 3.94, hind femur length 6.5.

Allotype.—Head: Similar to holotype, except labrum pale yellow, postclypeus and antefrons off-yellow with greenish cast lat-
Fig. 9. *Cordulegaster diastatops* group, male epiproct width (mm) vs. metepimeral yellow stripe width (mm). Open circle (○) = *C. bilineata*, solid circle (●) = *C. diastatops*, plus sign (+) = *C. sayi*, open diamond (◊) = *C. talaria*, half-filled circle (⊙) = intermediate between *bilineata* and *diastatops*.

Generally. Gap between compound eyes 0.48 mm. *Thorax*: Similar in color pattern to holotype; metepimeral yellow stripe 1.64 mm wide. *Abdomen*: Color pattern similar to holotype male, except yellow triangle on AbS 8 abbreviated and AbS 9 without yellow markings. Cercus length 0.91 mm. Tip of ovipositor extends about 1.1 mm beyond posterior margin of paraprocts. *Measurements* (mm): Total length 67, abdomen length 51, hind wing length 42, pterostigma (h.w.) 4.18, hind femur length 7.0, ovipositor 4.0.

I have collected and reared larvae of *C. talaria*, the description of which will appear in a future paper.

Variation in paratypes.—Two paratype males and one female have definite yellow markings on the metepisternum between the large lateral yellow stripes and above the second thoracic spiracle. Maximum width of metepimeral yellow stripes ranged from 1.44–1.68 mm in the male and 1.64–1.80 mm in the female. In 3 males, the anterolateral elongate yellow markings on AbS 4 were narrower than in the holotype and did not reach the anterior margin of the segment. The anterolateral spots on AbS 5 were more elongate than in the holotype in 3 males and were reduced or wanting on AbS 6 in 4 males; the spots on AbS 5–7 in the female varied in length from shorter to longer than in the allotype. The midlateral yellow spots on AbS 8 were usually sepa-
rated as in the holotype, but were contiguous middorsally in 2 males. Cercus length ranged from 1.55 to 1.73 mm in the male, 0.95 to 1.09 mm in the female. The apical third of the male cerci varied slightly in ventrolateral view, from not as lobate to slightly more lobate than the holotype. The ratio of maximum distal epiproct width to cercus length (measured dorsally) ranged from 1.28 to 1.42 (mean 1.36). The ovispositor length ranged from 3.70 to 3.95 mm in the paratypes vs. 4.00 mm in the holotype. Antenodal crossveins in f.w. of male varied from 15–21, in h.w. 12–16; postnodals 10–18 in f.w., 11–17 in h.w. Antenodal crossveins in f.w. of female varied from 17–22, in h.w. 13–16; postnodals 13–18 in f.w., 15–18 in h.w.

Range in measurements (mm): Male, total length 59.0–65.0, abdomen length 44.0–50.0, hind wing length 37.0–39.5, pterostigma length (h.w.) 3.53–4.02, epiproct width 1.69–1.91. Female, total length 64.5–67.0, abdomen length 49.0–52.0, hind wing length 42.0–43.0, pterostigma length (h.w.) 3.77–4.18.

Diagnosis.—The distance, or gap, between the tips of the ventral cercal teeth of *C. talaria* males will separate them from the other three species in the *diastatops* group; this gap is greatest in *C. talaria* and does not overlap that of any of the other species (Table 1). I found no significant difference between *C. bilineata* and *C. diastatops*, whereas *C. sayi* had the smallest gap (Table 2). These species are usually distinguishable also by cercus shape. In ventrolateral view, the cercus is of uniform width with a definite lobate apex in *C. talaria* (Fig. 6), wider basally than apically and with a more tapered apex in *C. diastatops* (Fig. 7), and narrower basally than apically and with a widened, enlarged angle in *C. bilineata* (Fig. 8). Cercus shape is quite variable, however, especially in *C. bilineata* and *C. diastatops*, and these differences may not always be reliable. In epiproct distal width, *C. talaria* was significantly narrower than *C. diastatops* but was not different from *C. bilineata*. On the other hand, metepimeral yellow stripe width was significantly greater in *C. talaria* than in *C. bilineata* but not different from *C. diastatops* (Tables 1 and 2).

Pilgrim et al. (2002) found a significant difference between *C. bilineata* and *C. diastatops* in the ratio of epiproct distal width to cercus length. Calculating this ratio for specimens available to me, I obtained significant differences between *C. talaria* and the other three species (Table 2); the only species pair not yielding a signif-
icant difference was C. bilineata sayi. Another combination of characters by which to distinguish C. talaria is epiproct distal width plotted against metepimeral yellow stripe width (Fig. 9). The C. talaria cluster is close to that of C. diastatops, whereas the C. bilineata cluster overlaps the C. sayi cluster to a large degree. Several specimens from WV, OH, and MI (indicated by a half-filled circle on the graph) are difficult to assign to either the C. bilineata or C. diastatops cluster; these are dealt with further in the Discussion.

In male color pattern, C. talaria is most similar to C. diastatops. The ground color is very dark brown to black and brown, although not quite as black as in most C. diastatops. The yellow stripes and spots are a darker hue than the pale yellow markings of C. bilineata. On AbS 2, the dorsolateral yellow bands have a definite dorsomedially-directed dark yellow offshoot in C. talaria that is absent or obscured in C. bilineata and C. diastatops. On AbS 4, the anterolateral yellow marking is elongate and usually extends to the anterior margin of the segment in C. talaria. This mark is variable in C. diastatops but usually does not reach the anterior margin; in C. bilineata it is very abbreviated and triangular.

Female C. talaria differ from female C. bilineata in having wider metepimeral stripes (1.64–1.80 mm vs. 1.15–1.31 mm) and an elongate anterolateral yellow spot on AbS 4 (often 4–7) vs. a small rounded spot in C. bilineata. I did not find a consistent color pattern difference between females of C. talaria and C. diastatops. Although the ground color of C. diastatops females throughout most of its range is much darker than that of C. talaria, several C. diastatops from MI are not totally black but are rather similar in color to C. talaria. The crest of the occiput, in direct anterior view, is distinctly convex in C. diastatops (Fig. 10), slightly to distinctly convex in C. bilineata (Fig. 11), and straight to very slightly convex in C. talaria (Fig. 12); in C. sayi it is even more convex than in C. diastatops (Fig. 13).

I found another difference on the posterior surface of the occiput. In the dark groove along each side of the convex yellow medial surface there is an elongate, gray, rugulose “pad” that is short and narrow (0.84–0.88 mm × 0.14–0.16 mm) in

<table>
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<tr>
<th>Character</th>
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<th>Mean</th>
<th>Range</th>
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<tr>
<td>1) Cercus Teeth Gap</td>
<td>C. bilineata</td>
<td>77</td>
<td>0.64</td>
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<td></td>
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<td></td>
<td>C. sayi</td>
<td>40</td>
<td>0.46</td>
<td>0.36–0.52</td>
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<td>0.83</td>
<td>0.77–0.89</td>
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<td>2) Epiproct Width</td>
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<td>1.93</td>
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<td>3) Epiproct Width/Cercus Length</td>
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C. talaria (Fig. 14) versus longer and wider (1.00–1.04 mm × 0.22–0.26 mm) in C. diastatops (Fig. 15). Also, the pads diverge at a greater angle in C. diastatops. In C. bilineata, the pads are 0.90–0.94 mm long × 0.20–0.22 mm wide and are only slightly divergent dorsally (Fig. 16). To my knowledge, a description of these “postoccipital pads” has not appeared previously in the literature and their usefulness as taxonomic characters is unknown. They vary interspecifically in other Cordulegaster species, being black and nearly circular in C. erronea Hagen, tan and oval with pits near the center in C. obliqua (Say), and vestigial or absent in C. maculata Selys and C. dorsalis Hagen. It is possible that they are contacted by the ventral edge of the male cerci during tandem formation and that they act as sensory structures, although they also occur on the male occiput.

**DISCUSSION**

Taxonomy of the seven North American species of Cordulegastridae described prior to 1880 has been stable, whereas the validity of several recently described taxa is uncertain. For example, Needham et al. (2000) considered C. deserticola Cruden (1969) as a “questionably distinct subspecies” of C. dorsalis Hagen. More study is needed to determine its status. Glotzhober (1997) pointed out doubt among taxonomists concerning the validity of C. bilineata based on the presence of intermediate specimens from several central states. Pilgrim et al. (2002) combined external morphology and DNA sequencing and determined that C. bilineata is distinct from C. diastatops. Although they found one specimen from WI that appeared to be a hybrid based on genetic data, they concluded that this was not sufficient evidence to synonymize the two taxa. Eric Pilgrim (personal communication) prepared internal transcribed spacer 1 (ITS-1) sequences of rDNA from two paratype males of C. talaria and without seeing morphological data concluded it is likely a distinct species from C. bilineata and C. diastatops. His genetic data indicate that the number of differences between the four species in the diastatops group is small, and that C. talaria is likely the sister species of C. bilineata whereas C. diastatops is likely the sister species of C. sayi.

As mentioned in the Diagnosis section, some specimens in the middle of the geo-
Table 2. *P* values for characters in Table 1 Scheffe Test; asterisk denotes significance at *P* = 0.05.

<table>
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<td>sayi, talaria</td>
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graphic range of *C. bilineata* and *C. diastatops* are difficult to determine. I examined several specimens from WV to WI that have intermediate character states (Fig. 9). In a key to species, Carle (1983) gave but one morphological character to distinguish the two species: epiproct width (maximum width measured near distal end) nearly equal to cercus length in *C. bilineata* vs. epiproct width about 1.3 times as long as cercus length in *C. diastatops*. He did not quantify variation in epiproct width for either species. Pilgrim et al. (2002) found considerable variation in epiproct width of the two species, but nearly all *C. bilineata* had an epiproct width to cercus length ratio (EDW/CL) less than 1.35 whereas the ratio was greater than this critical value in nearly all *C. diastatops*. I measured cercus length laterally and obtained greater values than Pilgrim et al. (2002) who measured cercus length dorsally; therefore I obtained correspondingly smaller EDW/CL ratios. For specimens I identified positively as *C. bilineata* (i.e., light brown ground color and metepimeral stripe 0.82–1.23 mm wide, from AL, GA, IL, IN, KY, LA, NC, TN and VA), epiproct width varied from 1.57 to 1.97 mm and EDW/CL ratio from 0.87–1.16. In specimens I identified positively as *C. diastatops* (i.e., black ground color and metepimeral stripe 1.39–1.80 mm wide, from ME, MA, NH, NJ, NY, PA, VT, WV and Ontario), epiproct width varied from 1.99 to 2.24 mm and EDW/CL ratio varied from 1.12–1.40. Specimens from OH and MI with intermediate body color (very dark brown) and metepimeral stripe widths at the upper end of the *C. bilineata* range and lower end of the *diastatops* range had intermediate EDW/CL ratios (0.97–1.23). It is possible that at least some of these are hybrid individuals; further study with larger sample sizes is indicated. If *C. bilineata* and *C. diastatops* are valid species, it appears that intermediates and possibly hybrids occur from east to west where their ranges overlap.

Hybridization in the *C. diastatops* group might not be limited to *C. bilineata* and *C. diastatops*. I examined two specimens from extreme southern Alabama that are intermediate between *C. bilineata* and *C. sayi*. A male collected by R. S. Krotzer (RSK)
in Escambia County, seepage headwaters of Little Creek, ca. 40 km SW of Andalusia (N31.018° W86.842°), 22 Apr 1993, has the light brown ground color of *C. bilineata* and lacks magenta in the thoracic stripes. However, the distance between the ventral teeth of the cerci is only 0.52 mm (equal to the minimum I measured in *C. bilineata* and maximum in *C. sayi*). AbS 3–5 have yellow medial spots nearly contiguous mid-dorsally and extended ventrolaterally to the yellow ventral margin of the tergites (Fig. 18); this color pattern is more extensive than in *C. bilineata* (Fig. 17) but more constricted than in *C. sayi* (Fig. 19). On AbS 4, there is a lateroapical yellow spot (Fig. 18) which is smaller than in *C. sayi* (Fig. 19); this spot is usually lacking in *C. bilineata* (Fig. 17) although a few specimens I examined had a faint indication of it. If this male is a hybrid, it appears to be more like *C. bilineata* than *sayi*. A female collected by RSK at the same locality (19 Mar 1994) has faint magenta coloration at the edges of the lateral yellow thoracic stripes and wide, nearly complete, medial yellow rings on AbS 3–6 (middorsal carina light brown) and complete apical yellow rings on AbS 3–5. This combination of markings is less developed than in *C. sayi* yet much more developed than in *C. bilineata*, which has the medial yellow spots on AbS 3–6 roughly triangular and distinctly separated mid-dorsally, and the lateroapical spots on AbS 3 small and widely separated (these spots are usually absent on AbS 4–6). Therefore, if this female is a hybrid, it appears to be more like *C. sayi* than *C. bilineata* (*C. sayi* has not been recorded in Alabama previously, although a population occurs in Santa Rosa County, Florida, approximately 15 km south of Little Creek where RSK collected the possible hybrids). The two specimens collected in southern Alabama indicate further hybridization in this closely related species complex, but I doubt anyone would suggest synonymizing *C. bilineata* and *C. sayi*. If these species occasionally interbreed, it casts further doubt that *Arche-gaster* (Lohmann 1992) is a valid genus.

The first-order tributary where most of the *C. talaria* specimens were collected originates at the base of a wooded hill approximately 150 m from the Caddo River. The head of the seep branches from a densely shaded area, forming a small stream about 25–40 cm wide which runs through open pasture for most of its length before entering the wooded bank of the river. The dominant aquatic macrophyte in the open part of the stream was water starwort (*Callitriche heterophylla*). The shady seep comprises a small area, approximately 50 m², and is only 2.5–10 cm deep, with a substrate of organic ooze, mud, and dead sticks partly covered with moss. The future integrity of the seep is questionable. Cattle graze the pasture along the first-order stream and adjacent to the seep, although they apparently do not enter the actual seep probably because of the density of brush. If the brush were cleared from the seep, the habitat may become unsuitable for *Cordulegaster*. On two occasions, I saw deep tire tracks from an off-road vehicle in the mud at the edge of the seep.

Males of *C. talaria* perched on sticks along the open part of the tributary, occasionally flying upstream into the shaded seep, usually within 7.5–20 cm of the water surface. Their flight appeared very purposeful, often interrupted by short hovering bouts, then continuing for a meter or more. The latest I saw males active was about 1800h CDT. I observed females oviposit in mid- to late-afternoon, but only in the shaded seepage area. They were unobtrusive, dipping straight down (with head directed upward in rather typical *Cordulegaster* fashion) about once a second to “stab” eggs in mud and moss, both in shallow water and above the waterline. One female made these oviposition movements into moss growing on a woody root about 8 cm above the water.

The dragonfly fauna of the Ozark Plateau in the south-central United States contains
several endemic species, viz. *Somatochlorda ozarkensis* Bird, *Gomphus ozarkensis* Westfall, and *Ophiogomphus westfalli* Cook & Daigle. It is very probable that *Cordulegaster talaria* is also endemic to this region. Two species of Cordulegastridae have been recorded previously for Arkansas, *Cordulegaster maculata* Selys and *C. obliqua* (Say) (Harp and Rickett 1977, 1985). I found larvae of one other species of Odonata in the seep, namely *Libellula flavida* Rambur. Several *Cordulegaster obliqua* females were seen in the pasture along the Caddo River, and one male was collected at the seep. Although I found larvae of *C. talaria* in the seep, I did not find larvae of *C. obliqua* there. Other Anisoptera present in the openings and pastures surrounding the seep were *Tachopteryx thoreyi* (Hagen), *Gomphus graslinellus* Walsh, *Gomphus ozarkensis*, *Ophiogomphus westfalli*, *Didymoptra transversa* (Say), *Macromia pacifica* Hagen, *Epitheca costalis* (Selys), *Epitheca cynosura* (Say), *Neurocordulia xanthosoma* (Williamson), *Libellula semifasciata* Burmeister and *Plathemis lydia* Drury. Although I did not find larvae of *T. thoreyi* in the seep, adults were active nearby and larvae probably occur at the edges of the seep. Two Zygoptera, *Hetaerina americana* (Fabricius) and *Enallagma divagans* Selys, were seen in vicinity of the seep. The majority of the other species do not inhabit the seep but rather the Caddo River or nearby ditches and wetlands.

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**LITERATURE CITED**


A NEW SPECIES OF ZEALEUCTRA RICKER (PLECOPTERA: LEUCTRIDAE) AND CONFIRMATION OF HYDROPERLA FUGITANS (NEEDHAM AND CLAASSEN) (PLECOPTERA: PERLODIDAE) FROM TEXAS

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Abstract.—A new species of stonefly, Zealeuctra stewarti, is described from Real Co. and Bandera Co., Texas, U.S.A. The male of Z. stewarti is distinguished from all other species by a single, long, slender curved epiproctal spine. We also confirm the occurrence of Hydroperla fugitans (Needham and Claassen) from Texas.

Key Words: U.S.A., Texas, stonefly, Leuctridae, Perlodidae, Zealeuctra, Hydroperla

Currently, eight species of the Nearctic genus Zealeuctra Ricker are known from the central United States ranging from Wisconsin to Texas and east to West Virginia (Stark 2001). Adults of this genus emerge from October to April (Ricker and Ross 1969, Stark and Stewart 1973, Poulton and Stewart 1991) and are often associated with low order intermittent streams. Szczytko and Stewart (1977) reported three species of Zealeuctra from Texas, Z. arnoldi Ricker and Ross, Z. claasseni (Frison), and Z. hitei Ricker and Ross. Both Z. arnoldi and Z. hitei are considered endemic to the Edwards Plateau and surrounding areas west of the Blackland Prairie of Texas. A collection of stoneflies submitted to the authors for identification from Texas A&M University included an additional species from Real County. Additional material was recently collected by the authors. The description follows the style of Stark and Stewart (1973).

Zealeuctra stewarti Kondratieff and Zuellig, new species (Figs. 1–3)

Male.—Forewing length 7.0–7.2 mm; body length 5.0–5.5 mm. General body color or brown. Cleft of ninth tergum sclerotized around margins with posterior small rounded teeth, broadly U-shaped anteriorly (Fig. 1). Epiproct with a single, long, slender, curved spine (Figs. 1 and 2). Cerci sclerotized, with an apical dorsal inner lobe and a dorsal ridge, ventral margin with long hairs (Fig. 2). Length of vesicle 1.5× width.

Female.—Forewing length 8.0–8.5 mm; body length 7.0–7.5 mm. Sternum 7 produced and strongly sclerotized at posterior margin and slightly notched (Fig. 3).

Nymph.—Unknown.

Types.—Holotype ♂, and 1 ♀ and 2 ♀ paratypes, TEXAS, Real County, 5.2 mi east of Leakey, April 14, 1985, J. C. Schaffner; Bandera Co., Elam Creek, Farm Road 337 East of Tuff, 511 m, N29°46’58” W099°22’58”, 3 April 2004, B. Kondratieff and R. Zuellig, 1 ♀ (CSUC); Real Co., Little Dry Frio, Farm Road 337, East of Leakey, 545 m, N29°43’17” W099°40’26”, 4 ♀, 6 ♀ (CSCU, BYUC, USNM). The holotype is deposited in the Texas A&M University insect collection. Paratypes are deposited in the C. P. Gillette Museum of Arthropod Diversity, Colorado State University (CSUC), and in the Monte L. Bean Life Science Museum,
Brigham Young University, Provo, Utah (BYUC), and the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). The stream was not indicated on the collection label of the holotype, but the type locality is the Little Dry Frio.

Etymology.—The patronym honors Dr. Kenneth W. Stewart, University of North Texas, for his numerous substantial contributions to Plecopteroology and his studies of Texas aquatic insects.

Diagnosis.—The male of Z. stewarti can be easily distinguished from all other species of Zealeuctra by the single long, slender, and gently curved spine of the epiproct (Figs. 1–2). The U-shaped cleft of the 9th tergum is similar to Z. arnoldi, Z. fraxina Ricker and Ross, and Z. warreni Ricker and Ross, but males of these species have an epiproct with two spines or a small cusp. Males of Z. cherokee Stark and Stewart and Z. wachita Ricker and Ross, also have the 9th tergum with a U-shaped cleft, but the epiproctal spine is short and thick in both species (Stark and Stewart 1973, fig. 2; Poulton and Stewart 1991, fig. 121). The male of Z. stewarti appears to be most similar in the structure of the epiproct and cerci to Z. wachita, a species originally described from a single female by Ricker and Ross (1969) from Polk Co., Arkansas. In 1991, Poulton and Stewart associated the male of Z. wachita with the female and provided a description. This species is a regional endemic to the Ouachita Mountains of Arkansas (Poulton and Stewart 1991). Among the three other reported Texas species, males of Z. stewarti are most similar in general habitus to Z. arnoldi, but are easily distinguished by the single long, slender, and gently curved epiproctal spine. The produced 7th sternum of the female of Z. stewarti appears similar to Z. warreni, but the slight medial notch of the 7th sternum (Fig. 3) distinguishes the former species.

Remarks.—The type locality, Little Dry Frio and Elam Creek, is located within the southern reaches of the Edwards Plateau of Texas. A survey of the Little Dry Frio and surrounding streams by the authors seems to indicate that this species may be restricted to a small area of the Texas Hill Country in Real and Bandera counties. Only Z. arnoldi occurred in other streams in the surrounding Bandera, Kerr, and Uvalde counties.

Confirmation of Hydroperla fugitans (Needham and Claassen) from Texas

Szczytko and Stewart (1977) indicated that the only specimen of Hydroperla fugitans (Needham and Claassen) known from Texas, the holotype, apparently collected from Austin (Travis Co.) was lost. In 1998, a population of H. fugitans was discovered at the Canadian River north of Amarillo, Texas. Much of the river in this region becomes dry or intermittent during summer and fall. The substrate is mostly shifting red sand at the Tascosa site, with a sparse riparian zone of tamarisk and cottonwood. On every visit listed below, the river was running red, with water depth 20–30 cm deep in riffle areas.


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LITERATURE CITED


MAIPOMYIA (DIPTERA: DOLICHOPODIDAE), A NEW GENUS FROM CHILE

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Abstract.—Maipomyia Bickel (Diptera: Dolichopodidae) is newly described from the Central Valley of Chile, and comprises two new species, M. insolita Bickel and M. velata Bickel. Although the genus shares many characters with the subfamily Medeterinae, especially a depressed posterior mesonotum, concave dorsal postcranium, and a life stance on vertical surfaces, other character states suggest it is more isolated. In particular, it has a highly reduced male postabdomen and distinct anterior preapical setae on femora II and III, characters that are not congruent with the traditional concept of the Medeterinae.

Key Words: Diptera, Dolichopodidae, Medeterinae, Chile

The Chilean Dolichopodidae are best known from the southern Valdivian forests (e.g., Van Duze 1930, Parent 1932), while the faunas of the central Mediterranean and northern arid regions, by comparison, have been little studied. This paper describes an unusual new genus, Maipomyia, based on specimens collected south of Santiago, central Chile. The genus comprises two sympatric species, taken in yellow pan traps and hand-collected off adobe walls. Although Maipomyia shares many features with the subfamily Medeterinae, it is unusual in having the hypopygium highly reduced and almost completely enclosed by the abdomen. This contrasts markedly with the characteristic pedunculate hypopygium of most Medeterinae.

Materials and Methods

This study is based largely on material I collected in Chile, with additional specimens from CAS. Repositories mentioned in this paper use the following abbreviations: (AMS)—Australian Museum, Sydney; (CAS)—California Academy of Sciences, San Francisco; (MEUC)—Luis E.

Peña Museo Entomologico, Universidad de Chile, Santiago, Chile; (USNM)—National Museum of Natural History, Smithsonian Institution, Washington, D.C.

The positions of features on elongate structures, such as leg segments, are given as a fraction of the total length, starting from the base. The CuAx ratio is the length of the m-cu crossvein/distal section CuA. The relative lengths of the podomers should be regarded as representative ratios and not measurements. The ratios for each leg are indicated in the following formula and punctuation: trochanter + femur; tibia; tarsomere 1/2/3/4/5. The following abbreviations and terms are used: I, II, III: pro-, meso-, metathoracic legs; C, coxa; T, tibia; F, femur; ac, acrostichal setae; ad, anterodorsal; av, anteroventral; dc, dorsoventral setae; dv, dorsoventral; pd, posterodorsal; pv, posteroventral.

Maipomyia Bickel, new genus

Etymology.—Maipomyia is a combination of the word “Maipo”, from Rio Maipo, a Chilean river in whose drainage all known specimens were collected, and
"myia", from the Greek meaning fly. The gender is feminine.

Type species.—*Maipomyia insolita* Bickel, new species.

Description.—Length approximately 2.0 mm; dorsal posteralum concave; face narrow; first flagellomere rounded; arista apical; posterior mesonotum distinctly flattened and slightly depressed; ac short biserialte, or absent; 5 or 6 de present; 2 proepisternal setae present above coxa I; coxa III with single strong lateral seta; femora slender; FII and FIII each with strong anterior preapical seta; TII with ad seta at $\frac{1}{4}$, pd seta at $\frac{1}{3}$, and ad setae at $\frac{1}{2}$ and $\frac{3}{4}$; veins R$_{2+3}$ and R$_{4+5}$ closely parallel, and both ending before wing apex; vein M distinctly weaker than other veins; vein M curved beyond m-cu crossvein curved, but without *bosse alaire*; male abdominal segment 7 hidden and not forming peduncle, but with well separated bandlike tergum and rounded sternum; male sternum 8 covering left lateral foramen; hypopygium (Figs 2a, d): epandrium ovate, with left lateral foramen; hypandrium not evident, but aedeagus elongate and with lateral projections as figured; surstylus very short and reduced, with some long setae; male cercus short and rounded; oviscap (Figs 2b, c) with tergum 8 forming sclerotised lateral bands which abut fused terga 9+10; terga 9+10 forming transverse band, divided into hemitergites, and with only short hairs, no strong setae or acanthophorites present; sternum 8 forming rounded ventral band.

Remarks.—*Maipomyia* comprises two species, *M. insolita* and *M. velata*. Although the genus shares many characters with the dolichopodid subfamily Medeterinae, especially a depressed posterior mesonotum, concave dorsal posteralum, and a characteristic life stance on vertical surfaces, other character states suggest it is more isolated. In particular, it has a highly reduced male postabdomen that is almost completely enclosed by the abdomen, and distinct anterior preapical setae on femora II and III, characters that contrast markedly with the characteristic large pedunculate hypopygium and bare femora of most Medeterinae.

All specimens of *Maipomyia* were collected within the drainage of the Rio Maipo in the Central Valley of Chile, near the southern margin of metropolitan Santiago. Although much of the landscape has been altered by human settlement, the slopes of the upper valley near San José de Maipo are covered with a dry cactus-thorn scrub, and Parque Nacional Rio Clarillo preserves a remnant riverine woodland vegetation.

The two included species, *Maipomyia insolita* and *M. velata*, are sympatric. They were collected together at Rio Clarillo, both in yellow water traps, and off the white adobe walls of a park building. On the walls, individuals were seen to display characteristic medeterine behavior, resting with the head upwards and moving about the surface in short quick flights, up, down and laterally. Unlike *Medetera*, which rests with the upper body leaning out, *Maipomyia* aligns its body parallel to the vertical surface. The presence of *Maipomyia* on vertical walls suggests it normally occurs on tree trunks, like many other medeterines.

*Maipomyia* (Fig. 1) can be separated from all other Dolichopodidae by the following combination of characters: posterior mesonotum strongly flattened; femora II and III with anterior preapical seta; dorsal posteralum concave; vein M distinctly weaker than other veins and gently curved beyond crossvein m-cu; male hypopygium small, not pedunculate, and enclosed by preceding abdominal segments; upper proepisternum with two pale setae.

*Maipomyia* is distinctive and I have not seen the genus in other Neotropical collections. It possibly is confined to the region of Mediterranean climate in Central Chile, and is isolated from the rest of South America by the high Andes immediately to the east, arid deserts to the north, and cool temperate Valdivian rainforests to the south.
Fig. 1. *Maipomyia insolita*, male habitus.
SYSTEMATIC POSITION OF MAIPOMYIA

What are the phylogenetic relationships of *Maipomyia*? Apart from the highly reduced male hypopygium and the anterior preapical setae on femora I and II, the genus appears to be closest to the subfamily Medeterinae. However, the limits of this subfamily are uncertain, and much more basic systematic investigation is needed before any meaningful phylogenetic analysis can be undertaken (also see Bickel 1986). However, the character states of *Maipomyia* are discussed below and related to those of the type genus, *Medetera* Fisher von Waldheim.

I. Characters shared by *Maipomyia* and *Medetera* (not necessarily derived)
1. First flagellomere subrectangular to subovate, with apical arista.
2. Dorsal postcranium concave.
3. Face width subequal in both sexes, and parallel sided or slightly converging ventrally.
4. Posterior mesonotum strongly flattened and slightly depressed.
5. Lateral scutellar setae reduced to tiny setae or absent.
6. Legs usually without strong male secondary sexual characters.
7. Leg I without major setae.
8. Vein M without *bosse alaire*, the flexion and slight wing indentation found in some dolichopodids.
9. Hypopygal foramen left lateral.

II. Characters diagnostic for *Maipomyia*
1. Proepisternum with two setae. Most Medeterinae have a bare proepisternum, except for *Systenus* Loew, which has a single proepisternal seta.
2. Femora II and III each with strong anterior preapical seta. All Medeterinae have the femora bare of anterior preapical setae, a key defining character state for the subfamily. However, anterior femoral preapical setae are widespread in other dolichopodid taxa and their presence is possibly plesiomorphic with respect to the medeterine groundplan.
3. M distinctly weaker than other veins. In most dolichopodid genera the major longitudinal veins of the wing are more or less subequal in thickness. This weak vein M is probably an autapomorphy for *Maipomyia*.
4. Male abdominal segment 7 hidden and not forming peduncle, but with well separated band-like tergum and rounded sternum (Fig. 2d). In all other Medeterinae, the hypopygial peduncle formed from segment 7 is prolonged, often greatly so, with the tergum and sternum often partially fused. The unfused non-pedunculate condition of segment 7 in *Maipomyia* is plesiomorphic with respect to most Medeterinae.
5. Hypandrium not evident and possibly fused with the epandrium. This is an autapomorphy, as the hypandrium is present in most Dolichopodidae.
6. Surstylus only very short, conforming to curvature of epandrium. This is an autapomorphy, as most Dolichopodidae have arm-like surstyli.
7. Oviscapt (Figs 2b, c) with tergum 8 forming sclerotised lateral bands which abut fused terga 9+10; terga 9+10 forming transverse band, divided medially into hemitergites, but with only short vestiture, no strong setae or acanthophorites present. This oviscapt structure is possibly unique in the family, and is an autapomorphy for the genus. Most Dolichopodidae have terga 9+10 divided into hemitergites, which bear strong setae or acanthophorites.

KEY TO SPECIES OF MAIPOMYIA
1. Ac absent; 5 strong dc present; ventralmost postorbital seta greatly prolonged and curved (Fig. 1); wing length < 2.1 mm; hypopygium (Fig. 2a) (Chile) ............... *M. insolita*
   – Ac short biseriate; 6 strong dc present; ventralmost postorbital seta not greatly prolonged;
Fig. 2. *Maipomyia insolita*. a, Hypopygium, left lateral. b. Female oviscapt, left lateral. c. Female oviscapt, dorsal. *M. velata*. d, Male postabdomen; left lateral. Legend: aed, aedeagus; cer, cercus; sur, surstylus; tg, tergum; st, sternum. Scale line = 0.1 mm.

Maipomyia insolita Bickel, new species
(Figs. 1, 2a–c)

Type material.—Holotype, ♂ Paratypes, 4 ♂, 8 ♀, CHILE: nr. San José de Maipo, 33°25’S 70°23’W, 2–3.i.1997, 1050 m, cactus/thorn scrub, yellow water traps, D. J. Bickel (Holotype, ♂, paratype ♀, deposited MEUC; 3 ♂, 7 ♀ paratypes deposited USNM).

Additional material.—CHILE: 2 ♂, 4 ♀, PN Rio Clarillo, 33°29’S 70°29’W, 2–3.i.1997, 870 m, dry riverine forest, yellow water traps, D. J. Bickel; 4 ♀, same but 2.i.1997, collected off white adobe walls (AMS).

Description.—Male: 1.8 mm; Wing: 2.0 × 0.8 mm; habitus (Fig. 1).

Head: Dorsal postcranium concave; frons black, covered with grey pruinosity; setae brown with yellowish reflections; strong vertical and ocellar setae present; face narrow and slightly converging ventrally; palp brown, ovate, with short hairs; proboscis brown; scape and pedicel yellowish, but infuscated in some specimens; first flagellomere black, rounded; arista apical, and slightly longer than head height; postorbital setae white, longer on ventral third, with ventralmost seta long and curved.

wing length > 2.2 mm; hypopygium (Fig. 2d)

(M. velata)
Thorax: Mostly black, covered with grey pruinosity; scutellum black basally with a distinct wide yellow rim; posterior mesonotum distinctly flattened and slightly depressed; setae yellowish; ac absent: 5 strong dc present which decrease in size anteriorly; 1 posterior supra-alar seta. 2 postalar setae, 1 postpronotal seta, and 2 notopleural setae; 2 proepisternal setae above coxa 1. ventral seta about twice length of dorsal; scutellum with strong median and tiny weak lateral setae; postnotum broad and slightly bulging.

Legs: CI yellow; CII and CIII yellowish with some infuscation; remainder of legs mostly yellow; with distal tarsomeres slightly infuscated: major setae yellow; CI with 6–7 lateral setae; CII with some short distolateral setae; CIII with single strong lateral seta; femora slender: I: 3.0; 2.5; 1.2/0.8/0.6/0.4/0.3; leg I without major setae: II: 3.5; 3.5; 1.4/0.8/0.6/0.4/0.3; FII with strong anterior preapical seta; TII with ad seta at 1/3 and 3/4, pd seta at 1/3, and apically with anterior, ad and ventral setae; tarsi bare; III: 3.8; 4.0; 0.7/1.2/0.6/0.5/0.3; FIII with anterior preapical seta; TIII with some dorsal setae but no major ad or pd setae, and apically with dorsal, av and ventral setae.

Wing: Hyaline and relatively broad; R4+5 and R4+5 closely parallel and both ending well before wing apex; costa weakened beyond R4+5 before ending at apex; vein M with gentle curve beyond m-cu crossvein, distinctly weaker than R4+5 and R4+5, and ending at apex; CuAx ratio: 0.8; anal vein weak; halter yellow; lower calypter yellow with fan of yellow setae.

Abdomen: Terga brown with some metallic green reflections, and covered with grey pruinosity; terga 1–5 with long yellowish marginal setae, longer laterally; terga 2–5 each with 3–4 lateral abdominal plaques: abdominal sterna 2–5 brown; tergum 6 yellow, contrasting with preceding dark brown segments; segment 7 hidden and not forming peduncle, with band-like tergum and rounded sternum; sternum 8 dark brown and covering foramen; hypopygium (Fig. 2a) dark brown with yellowish cercus; epandrium ovate, with large left lateral foramen; hypandrium not evident; aedeagus with lateral projections as figured; surstylus very short and with some long setae; cercus short and rounded, with short setae.

Female: Similar except as noted: no strong secondary sexual differences evident: podomere ratios similar; ventralmost postorbital seta also long and curved; oviscapt (Figs. 2b, c) with tergum 8 forming well-sclerotised lateral bands which abut fused terga 9+10; sternum 8 forming rounded ventral band; terga 9+10 forming transverse band, divided medially into hemitergites, but with only short hairs, no strong setae or acanthophorites present.

Remarks.—The specific epithet, insolita, is from the Latin for “isolated”, referring to the fact that Maipomyia is morphologically distinct or isolated from other dolichopod genera. For further notes, see “Remarks” under the generic discussion.

Maipomyia velata Bickel, new species
(Fig. 2d)

Type material.—Holotype, ♂. Paratypes. 2 ♀. CHILE: PN Rio Clarillo. 33°29’S 70°29’W. 2.i.1997. 870 m. dry riverine forest, collected off white adobe walls D. J. Bickel: Paratype, ♂, same but 2–3.i.1997, in yellow water traps (Holotype, ♂. Paratype ♀, deposited MEUC; ♂, ♀ paratypes deposited USNM).

Additional material.—CHILE: 2 ♂, 2 ♀. Santiago Prov., Quebrada de la Plata. 33°30’S 70°55’W. nr Malpú. 2.ii.1966. 510 m. malaise trap, M.E. Irwin (CAS).

Description.—Male: 2.2 mm; Wing: 2.3 × 0.8 mm; similar to M. insolita except as noted:

Head: Without long ventralmost postorbital seta.

Thorax: Setae yellow; ac biseriate, with 5–6 short pairs; 6 strong dc present which decrease in size anteriorly.

Legs: Color similar but coxae II and III
more yellow; setation and podomere ratios similar.

*Abdomen:* Color similar, except segment 6 brown; hypopygium (Fig. 2d); surstylus with longer setae, and with lobate dorsal projection; cercus also short and rounded, with somewhat longer setae.

*Female:* Similar to male.

Remarks.—The specific epithet, *velata*, is from the Latin for "hidden", referring to the fact I did not initially recognise it as a species distinct from *M. insolita*. For further notes, see “Remarks” under the generic discussion.

**Acknowledgments**

H. Finlay drew the figures. I thank K. Ribardo (CAS) for the loan of specimens.

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**Literature Cited**


APPLICATION OF SPECIFIC NAMES AND ASSOCIATION OF SEXES IN CADEGUALINA MICHENER (HYMENOPTERA: COLLETIDAE: DIPHAGLOSSINI)

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Abstract.—Males and females of the Andean genus Cadegualina Michener are associated for the first time from the same place, in the eastern Andes of Colombia. They are probably C. sericata (Friese), new combination, resurrected from probable synonymy under the only other species, C. andina (Friese). Cadegualina sericata is described in full, as is its variable melanism in females. A female of presumed C. andina, hitherto known only from males, is also described. Males of C. sericata can be separated from C. andina by the shape of the apical pilose lobe of sternum seven, the shape of penis valve, and the shape and pubescence of the gonostylus in the genitalia; females can be distinguished by the projecting posterodistal angle of the hind basitarsus and second tarsomere.

Resumen.—Machos y hembras del género andino Cadegualina Michener son asociados por primera vez del mismo lugar en la cordillera Oriental de Colombia. Probablemente corresponden a C. sericata (Friese), nueva combinación, cuyo nombre es resucitado de una probable sinonimia con la única especie, C. andina (Friese). Cadegualina sericata es descrita completamente, así como el melanismo variable de las hembras. También se describe una hembra, aparentemente de C. andina, especie hasta ahora conocida de machos. El macho de C. sericata se puede separar de C. andina por la forma del lóbulo apical piloso del esterno siete, la forma de las valvas peneales y la forma y pubescencia del gonostilo de la genitalia; la hembra se puede reconocer por el ángulo posterodistal proyectado del basitarso posterior y segundo tarsómero.

Key Words: Apoidea, Andes, Cadegualina, taxonomy, Colombia, melanism

Michener (2000a) recently pointed out that the least known bee fauna in the world is that of the higher Andes, from Perú to Venezuela. The genus Cadegualina Michener (Colletidae, Diphaglossini) is one example about which almost nothing is known. The genus seems to occur above 2500 m from Bolivia to Venezuela, and consists of hairy, robust, middle-sized bees (10–12 mm) with an elongated malar area, an obliquely truncated apex of the marginal cell, and a reduced third submarginal cell. Sternum seven of the male has a small body, almost without the apical lobes found in most colletids. Cadegualina, as previously recognized, superficially resembles fulvous-haired specimens of Cadeguala occidentalis (Haliday) from Chile, but it is probably more closely related to another Chilean diphaglossine genus, Diphaglossa...
Spinola, as suggested by the similarity of the male genitalia and reduced third submarginal cell (Michener 1986, 2000b). Commonly bees with elongate heads as in *Cadegualina* are thought to be adapted for tubular flowers; however, no behavioral observations are available to test this hypothesis for *Cadegualina*. Nests and immatures of *Cadegualina* remain unknown.

Until now, *Cadegualina* has been known from only four specimens: A) Two males, the types of *C. andina* (Friese), from an unknown locality in Venezuela; one of them designated as the lectotype by Michener (1986) (for more about the locality, see Michener 1986). B) One male from Tarata, Bolivia, included in *C. andina* by Friese (1925), that has not been found in spite of a search at the presumed depository in Berlin (F. Koch, personal communication). Since we now know that at least two species exist (see below), the specific identity of the Bolivian specimen, which we have not seen, must be considered unknown. C) Finally, one female, the type of *C. sericata* (Friese), labelled Guayaquil, Ecuador. Guayaquil is at sea level, but other high Andean bees described by Friese were labelled Guayaquil (Michener, in prep.). We therefore assume that this specimen also came from somewhere in the Ecuadorian Andes. Of course there is no way to determine if this female belongs to the same species as the male type of *C. andina*. Friese (1925) suggested this possibility, and Michener (1986) listed *C. sericata* as a questionable synonym of *C. andina*.

We recently examined males and females of *Cadegualina* collected for the first time for the genus at the same time and place, in the eastern Andes of Colombia. The male differs from the type of *C. andina* in sternal and genitalic characters; hence, the species is not *C. andina*. The female agrees with the female from “Guayaquil”, the type of *C. sericata*, in the hind tarsal character that differentiates this species from a female that may be properly associated with male types of *C. andina*. We therefore recognize and describe in full both sexes of *C. sericata* (Friese). **n. comb.** The female of the presumed *C. andina* is also described.

**Materials and Methods**

The morphological description and illustrations were made using an Olympus SZ microscope. The description format and morphological terminology follow Michener (1986) and terminology for surface sculpturing follows Harris (1979). Setal length is given relative to the diameter of the median ocellus. The abbreviations F, S, OD, and T are used for flagellomere, metasomal sternum, ocellar diameter, and metasomal tergum, respectively. Measurements are given with standard errors. Specimens are placed in the following institutions:

LABUN Laboratorio de Investigaciones en Abejas, Universidad Nacional de Colombia, Santa Fé de Bogotá, AA. 14490, Colombia (G. Nates-Parrá).

MNHV Museum für Naturkunde der Humboldt-Universität, Berlin, Germany (F. Koch).

SEMC Snow Entomological Division, Natural History Museum, University of Kansas, Lawrence, KS, 66045-7523, USA (Z. Falin).

*Cadegualina sericata* (Friese), **new combination** (Figs. 1-7)

*Bicornelia sericata* Friese 1925: 11 (holotype female, MNHV).


Diagnosis.—Males can be separated from *C. andina* by the shape of the apical pilose lobe of S7 (Fig. 2), shape of penis valve, and shape and pubescence of the gonstylus in the genitalia (Fig. 5) (compare with Michener 1986, figs. 17–20); females of *C. sericata* can be distinguished by the projected posterodistal angle of the hind
Fig. 1–8. Male genitalia and hind basitarsus of Cadegualina. 1–7, C. sericata. 8, C. cf. andina. 1, S6, ventral view. 2–3, S7–S8, dorsal (left) and ventral (right) views. 4, Lateral view of S8. 5–6, Genital capsule, dorsal (left), ventral (right) and side views. 7–8, Hind basitarsus and second tarsomere of the females of C. sericata and C. cf. andina, respectively.
basitarsus and of the next tarsomere (Fig. 7).

Description.—Male: Body length 12.3 mm; forewing length 9.8 mm. Structure: Superior interorbital distance 0.8 as long as inferior interorbital distance; interantennal distance 1.3 times as long as alveolar orbital distance; intercellar distance about as long as ocellocular distance; ocelloccipital distance about 1.3 times diameter of median ocellus; distance from median to lateral ocellus about half diameter of median ocellus; malar area 1.7 times as long as broad, about one-third of compound eye length in lateral view; head 1.1 times as wide as long; labrum triangular, convex, gently tumescent midbasally, slightly wider than long; clypeus about as long as broad, projecting about 0.8 compound eye width in lateral view; clypeus medioapically with shallow, broad (OD) emargination; compound eye 2.4 times as long as broad; gena about 0.7 times compound eye width in profile; scape 2.8 times as long as broad, F1 about as long as broad, 0.7 length F2, F2 1.5 times as long as broad, F3 1.4 times as long as broad; mandible with small preapical tooth. Triangle on posterior surface of propodeum delimited by ridge or carina that extends up to midpoint of posterior propodeal surface. Second recurrent vein of forewing about 2 vein widths before third submarginal cross-vein; marginal cell length 1.4 times the distance from its apex to wing tip; right hind wing with row of 15 hamuli, left wing with 15 and one isolated hook. Front and middle legs unmodified; hind basitarsus about 2.5 times as long as broad, slightly less than half hind tibial length, with posterior margin gently convex. Genitalia and associated sterna as in Figs. 1–6. Coloration: Integument black, except labrum brownish, pronotum and apical half of mandible dark reddish brown; anterior pronotal margin yellowish cream; front tibia, tarsi, tibial spurs and bases of pretarsal claws of all legs brownish, remainder of legs dark reddish brown; tegula translucent dark reddish brown; wings translucent dusky, clearer to-ward apices, veins dark brown to black; metasomal terga dark brownish black, posterior margins broadly translucent brown; metasomal sterna dark brown, basal parts blackish. Pubescence: On head mainly yellowish white; margins of labrum with short (< OD), stout, simple, ferrugineous setae, longer toward apex; malar area nearly hairless, except median longitudinal area with sparse, very short and fine setae; clypeus with a premarginal fringe of long (3 OD), simple, pale ferruginous setae as on outer margin and condylar groove of mandible; lower and lateral marginal paraocular area densely covered (integument not visible) with short (< OD), appressed, white, branched setae; upper paraocular area, frons, vertex, preoccipital margin, and along outer orbital margin with long (≥ 3 OD), sparse, erect, dusky, branched setae, those on upper face arising among whitish short pubescence, longest (≥ 4 OD) and denser on vertex and preoccipital margin; clypeus and supraclypeal area densely covered (integument barely visible) with long (3 OD), branched, dusky setae, longest and denser on latter; outer surface of scape with long, branched, dusky setae, longest setae about 1.6 times as long as maximum width of scape; gena with yellowish white setae as on clypeus, longest (> 6 OD) and denser on lower gena and hypostomal area. Mesosoma, except for bare basal area of propodeum, densely covered (integument of scutum barely visible) with long (5–6 OD), branched, yellowish setae as on gena; outer surfaces of femora, tibiae and basitarsi of all legs, and inner surfaces of hind and middle tibiae with dark brown setae; inner surface of front tibia, and inner and outer surfaces of mediotarsi and distitarsi of all legs with ferrugineous setae, remainder of legs with yellowish setae as on mesoscutum. T1 with long (≥ 3 OD), sparse, erect, branched, yellowish setae; T2–T3 densely covered with short (≥ OD), erect, branched, black setae, except for sides of T2 with long, yellowish setae as on T1; T4–T7 with branched, blackish-ferruginous setae (> 2
OD); shorter ferrugineous setae on inner surface of hind basitarsus, longer on sides of T5 and T6. Remainder of these terga mostly with simple setae, T7 with mostly simple, shorter (≥ OD) and denser setae on apical margin. Apical margins of S1–S4 with long (> 2 OD), branched, mostly anteriorly curved, ferruginous setae as on T4. **Puncturation:** Labrum weakly imbricate; clypeus with strong punctures, as close as they can be except preapical area smooth and shiny; paraocular area with stronger and denser punctures (< 1 puncture widths) than on clypeus, integument between punctures micropunctate-lineolate; malar area smooth and shiny; supraclypeal area with coarser, denser punctures, less punctuate above antennal socket; vertex with sparse punctures (> 3 puncture widths), weakly imbricate, shiny as on gena. Mesosoma with faint punctures separated by 2–3 puncture widths, integument imbricate to micropunctate-lineolate. Metasoma with sparse punctures separated by 2–3 puncture widths, integument otherwise weakly imbricate to micropunctate-lineolate.

**Female:** As described for male except for (n = 4): body length 13.7 mm (± 0.2); forewing length 10.1 mm (± 0.1). **Structure:** Superior interorbital distance 0.7 as long as inferior interorbital distance; interantennal distance about as long as alveolar distance; ocellocapitellar distance about 1.2 times diameter of median ocellus; malar area about 1.4 times as long as broad; head 1.2 times as wide as long; clypeus wider than long (about 0.9 times as long as wide), projecting more than half compound eye width in lateral view; compound eye 2.9 times as long as broad; gena about as broad as compound eye width in profile; scape 3.8 times as long as broad, F1 1.2 times as long as broad, F2 and F3 about 1.3 times as long as broad; mandible with two small preapical teeth. Carina delimiting triangle on posterior surface of propodeum more pronounced and sharper than in male. Second recurrent vein of forewing about one to three vein widths before second submarginal crossvein; marginal cell length 1.3 times the distance from its apex to wing tip; left hind wing with a row of 17 hamuli, right with 16 and one isolated hook. Hind basitarsus and next tarsomere with posterodistal angles projected as in Fig. 7. Hind basitarsus about 0.6 times hind tibial length. **Coloration:** Integument black as in male, except for malar area, disc of clypeus, lower parts of posterior surface of propodeum and metepisternum, and all legs dark brown. **Pubescence:** On head mainly dark brown; paraocular area with longer (≥ OD), branched, yellowish setae, sparser than in male, longer (> 2 OD) and denser on supraclypeal area; clypeus with short (about OD), semierect, branched, sparse yellowish setae (integument visible); long (> 2 OD), branched, dark brown setae arising among yellowish setae on clypeus, such dark setae denser than in male: upper gena with mostly brownish dusky setae, lower gena with longer (> 4 OD), branched, yellowish setae; scape with branched, short (equal or shorter than scape maximum diameter), dusky setae. Thoracic setae and those of leg bases (coxae to femora), and T1 variable (see Variations below). Remainder of legs covered with dark brown setae or black on outer sides of tibiae and basitarsi; hind femur and tibia with dense and well-formed scopae. T2–T3 densely covered with rather short (about OD), branched, black setae; T4 and T5 with rather appressed, branched cossyry setae. T6 covered with branched, dark brown setae, setae longer (≥ 3 OD) on lateral sides. S1 densely covered with long (> 3 OD), branched, brownish or dusky setae; apical margins of S2–S5 with long, erect dusky to brownish fringes, discs of these sterna and S6 with short hairs (≤ OD). **Puncturation:** Apical half of labrum with stronger punctures than in male, punctures separated by one puncture width, integument strongly imbricate; clypeus with strong punctures throughout, separated by ≤ 1 puncture width. Metasoma in general more finely punctuate than in male, sterna
with punctures stronger and more scattered (2–3 puncture widths) than terga.

Material examined.—COLOMBIA: 1 ♂, 3 ♀, Boyacá, Tunja, Santuario de Fauna y Flora de Iguáque [5°70’N, 73°46’W], Carrizal Creek, January 8 1992, 2830 m, C. Sarmiento Coll. 1 ♀, Cundinamarca, La Calera [4°43’N, 73°58’W], November 12 1983 [2800 m], G. Nates Coll. (LABUN, SEMC).

According to their collector (C. Sarmiento, personal communication), all three females and the male from Boyacá were caught at the same nest site, and all were collected in the dry season. The females have pollen on their scopas, indicating that they were actively provisioning nests; however, Cadegualaula adults may fly at other seasons as indicated by the C. cf. andina female (see below), with worn wings and mandibles, collected on July 21, in the central Andes.

Variations.—The four known females from the eastern Andes of Colombia vary greatly in pile color, even among the three specimens from the same locality in Boyacá. The following comments concern the specimens from Boyacá except as indicated for the specimen from Cundinamarca. One specimen (1) has the long, dense setae of the thorax, leg bases (coxae to femora) and T1 entirely fulvous, paler on the sides of the thorax and leg bases than on the dorsum, the femoral scopas whitish with some dusky admixture. This is much as in known specimens of C. andina. At the opposite extreme in coloration is a specimen (2) with the setae of the areas listed above black, somewhat dusky on the propodeum, femoral scopas and T1, but with a patch of bright fulvous just below the tegula and wing bases, grading into brownish dusky on the lower mesepisternum. An intermediate specimen (3) (in bad condition with many setae in many areas matted) has the setae of the areas listed largely black, but somewhat dusky on posterior part of scutum, scutellum, sides of thorax, propodeum and T1, brownish dusky on outer side of femoral scopas, dull whitish on inner side of femoral scopas; patch below tegula yellowish white. The specimen from Cundinamarca (4) is also intermediate, with the setae on the areas listed black with some dusky intermixed, on posterior lateral angles of scutum and scutellum and metanotum pale fulvous, on lower part of mesepisternum dusky fulvous, on rest of side of thorax and propodeum and T1 dusky; femoral scopas almost entirely white. The setae below the tegula and wing bases are black so that there is no patch as in specimens 2 and 3.

Another variation is in wing venation. In female number 4, the third submarginal cell is much narrowed toward the anterior wing margin, so that cell is almost triangular, while in specimens 1 to 3 and in the male the cell is about half as wide on the anterior margin as on the posterior margin. Also in number 4 the second recurrent vein meets the third submarginal crossvein on the left wing; on the right wing they are separated by about one vein width. In the other specimens the veins are separated by two or three vein widths.

Comments.—The male described above differs from the type of C. andina in the sternal and genitalic characters as stated in the diagnosis. The female agrees with the type of C. sericata [CDM examined that type in 1984 and Frank Koch kindly checked the hind tarsal character that differentiates C. sericata from a female that may be properly associated with male types of C. andina (see below)]. This hind tarsal character (Fig. 7) is rather weak, and males from Ecuador, more certainly associated with the female type from “Guayaquil”, would help to verify our use of the name C. sericata.

Interestingly, Cadeguala occidentalis of Chile and neighboring countries also exhibits melanism, principally evident among females. There is no evidence that the black-haired females named Cadeguala tetra (Spinola) are a different species from the common fulvous-haired individuals (Michener 1986).
Cadegualina andina (Friese)
(Fig. 8)


Description.—Female: As for C. sericata except as follows: body length 14 mm; forewing length 10.6 mm. Structure: Second recurrent vein of forewing about three vein widths before second submarginal crossvein; left hind wing with row of 18 hamuli and two isolated hooks; right with 16 and two isolated hooks. Hind basitarsus and next tarsomere with posterodistal angles broadly rounded as in Fig. 8. Coloration: Leg bases (coxae to femora) dark brown, remainder of legs brownish. Pubescence: Thorax, legs bases and T1 with yellowish setae; scutum with some dusky setae intermixed; remainder of legs with brownish setae. T2–T3 with mostly dusky setae intermixed with yellowish to coppery setae, especially along apical margin of T3.


This female was collected while presumably entering the nest in the ground. The nest entrance was 8 mm in diameter. A female of the Sphecid wasp Podagriritus Spinola (Cabroninae) was also captured leaving the same nest (S. Sendoya, personal communication).

Comments.—Our recognition of the female for C. andina is extremely tenuous. It is based on a single female from the central Andes of Colombia that differs slightly from the females called C. sericata. We therefore consider that it may be the female of the only other named species, C. andina. The female described above has a lighter pubescence on the body, similar to lighter specimens of C. sericata. It differs primarily from C. sericata females by the posterodistal angles of the hind basitarsus and next tarsomere; such angles are projecting and acute in C. sericata, broadly rounded in the presumed C. andina (Fig. 8).

Acknowledgments

We thank Guiomar Nates-Parra for lending us the material used in this study. As indicated in Material and Methods, we are indebted to Frank Koch of the Museum für Naturkunde der Humboldt-Universität for examining and reporting to us on the type of Cadegualina sericata. VG gratefully acknowledges the financial support of Idea-wild and NSF grant DBI-0096905 (to J. S. Ashe and M. S. Engel). This is contribution Nr. 3351 of the Division of Entomology, Natural History Museum and Biodiversity Research Center, University of Kansas.

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FLEA BEETLES (COLEOPTERA: CHRYSOMELIDAE) OF ISPARTA, TURKEY, WITH HABITAT USE AND HOST PLANT ASSOCIATIONS

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Abstract.—85 species and 2 subspecies belonging to 14 genera of the Alticinae collected from İsparta, Turkey, and adjacent areas in 2002–2003 are ecofaunistically investigated. The species are categorized as abundant, common, or rare based on the relative abundance for each species. An ecological discussion of findings, including habitat use and host plant preference for each genus, is provided with related tables.

Key Words: Alticinae, İsparta, fauna, ecology, food plant, habitat use, abundance

The Alticinae are highly specialized phytophagous insects well adapted to their host plants. Both the adult and larval forms feed on stems, roots, and leaves of plants from various plant families (Jolivet 1988, Konstantinov and Vandenberg 1996). Most Alticinae species are neither very host specific nor general feeders. For each genus, the majority of species feed on hosts in one or a few plant families that are often chemically related (Furth 1979).

Flea beetles occur virtually everywhere, in almost all types of habitats. Palearctic flea beetle communities usually occur in open areas near forests or scrublands often associated with rivers or lakes, and nearly all kinds of meadows (Konstantinov and Vandenberg 1996).

Turkey is a biologically diverse region mainly due to being a bridge between Asia and Europe, and also a link to the Ethiopian region via the Arabian peninsula, thus providing a natural pathway for the spread of species both north–south and east–west (Çiplak 2003). Because of this important geographical situation and being a transitional region, many different macro and microhabitats occur in Turkey. The Alticinae in Turkey are relatively poorly studied, especially from the ecological point of view.

İsparta has an altitude of 1050 m, situated in the western Mediterranean part of Turkey. Both the Mediterranean and Central Anatolia have major extensions into İsparta. Northern parts of the area have arid climatic conditions while southern parts are temperate. These different climatic factors and geographical position have allowed a rich flora and fauna to occur in the research area. According to Gruev (2002), İsparta is one of the important regions with refuge habitats in Asiatic Turkey.

The purpose of this study is to determine the flea beetle species existing in the research area with some additional ecological data such as generally preferred food plant families and habitat types.

Materials and Methods

This study is based on material gathered throughout the spring season from İsparta and adjacent areas in 2002–2003. A total of 5939 beetles were collected by sweeping. The relative abundance of each species was determined by using the sample formula $n_s / N_r \times 100$ ($n_s$ = individuals of species $s$; $N_r$ = total number of individuals).
\[ N_T = \text{total individuals of all species} \]. All the species were categorized as abundant, common, or rare based on these abundance degrees. Species which constituted more than 2\% of the total number of captured beetles were considered as abundant, 0.1–2.0\% as common, and less than 0.1\% as rare. The specimens are deposited at the Department of Biology, Faculty of Art and Science, Süleyman Demirel University.

RESULTS AND DISCUSSION

As a result of collections in the study area, we identified 85 species and 2 sub-species of flea beetles belonging to 14 genera; 31 species in the genus *Longitarsus* Latreille, 16 in *Phyllotreta* Chevrolat, 8 in *Chaetocnema* Stephens, 7 in *Psylliodes* Latreille, 6 in *Dibolia* Latreille, 5 in *Aphthona* Chevrolat, 3 species of *Altica* Fabricius and *Neocrepidodera* Heikertinger, 2 species of *Crepidodera* Chevrolat and *Mantura* Stephens, and 1 species of *Ochrrosis* Foudras, *Derocrepis* Weise, *Epitrix* Foudras and *Podagrica* Foudras (Table 1).

The most common and dominant genus in the research area was *Longitarsus* of which species occur in almost all types of habitats, including piedmonts, heath lands, meadows, and open spaces near forests or scrublands (Table 2). *Xerophile Verbascum spp.* (*Scrophulariaceae*), growing near roadsides, were especially preferred by many species of *Longitarsus*. Because of the broad range of habitats, *Longitarsus* has a wider range of species diversity and a large range of host plant families than most *Alticinae* genera (Furth 1980). In our studies *Boraginaceae*, *Scrophulariaceae*, and *Lamiaeae* were most commonly used by *Longitarsus* species (Table 2).

*Phyllotreta* is the second largest *Alticinae* genus in Isparta. Cultivated areas, such as fields, gardens, and orchards, and shrubs and roadsides are commonly preferred habitats. Among the genera found in the research area, *Phyllotreta* species mainly prefer plants belonging to the family *Brassicaceae*. The glucosinolates characteristical-
Table 1. List and relative abundance of flea beetles collected from Isparta. Categories are ‘‘+’’ for rare species; ‘‘++’’ for common species; and ‘‘+++’’ for abundant species.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Number (n.)</th>
<th>Relative Abundance (%)</th>
<th>Abundance Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phyllotreta Chevrolat</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. aerea</em> Allard</td>
<td>69</td>
<td>1.2</td>
<td>++</td>
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<tr>
<td><em>P. astrachanica</em> Lopatin</td>
<td>39</td>
<td>0.7</td>
<td>++</td>
</tr>
<tr>
<td><em>P. atra</em> (Fabricius)</td>
<td>24</td>
<td>0.4</td>
<td>++</td>
</tr>
<tr>
<td><em>P. bolognai</em> Biondi</td>
<td>18</td>
<td>0.3</td>
<td>++</td>
</tr>
<tr>
<td><em>P. corrigata</em> Reiche</td>
<td>225</td>
<td>3.8</td>
<td>+++</td>
</tr>
<tr>
<td><em>P. cruciferae</em> (Goeze)</td>
<td>72</td>
<td>1.2</td>
<td>++</td>
</tr>
<tr>
<td><em>P. diademata</em> (Foudras)</td>
<td>42</td>
<td>0.7</td>
<td>++</td>
</tr>
<tr>
<td><em>P. egridirensis</em> Gruev &amp; Kasap</td>
<td>19</td>
<td>0.3</td>
<td>++</td>
</tr>
<tr>
<td><em>P. erysími</em> Weise</td>
<td>175</td>
<td>2.9</td>
<td>+++</td>
</tr>
<tr>
<td><em>P. ganglbaueri</em> Heikertinger</td>
<td>5</td>
<td>0.08</td>
<td>+</td>
</tr>
<tr>
<td><em>P. nemorum</em> (Linnaeus)</td>
<td>9</td>
<td>0.2</td>
<td>++</td>
</tr>
<tr>
<td><em>P. nigripes</em> (Fabricius)</td>
<td>51</td>
<td>0.9</td>
<td>++</td>
</tr>
<tr>
<td><em>P. pontoaegeica</em> Gruev</td>
<td>30</td>
<td>0.5</td>
<td>++</td>
</tr>
<tr>
<td><em>P. procerá</em> (Redtenbacher)</td>
<td>45</td>
<td>0.8</td>
<td>++</td>
</tr>
<tr>
<td><em>P. variípennis</em> (Boieldieu)</td>
<td>232</td>
<td>3.9</td>
<td>+++</td>
</tr>
<tr>
<td><em>P. vittula</em> (Redtenbacher)</td>
<td>26</td>
<td>0.4</td>
<td>++</td>
</tr>
<tr>
<td><strong>Aphthona Chevrolat</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>A. atrovírensis</em> (Förster)</td>
<td>3</td>
<td>0.05</td>
<td>+</td>
</tr>
<tr>
<td><em>A. bonvouloiri</em> Allard</td>
<td>76</td>
<td>1.3</td>
<td>++</td>
</tr>
<tr>
<td><em>A. nigriceps</em> (Redtenbacher)</td>
<td>13</td>
<td>0.2</td>
<td>++</td>
</tr>
<tr>
<td><em>A. nigrisícutis</em> Foudras</td>
<td>67</td>
<td>1.1</td>
<td>++</td>
</tr>
<tr>
<td><em>A. pygmaea</em> Kutschera</td>
<td>294</td>
<td>5.0</td>
<td>+++</td>
</tr>
<tr>
<td><strong>Longitarsus Latreille</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>L. aeneicollis</em> (Faldermann)</td>
<td>22</td>
<td>0.4</td>
<td>++</td>
</tr>
<tr>
<td><em>L. albinus</em> (Foudras)</td>
<td>25</td>
<td>0.4</td>
<td>++</td>
</tr>
<tr>
<td><em>L. alfieri farthi</em> Gruev</td>
<td>30</td>
<td>0.5</td>
<td>++</td>
</tr>
<tr>
<td><em>L. anchusae</em> (Paykull)</td>
<td>58</td>
<td>1.0</td>
<td>++</td>
</tr>
<tr>
<td><em>L. ballotae</em> (Marsham)</td>
<td>70</td>
<td>1.2</td>
<td>++</td>
</tr>
<tr>
<td><em>L. bertii</em> Leonardi</td>
<td>27</td>
<td>0.5</td>
<td>++</td>
</tr>
<tr>
<td><em>L. corynthius corynthius</em> (Reiche et Saulcy)</td>
<td>50</td>
<td>0.8</td>
<td>++</td>
</tr>
<tr>
<td><em>L. dimidiatus</em> (Allard)</td>
<td>42</td>
<td>0.7</td>
<td>++</td>
</tr>
<tr>
<td><em>L. exoletus</em> (Linnaeus)</td>
<td>63</td>
<td>1.1</td>
<td>++</td>
</tr>
<tr>
<td><em>L. karlheinzi</em> Warchalowski</td>
<td>77</td>
<td>1.3</td>
<td>++</td>
</tr>
<tr>
<td><em>L. kutschera</em> Rye</td>
<td>3</td>
<td>0.05</td>
<td>+</td>
</tr>
<tr>
<td><em>L. limæi</em> (Duftschmidt)</td>
<td>73</td>
<td>1.2</td>
<td>++</td>
</tr>
<tr>
<td><em>L. longipennis</em> Kutschera</td>
<td>163</td>
<td>2.7</td>
<td>+++</td>
</tr>
<tr>
<td><em>L. luridus</em> (Scopoli)</td>
<td>227</td>
<td>3.8</td>
<td>+++</td>
</tr>
<tr>
<td><em>L. lycopi</em> (Foudras)</td>
<td>139</td>
<td>2.3</td>
<td>+++</td>
</tr>
<tr>
<td><em>L. melanocephalus</em> (De Geer)</td>
<td>43</td>
<td>0.7</td>
<td>++</td>
</tr>
<tr>
<td><em>L. minusculus</em> (Foudras)</td>
<td>5</td>
<td>0.08</td>
<td>+</td>
</tr>
<tr>
<td><em>L. nasturtii</em> (Fabricius)</td>
<td>1</td>
<td>0.02</td>
<td>+</td>
</tr>
<tr>
<td><em>L. nigrofasciatus</em> (Goeze)</td>
<td>215</td>
<td>3.6</td>
<td>+++</td>
</tr>
<tr>
<td><em>L. ochroleucus</em> (Marsham)</td>
<td>118</td>
<td>2.0</td>
<td>+++</td>
</tr>
<tr>
<td><em>L. onosmæae</em> Paycirinoff</td>
<td>16</td>
<td>0.3</td>
<td>++</td>
</tr>
<tr>
<td><em>L. parvulus</em> (Paykull)</td>
<td>134</td>
<td>2.3</td>
<td>+++</td>
</tr>
<tr>
<td><em>L. pellucidus</em> (Foudras)</td>
<td>65</td>
<td>1.1</td>
<td>++</td>
</tr>
<tr>
<td><em>L. picicollis</em> Weise</td>
<td>36</td>
<td>0.6</td>
<td>++</td>
</tr>
<tr>
<td><em>L. pinguis</em> Weise</td>
<td>2</td>
<td>0.03</td>
<td>+</td>
</tr>
<tr>
<td><em>L. pratensis</em> (Panzer)</td>
<td>46</td>
<td>0.8</td>
<td>++</td>
</tr>
<tr>
<td><em>L. pinniflinæae</em> Weise</td>
<td>5</td>
<td>0.08</td>
<td>+</td>
</tr>
<tr>
<td><em>L. salvæae</em> Gruev</td>
<td>69</td>
<td>1.2</td>
<td>++</td>
</tr>
<tr>
<td><em>L. scutellaris</em> (Rey)</td>
<td>15</td>
<td>0.3</td>
<td>++</td>
</tr>
</tbody>
</table>
Table 1. Continued.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Number (n.)</th>
<th>Relative Abundance (%)</th>
<th>Abundance Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Longitarsus Latreille</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. solaris Gruev</td>
<td>4</td>
<td>0.07</td>
<td>+</td>
</tr>
<tr>
<td>L. stragulatus (Foudras)</td>
<td>21</td>
<td>0.4</td>
<td>++</td>
</tr>
<tr>
<td><strong>Allica Fabricius</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. deserticola (Weise)</td>
<td>152</td>
<td>2.6</td>
<td>+++</td>
</tr>
<tr>
<td>A. lylthi Aubé</td>
<td>3</td>
<td>0.05</td>
<td>+</td>
</tr>
<tr>
<td>A. oleracea (Linnaeus)</td>
<td>226</td>
<td>3.8</td>
<td>+++</td>
</tr>
<tr>
<td><strong>Ochrosis Foudras</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O. ventralis (Illiger)</td>
<td>20</td>
<td>0.3</td>
<td>++</td>
</tr>
<tr>
<td><strong>Neocrepidodera Heikertinger</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. cressicornis (Faldermann)</td>
<td>4</td>
<td>0.07</td>
<td>+</td>
</tr>
<tr>
<td>N. ferruginea (Scopoli)</td>
<td>62</td>
<td>1.0</td>
<td>++</td>
</tr>
<tr>
<td>N. transversa (Marsham)</td>
<td>5</td>
<td>0.08</td>
<td>+</td>
</tr>
<tr>
<td><strong>Crepidodera Chevrolat</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. aurata Marsham</td>
<td>123</td>
<td>2.1</td>
<td>+++</td>
</tr>
<tr>
<td>C. lamina (Bedel)</td>
<td>28</td>
<td>0.5</td>
<td>++</td>
</tr>
<tr>
<td><strong>Derocephis Weise</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Anatolica Heikertinger</td>
<td>77</td>
<td>1.3</td>
<td>++</td>
</tr>
<tr>
<td><strong>Epitrix Foudras</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. dieckmanni Mohr</td>
<td>86</td>
<td>1.4</td>
<td>++</td>
</tr>
<tr>
<td><strong>Podagrica Foudras</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. malvae (Illiger)</td>
<td>135</td>
<td>2.3</td>
<td>+++</td>
</tr>
<tr>
<td><strong>Mantura Stephens</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. mathewsi (Curtis)</td>
<td>2</td>
<td>0.03</td>
<td>+</td>
</tr>
<tr>
<td>M. rustica (Linnaeus)</td>
<td>2</td>
<td>0.03</td>
<td>+</td>
</tr>
<tr>
<td><strong>Chaetocnema Stephens</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. concina Marsham</td>
<td>45</td>
<td>0.8</td>
<td>++</td>
</tr>
<tr>
<td>C. condacta (Motschulsky)</td>
<td>64</td>
<td>1.1</td>
<td>++</td>
</tr>
<tr>
<td>C. covei (Allard)</td>
<td>155</td>
<td>2.6</td>
<td>+++</td>
</tr>
<tr>
<td>C. hortensis (Geoffroy)</td>
<td>75</td>
<td>1.3</td>
<td>++</td>
</tr>
<tr>
<td>C. montenegrina Heikertinger</td>
<td>5</td>
<td>0.08</td>
<td>+</td>
</tr>
<tr>
<td>C. salbergi (Gyllenhal)</td>
<td>20</td>
<td>0.3</td>
<td>++</td>
</tr>
<tr>
<td>C. schleifleri (Kutchera)</td>
<td>14</td>
<td>0.2</td>
<td>++</td>
</tr>
<tr>
<td>C. tibialis (Illiger)</td>
<td>245</td>
<td>4.1</td>
<td>+++</td>
</tr>
<tr>
<td><strong>Dibolia Latreille</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. numidica Doguet</td>
<td>3</td>
<td>0.05</td>
<td>+</td>
</tr>
<tr>
<td>D. occultans (Koch)</td>
<td>128</td>
<td>2.2</td>
<td>+++</td>
</tr>
<tr>
<td>D. rugulosa Redtenbacher</td>
<td>152</td>
<td>2.6</td>
<td>+++</td>
</tr>
<tr>
<td>D. schilingi Letzner</td>
<td>75</td>
<td>1.3</td>
<td>+</td>
</tr>
<tr>
<td>D. timida (Illiger)</td>
<td>5</td>
<td>0.08</td>
<td>+</td>
</tr>
<tr>
<td>D. tricolor Reiter</td>
<td>15</td>
<td>0.3</td>
<td>+</td>
</tr>
<tr>
<td><strong>Psylliodes Latreille</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. cerenae Gök, Doguet and Çilbiroğlu</td>
<td>160</td>
<td>2.7</td>
<td>+++</td>
</tr>
<tr>
<td>P. chalcconeris (Illiger)</td>
<td>88</td>
<td>1.5</td>
<td>++</td>
</tr>
<tr>
<td>P. cupreus (Koch)</td>
<td>32</td>
<td>0.5</td>
<td>+</td>
</tr>
<tr>
<td>P. instabilis Foudras</td>
<td>141</td>
<td>2.4</td>
<td>++</td>
</tr>
<tr>
<td>P. kiesenwetteri Kutchera</td>
<td>17</td>
<td>0.3</td>
<td>++</td>
</tr>
<tr>
<td>P. magnificus Gruev</td>
<td>2</td>
<td>0.03</td>
<td>+</td>
</tr>
<tr>
<td>P. sophiae Heikertinger</td>
<td>175</td>
<td>2.9</td>
<td>+++</td>
</tr>
</tbody>
</table>
Table 2. Habitat and preferred host plant families of the flea beetle genera occurring in Isparta (% calculated based on total number of species).

<table>
<thead>
<tr>
<th>Genus</th>
<th>%</th>
<th>Habitat</th>
<th>Preferred Host Plant Families</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Phyllotreta</em></td>
<td>19</td>
<td>Cultivated areas, road sides, orchards, shrublands</td>
<td>Brassicaceae, Resedaceae</td>
</tr>
<tr>
<td><em>Aphthona</em></td>
<td>6</td>
<td>Piedmonts, steppe areas, small valleys</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td><em>Longitarsus</em></td>
<td>37</td>
<td>Heath lands, shrubs, arid piedmonts, meadows, open spaces, moist places</td>
<td>Scrophulariaceae, Lamiaceae, Boraginaceae, Plantaginaceae Asteraceae, Convulvulaceae, Caryophyllaceae, Dipsacaceae</td>
</tr>
<tr>
<td><em>Altica</em></td>
<td>3</td>
<td>Moist areas associated with streams or lakes</td>
<td>Rosaceae, Scrophulariaceae, Asteraceae</td>
</tr>
<tr>
<td><em>Ochrosis</em></td>
<td>1</td>
<td>Bushes</td>
<td>?</td>
</tr>
<tr>
<td><em>Neocrepidodera</em></td>
<td>3</td>
<td>Moist areas including poplars</td>
<td>Violaceae, Lamiaceae</td>
</tr>
<tr>
<td><em>Crepидodera</em></td>
<td>2</td>
<td>Moist areas mainly consist of willows and poplars</td>
<td>Salicaceae</td>
</tr>
<tr>
<td><em>Derocripis</em></td>
<td>1</td>
<td>Mixed shrub vegetation</td>
<td>Fabaceae</td>
</tr>
<tr>
<td><em>Epitrix</em></td>
<td>1</td>
<td>Field sides</td>
<td>Solanaceae</td>
</tr>
<tr>
<td><strong>Podagrica</strong></td>
<td>1</td>
<td>Irrigation ditches</td>
<td>Malvaceae</td>
</tr>
<tr>
<td><em>Mantura</em></td>
<td>2</td>
<td>Open spaces, steppe areas</td>
<td>?</td>
</tr>
<tr>
<td><em>Chaetocnema</em></td>
<td>9</td>
<td>All kinds of meadows, marshy places</td>
<td>Amaranthaceae, Poaceae, Cyperaceae</td>
</tr>
<tr>
<td><em>Dibolia</em></td>
<td>7</td>
<td>Semi-arid and moist areas</td>
<td>Lamiaceae</td>
</tr>
<tr>
<td><em>Psylliodes</em></td>
<td>8</td>
<td>Mixed forests, scrublands, piedmonts</td>
<td>Poaceae, Brassicaceae, Asteraceae</td>
</tr>
</tbody>
</table>

*maea* Kutschera was the most abundant species (5.0%), and found in high population densities on different Euphorbia. *Aphthona nigriscutis* Foudras and *A. pygmaea* were sometimes seen feeding on the same host plant. *Aphthona nigriscutis* causes especially notable damage to the host plant leaves while feeding. Beetles nibble the upper sides of the leaves in large numbers. Leaves are nearly completely damaged.

The genus *Dibolia* is represented by 13 species throughout Turkey (Aslan et al. 1999), and 6 of them were found in Isparta. *Dibolia* species usually prefer wooded river banks, piedmonts that consist of shrubs, and open areas. We observed that members of this genus are closely associated with Lamiaceae (Table 2). Due to occurrence in large numbers, they skeletonize the leaves of various wild Lamiaceae, especially *Salvia spp*.

Three *Altica* species were determined from the research area. Among them, *Altica deserticola* (Weise) is particularly specialized on *Rubiсan ascens DC.* (Rosaceae) growing near streams. *Altica oleracea* (L.) is not limited to a single host plant and was observed feeding on plant species from different families such as *Sangiosorba minor Scop.* (Rosaceae), *Veronica sp.* (Scrophulariaceae), and *Cirsium sp.* (Asteraceae). *Altica lythri* Aubé, is a rather rare species in the area.

*Neocrepidodera* species prefer herbaceous vegetation found in moist poplar forests. *Crepидodera* differs from other genera recorded in the investigation area by feeding behavior. These beetles are usually dendrophilic on Salicaceous plants growing in moist areas. Both species collected (*C. aurata* Marsham and *C. lamina* (Bedel)) were observed on the fresh leaves of *Salix spp.* and *Populus spp.* Adults nibble the leaves and cause damage due to their occurrence in high densities.

In Isparta, the genus *Epitrix* is represented by a single species, *E. dieckmanni* Mohr. Solanaceae is the most preferred food plant
family (Lopatin 1984, Furth 1997). Our samples were also found on Lycium depressum Stocks (Solanaceae) growing on rocks near a wheat field.

Mantura, Derocrepis, Podagrica, and Ochrosis have fewer species than other genera in Isparta Province. Derocrepis anatolica Heikertinger was found on Genista tinctoria L. (Fabaceae) growing in shrub vegetation including mainly oak and hawthorn, and Podagrica malvae (Iliger) on Malva spp. (Malvaceae). Food plants of Mantura and Ochrosis species were not determined.

**DISCUSSION**

Analysis of the flea beetle fauna in Isparta shows that some species are closely associated with certain host plants. According to Jolivet (1992), the chemical composition and secondary substances produced by the plant are responsible for the trophic selection of insects. Lamiaceae and Brassicaceae are especially preferred food plant families by most of the flea beetle species in the study area. Many species of Longitarsus and Dibolia feed on Lamiaceae. This is probably because of the chemical structure, attractive smell, or possible taste of plants belonging to this family. Phyllostreta species show a distinct preference in food plant family, being mainly limited to Brassicaceae.

Our investigations revealed that flea beetle populations increase rapidly after over wintering as a response to the spring growth of the host plant. Species diversity was greatest in May–June.

The total number of Alticinae species recorded from Isparta is nearly ½ of the Turkish flea beetle fauna. This is because the investigated region has an important geographical position, suitable climatic factors, and different topographic zonation, all of which result in a rich flora and therefore a rich flea beetle fauna.

**ACKNOWLEDGMENTS**

We are grateful to Dr. A. S. Konstantinov (Systematic Entomology Laboratory, USDA, Washington, DC) for reviewing this manuscript and providing valuable suggestions.

**LITERATURE CITED**


Konstantinov, A. S., M. G. Volkovitsh, and M. Cristofaro. 2001. New data on Palearctic Aphthona (Coleoptera: Chrysomelidae) with description of a new species: Taxonomic and faunistic results of
STUDIES ON INDIANA STONEFLIES (PLECOPTERA), WITH AN ANNOTATED AND REVISED STATE CHECKLIST

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Abstract.—An historical account of taxonomic-based Indiana Plecoptera research is presented and current distribution records are provided for 76 species, including 17 new state records. Six species, Allocapnia minima (Newport), Allocapnia pygmaea (Burmeister), Leuctra tenella (Provancher), Alloperla atlantica (Baumann), Alloperla imbecilla (Say), and Sweltsa naica (Provancher), are removed from the state list. Distribution records are based on recent collections, examination of museum material, and credible literature.

Key Words: stoneflies, Plecoptera, Indiana, species, hydrologic unit codes

The stonefly fauna of Indiana received considerable attention during the 20th century. Ricker (1945) published the first list of Indiana stoneflies. Ricker's list included 38 species, gleaned mainly from collections housed at Indiana University and Purdue University (PU) and efforts of the Illinois Natural History Society (INHS) during the late 1930's and early 1940's. Frison (1937, 1942) conducted numerous studies on Indiana Plecoptera and frequent collecting sites included McCormick's Creek, Shades, and Turkey Run State Parks, and both the East Fork and mainstem of the White River. Acronuria perplexa has "White River, Petersburg" as the type locality (Frison 1937). The descriptions of five additional species, Allocapnia rickeri, Isoperla dicala, I. namata, and Taeniopteryx litia (Frison 1942), and I. frisoni (described as I. truncata) (Frison 1937), included paratype localities in Indiana. Ricker (1952) later included descriptions of three species, Allocapnia indiana, Amphineura delosa (described as Nemoura (A.) delosa), and A. varshava (described as N. (A.) varshava), each with an Indiana stream as the type locality.

Further studies by Ricker and Ross during the 1960's on Allocapnia and Taeniopteryx furthered the knowledge of the Indiana fauna. Numerous paratype localities in Indiana were included in the description of A. ohioensis (Ross and Ricker 1964). Similarly, Ricker and Ross (1968) included paratype localities from Indiana in descriptions of T. burksi and T. metequi. Later, Stark and Gaufin (1974) cited Turkey Run State Park as a paratype locality for Diploperla robusta and Stark and Baumann (1978) cited Clifty Falls State Park as a paratype locality for Neoperla gaufini.

The most recent compilation of Indiana Plecoptera (Bednarik and Mccafferty 1977) increased the number of Indiana species to 61. Their study, similar to Ricker's (1945), was mainly museum- and literature-based. Lastly, the most recent checklist of North American Plecoptera included 62 species for Indiana (Stark 2001). The intent of this study was two-fold: (1) review the literature and selected museum material regarding prior state records, and (2) document the diversity and distribution of Indiana stone-
flies with a particular focus directed at un-glaciated landscapes. Indiana can be conveniently split into two components, the central and northern sections that were repeatedly covered and scoured by glacial advances and retreats and the smaller southern unit that escaped all glacial episodes (Fig. 1). The Indiana fauna was delineated according to six-digit hydrologic unit codes.

**Materials and Methods**

Collecting trips were made to southern Indiana from 2000 through 2003. Frequent collecting sites included springs and intermittent streams in Hoosier National Forest and Indiana State Nature Preserves, and the Wabash, Blue, and East Fork White Rivers. In total 88 unique sites were visited at least once (Fig. 2), producing 151 collections and 361 vials of fresh material. Adults were collected with a beating sheet within riparian zones, by visually searching tree trunks, streamside rocks, snags and bridges (particular for Capniidae and Taeniopterygidae), and light-trapping for summer-emerging Perlidae. Adults were also reared from nymphs in an artificial stream unit. All new material was deposited in the S. A. Grubbs collection at Western Kentucky University.


**Results**

Stoneflies have been recorded from 9 of 10 hydrologic unit codes located in Indiana (Table 1). The Patoka-White (58 species), Lower Ohio-Salt (47 species), and Wabash (36 species) units supported the highest diversity. As a conservative number 76 stonefly species are recorded from Indiana, including 17 new state records. More specifically, 14 new records are based on material collected solely by the author and three based on a combination of the author’s and museum records. The following is a partially annotated, revised checklist of stoneflies reported from Indiana, where “*” indicates the new records. Records have been limited to counties only if a species had been listed previously from the state. Where a new state record is presented one detailed county record is provided. Future collecting will likely provide additional species to the state list, and these 18 taxa are marked by “+” followed by parentheses indicating the adjacent state(s) or region (OO = Ozark-Ouachita) where that species has been collected.

**Annotated List of Stoneflies from Indiana**

Suborder Euholognatha

Family Nemouridae

Subfamily Amphinemurinae

Amphinemura delosa (Ricker).—Crawford, Dearborn, Floyd, Franklin, Harrison, Jackson, LaPorte, Lawrence, Marion, Montgomery, Owen, Perry, Ripley, Switzerland.

Amphinemura nigrita (Provancher).—Although Bednarik and McCafferty (1977), Stark (2001) and Stewart and Stark (2002) listed this species from Indiana, no literature records or museum material have been located and fresh specimens have not been collected. Amphinemura nigrita is widely distributed throughout eastern North America, including Illinois, Kentucky, and Ohio. This state record is retained until a definitive determination can be made.

Amphinemura varshava (Ricker).—Bartholomew, Clark, Floyd, Harrison, Jackson, Jefferson, Kosciusko, Lawrence, Monroe, Ohio, Owen, Parke, Perry, Pike, Ripley.
Wisconsinan glacial boundary

Illinoian glacial boundary

unglaciated

Fig. 1. Map of Indiana depicting southern extent of the Illinoian and Wisconsinan glacial episodes and the south-central region that remained ice-free.

This species is a common inhabitant of intermittent streams in southern Indiana.

Subfamily Nemourinae
+ *Nemoura trispinosa* Claassen (IL, MI)
* *Ostrocerca truncata* (Walker).—Clark Co., seep into Fourteenmile Creek, nr. Charlestown, Charlestown State Park, 17 May 2000, SAG, 2♀; Crawford Co., tributary to Otter Creek, 1 km SE Taswell, Yellow Birches Ravine Nature Preserve (YBRNP), 22 April 2001, SAG and D. E.
Fig. 2. Map of Indiana showing collection sites visited between 2000 and 2003 in relation to six-digit hydrologic unit codes. 040400 = Southwestern Lake Michigan, 040500 = Southeastern Lake Michigan, 041000 = Western Lake Erie, 050800 = Great Miami, 050902 = Middle Ohio-Little Miami, 051201 = Wabash, 051202 = Patoka-White, 051401 = Lower Ohio-Salt, 051402 = Lower Ohio, and 071200 = Upper Illinois.
King-Grubbs (DEG), 1 �, 1 ♀; Harrison Co., tributary to Potato Run, 6 km E Leav-enworth, Harrison-Crawford State Forest (HCSF), 22 April 2001. SAG and DEG. 3 �, 4 nymphs; Perry Co., small spring-fed stream, Rich Cave Hollow. 2.5 km N Branchville, Saalman Hollow Nature Preserve (SHNP), 22 April 2001. SAG and DEG. 2 �, 1 ♀. Although the distribution of the eastern North American species of *Ostrocerca* is mainly Appalachian (Young et al. 1989), this species is a common inhabitant of spring-fed streams in south-central Indiana.


*Prostoia similis* (Hagen).—Brown, Jackson, Parke.

+ *Shipsa rotunda* (Claassen) (IL, MI, OH).

*Soyedina vallicularia* (Wu).—Crawford, Monroe, Montgomery, Tippecanoe.

Family Taeniopterygidae

Subfamily Brachypteraeinae

*Strophopteryx fasciata* (Burmeister).—Bartholomew, Benton, Carroll, Hancock, Henry, Jackson, Johnson, Knox, Lawrence, Martin, Monroe, Morgan, Owen, Pike, Starke, Tippecanoe, Washington, White.

Subfamily Taeniopteryginae


*Taeniopteryx lita* Frison.—Daviess, Dubois, Martin, Pike.

*Taeniopteryx maura* (Pictet).—Greene, Hamilton, Harrison, Jackson, Orange, Pike, Washington.

*Taeniopteryx metequi* Ricker & Ross.—Lawrence. Orange.

*Taeniopteryx nivalis* (Fitch)—Kosciusko, Martin, Parke.

*Taeniopteryx parvula* Banks.—Dubois, Greene, Jackson, Martin, Monroe, Pike.

Family Capniidae

*Allocapnia forbesi* Frison.—Crawford, Dearborn, Floyd, Jackson, Ohio, Perry.


*Allocapnia illinoensis* Frison.—Although Finni (1973a), Bednarik and McCafferty (1977) and Stewart and Stark (2002) listed this species from Indiana, no literature records (e.g., Ricker and Ross 1971) or museum material have been located and fresh specimens have not been collected. This state record is retained until a definitive determination can be made.

*Allocapnia indiana* Ricker.—Brown, Crawford, Jackson, Lawrence, Monroe, Morgan, Perry.

*Allocapnia mystica* Frison.—Brown, Dubois, Jackson, Orange, Parke, Perry, Washington.

*Allocapnia nivicola* (Fitch).—Crawford, Lawrence, Martin, Montgomery, Morgan, Orange.

*Allocapnia ohioensis* Ross & Ricker.—Brown, Jackson, Monroe, Morgan, Scott.

*Allocapnia recta* (Claassen).—Clark, Crawford, Floyd, Fountain, Harrison, Martin, Montgomery, Morgan, Orange, Parke, Perry, Washington.

*Allocapnia rickeri* Frison.—Bartholomew, Brown, Clark, Crawford, Dearborn, Dubois, Franklin, Harrison, Jackson, Jefferson, Lawrence, Martin, Monroe, Montgomery, Orange, Owen, Parke, Perry, Ripley, Spencer, Switzerland, Washington.
* Allocapnia smithi* Ross & Ricker.—Perry Co., East Deer Creek, 13 km E Tell City, HNF, 12 March 2000, SAG and JMF, 1 ♀. This species occupies a narrow distributional range in eastern North America, with prior state records from Alabama, Illinois, Kentucky, and Ohio.


* Nemocapnia carolina* Banks.—Martin, Pike. This species is spottily distributed across eastern North America. Collections made by INHS in 1936 and 1940 from the East Fork White River in Martin and Pike counties represent the only Indiana records for this species. Recent trips to the East Fork White River near Rogers have failed to produce fresh material.

+ *Paracapnia angulata* Hanson (IL, MI, OH).

**Family Leuctridae**

+ *Leuctra ferruginea* (Walker) (IL, KY, MI, OH).—Material housed at the INHS labeled as *L. decepta*, but indicated electronically as *L. ferruginea* (INHS 2002), are actually of *L. rickeri* James. Continued collecting may reveal populations of this ubiquitous species.

* Leuctra rickeri* James.—Clark Co., tributary to Nine Penny Branch, Fourteen-mile Creek, 4 km NE Charlestown, Nine Penny Branch Nature Preserve (NPBNP), 17 May 2000, SAG, 2 ♀; Crawford Co., small spring-fed stream, Rich Cave Hollow, 2.5 km N Branchville, SHNP, 16 May 2000, SAG, 14 ♀, 11 ♀; Floyd Co., tributary to Knob Creek, 17 km E Corydon, Brock Sampson Nature Preserve (BSNP), 17 May 2000, SAG 3 ♀, 3 ♀; Harrison Co., tributary to Potato Run, 6 km E Leavenworth, HCSF, 16 May 2000, SAG, 3 ♀, 2 ♀; Jackson Co., tributary to Little Salt Creek, 2 km SW Houston, HNF, 11 June 2000, SAG, 3 ♀, 7 ♀; Jefferson Co., tributary to Indian Kentucky Creek, 12 km W Vevay, Splinter Ridge Fish and Wildlife Area, 10 June 2000, SAG, 2 ♀, 5 ♀; Monroe/Morgan Co., 7 mi Martinsville, Morgan-Monroe State Forest, 16 May 1962, H. H. Ross and J. Kingsolver, 2 ♀, 10 ♀ (INHS); Perry Co., East Deer Creek, 13 km E Tell City, HNF, 16 May 2000, SAG, 12 ♀, 10 ♀; Ripley Co., tributary to Laughery Creek, 2 km E Versailles, 11 May 2003, SAG, 2 ♀. *Leuctra rickeri* is the most common *Leuctra* in southern Indiana, particularly in intermittent streams.

* Leuctra sibleyi* Claassen.—Brown, Crawford, Harrison, Lawrence, Monroe, Ohio, Orange, Perry.

+ *Paracapnia angulata* Hanson (IL, MI, OH).

**Family Leuctridae**

+ *Leuctra ferruginea* (Walker) (IL, KY, MI, OH).—Material housed at the INHS labeled as *L. decepta*, but indicated electronically as *L. ferruginea* (INHS 2002), are actually of *L. rickeri* James. Continued collecting may reveal populations of this ubiquitous species.

* Leuctra rickeri* James.—Clark Co., tributary to Nine Penny Branch, Fourteen-mile Creek, 4 km NE Charlestown, Nine Penny Branch Nature Preserve (NPBNP), 17 May 2000, SAG, 2 ♀; Crawford Co., small spring-fed stream, Rich Cave Hollow, 2.5 km N Branchville, SHNP, 16 May 2000, SAG, 14 ♀, 11 ♀; Floyd Co., tributary to Knob Creek, 17 km E Corydon, Brock Sampson Nature Preserve (BSNP), 17 May 2000, SAG 3 ♀, 3 ♀; Harrison Co., tributary to Potato Run, 6 km E Leavenworth, HCSF, 16 May 2000, SAG, 3 ♀, 2 ♀; Jackson Co., tributary to Little Salt Creek, 2 km SW Houston, HNF, 11 June 2000, SAG, 3 ♀, 7 ♀; Jefferson Co., tributary to Indian Kentucky Creek, 12 km W Vevay, Splinter Ridge Fish and Wildlife Area, 10 June 2000, SAG, 2 ♀, 5 ♀; Monroe/Morgan Co., 7 mi Martinsville, Morgan-Monroe State Forest, 16 May 1962, H. H. Ross and J. Kingsolver, 2 ♀, 10 ♀ (INHS); Perry Co., East Deer Creek, 13 km E Tell City, HNF, 16 May 2000, SAG, 12 ♀, 10 ♀; Ripley Co., tributary to Laughery Creek, 2 km E Versailles, 11 May 2003, SAG, 2 ♀. *Leuctra rickeri* is the most common *Leuctra* in southern Indiana, particularly in intermittent streams.

* Leuctra sibleyi* Claassen.—Brown, Crawford, Harrison, Lawrence, Monroe, Ohio, Orange, Perry.

* Leuctra tenuis* (Pictet).—Harrison Co., tributary to West Fork Mosquito Creek, 4 km E Laconia, Mosquito Creek Nature Preserve, 20 October 2002, SAG, 3 ♀, 4 ♀.

* Paraleuctra sara* Claassen.—Crawford Co., tributary to Otter Creek, 1 km SE Taswell, YBRNP, 14 March 2000, SAG and JMF, 12 ♀, 5 ♀; Parke Co., Newby Gulch, Turkey Run State Park (TRSP), 9 April 1940, Frison and Ross, 1 ♀ (INHS). The Turkey Run State Park record was documented by Frison (1942) under *Leuctra sara*. This species mainly has a widespread Appalachian distribution and these records likely represent the western limit of its range.

* Zealeuctra clausseni* (Frison).—Brown, Clark, Crawford, Dearborn, Dubois, Franklin, Jackson, Jefferson, Monroe, Morgan, Ohio, Parke, Perry, Pike, Spencer.

* Zealeuctra fraxina* Ricker & Ross.—Brown Co., Spanker Branch, Middle Fork Salt Creek, 14 km S Nashville, 7 April 2001, SAG and DEG, 1 ♀, 4 ♀; Crawford Co., small spring-fed stream, Rich Cave Hollow, 2.5 km N Branchville, SHNP, 12 March 2000, SAG and JMF, 4 ♀, 4 ♀, 1 nymph; Floyd Co., tributary to Knob Creek, 17 km E Corydon, BSNP, 13 March 2000, SAG and JMF, 1 ♀, 3 ♀; Harrison Co., tributary to Potato Run, 6 km E Leav-
enworth, HCSF, 12 March 2000, SAG and JMF, 1 ♂; Martin Co., tributary to Lost River, 4 km SE Shoals, 6 April 2001, SAG and DEG, 2 ♂, 9 ♀; Orange Co., spring into French Lick Creek, 6 km S French Lick, 6 April 2001, SAG and DEG, 1 ♀; Perry Co., East Deer Creek, 13 km E Tell City, HNF, 12 March 2000, SAG and JMF, 2 ♂, 1 ♀; Scott Co., tributary to Big Ox Creek, 14 km SW Scottsburg, CSF, 15 March 2000, SAG and JMF, 1 ♂.

+ Zealeuctra narfi Ricker & Ross (IL, OO).

Suborder Systellognatha
Family Chloroperlidae
Subfamily Chloroperlinae

Alloperla caudata Frison.—Clark, Crawford, Floyd, Harrison, Jackson, Perry. This species is the most common Alloperla in southern Indiana.

* Alloperla hamata Surdick.—Floyd Co., tributary to Knob Creek, 17 km E Corydon, BSNP, 17 May 2000, SAG, 1 ♂, 2 ♀; Jackson Co., Little Salt Creek, 7 km NNW Free-town, 25 May 2002, SAG, 1 ♂, same but 11 May 2003, SAG, 4 ♂. This species is sparsely distributed in the eastern United States, with previous records from the Ozark-Ouachita Mountain region (Poulton and Stewart 1991) east to Alabama (Surdick 1981) and Kentucky (Kondratieff and Kirchner 1988).

Haploperla brevis (Banks).—Crawford, Jackson, Parke, Perry.

* Sweltsa onkos (Ricker).—Crawford Co., tributary to Otter Creek, 1 km SE Taswell, YBRNP, 17 May 2000, SAG, 9 ♂, 31 ♀. This species is mainly Appalachian, distributed from Ontario east to Quebec and the Canadian Maritime provinces, south to Kentucky, North Carolina, and Virginia. This record represents the western limit of its range.

Family Perlidae
Subfamily Acroneuriinae

Acroneuria abnormis (Newman).—Dubois, Martin, Monroe, Owen, Pike, Pulaski, Tippecanoe.

Acroneuria covelli Grubbs & Stark.—Floyd, Harrison, Martin. New Albany (Floyd Co., Ohio River) is the type locality of this recently described species (Grubbs and Stark 2004).

Acroneuria evoluta Klapalek.—Clark, Dubois, Monroe, Pike, Tippecanoe, Vanderburgh.

Acroneuria filicis Frison.—Tippecanoe.

Acroneuria frisoni Stark & Brown.—Clark, Crawford, Fountain, Harrison, Kosciusko, Lawrence, Monroe, Montgomery, Owen, Pike, Ripley, Tippecanoe.

Acroneuria internata (Walker).—Harrison, Parke, Tippecanoe.

Acroneuria perplexa Frison.—Clark, Dubois, Knox, Lawrence, Monroe, Owen, Pike, Tippecanoe, Vanderburgh.

Attaneuria ruralis (Hagen).—Monroe, Tippecanoe.

* Perlesta adena Stark.—Clark Co., tributary to Silver Creek, 22 km ESE Salem, CSF, 10 June 2000, SAG, 2 ♂, 3 ♀; Floyd Co., tributary to Knob Creek, 17 km E Corydon, BSNP, 17 May 2000, SAG, 7 ♂, 3 ♀; Jackson Co., tributary to Little Salt Creek, 7 km WSW Waymansville, HNF, 11 June 2000, SAG, 2 ♂, 1 ♀, 13 nymphs; Monroe Co., tributary to Clear Creek, 3 km NW Harrodsburg, Cedar Bluff Nature Preserve, 11 June 2000, SAG, 1 ♂; Orange Co., Carters Creek, 5 km W Campbellsburg, 10 June 2000, SAG, 2 ♂, 6 ♀; Ripley Co., Falling Timber Creek, near Versailles, Falling Timber Nature Preserve, 10 June 2000, SAG, 2 ♂. This species was described from the Cincinnati Arch area in southwestern Ohio (Stark 1989) and is the most common perlid in small, intermittent streams in southern Indiana.

+ Perlesta cinctipes (Banks) (IL, OH, OO).

* Perlesta decipiens (Walsh).—Bartholomew Co., East Fork White River, Azalia Bridge, 1.5 km SW Azalia, 11 June 2000, SAG, 7 ♂, 6 ♀; Harrison Co., Blue River, 6 km NE Leavenworth, HCSF, 18 May 2000, SAG, 15 ♂, 7 ♀.
+ Perlesta golconda DeWalt & Stark (IL).
+ Perlesta lagoi Stark (IL).

* Perlesta napacola DeWalt.—Harrison Co., Buck Creek, 10 km SE Corydon, 9 June 2000, SAG, 3 ♂ ; Jackson Co., Guthrie Creek, 18 km E Bedford, HBNP, 10 June 2000, SAG, 5 ♂ , 4 ♀ . This species was recently described from east-central Illinois (DeWalt 2002).

* Perlesta nitida (Banks).—Crawford Co., Little Blue River, 3 km N Sulphur, HNF, 9 June 2000, SAG, 1 ♂ , 1 ♀ ; Harrison Co., Buck Creek, 10 km SE Corydon, 9 June 2000, SAG, 1 ♂ , 9 ♀ ; Jackson Co., Guthrie Creek, 18 km E Bedford, HBNP, 10 June 2000, SAG, 2 ♂ , 1 ♀ .

Notes.—These records represent the western limit of its range. Perlesta nitida has been recorded from Connecticut and Massachusetts southwest through Pennsylvania, Ohio, and south-central Kentucky (Stark 1989; Grubbs and Stark 2001).

+ Perlesta shubuta Stark (IL, OO).
+ Perlesta xube Stark & Rhodes (IL).

Perlinella drymo (Newman).—Bartholomew, Crawford, Daviess, Dubois, Fulton, Jackson, Martin, Monroe, Parke, Perry, Pike, Tippecanoe.

Perlinella ephyre (Newman).—Bartholomew, Daviess, Dubois, Harrison, Monroe.

Subfamily Perlinellinae

* Agnetina annulipes (Hagen).—Harrison Co., Blue River, 6 km NE Leavenworth, HCSF, 9 June 2000, SAG, 1 ♂ ; Pike Co., White River, Petersburg, 13 June 1936, Mohr and Burks, 1 ♂ , 1 ♀ (reared) (INHS). This species has a coastal distribution in Pennsylvania and Maryland, south to Florida, and east to Mississippi and Louisiana (Stark 1986). These records represent a northern range extension from the western Gulf Coast.

+ Agnetina capitata (Pictet) (IL, KY, OH, MI).—There are several vials of specimens at INHS labeled as Phasganophora capitata and electronically indicated as A. capitata (INHS 2002). All material examined were nymphs that could not be reliably identified to species. Continued collecting efforts may uncover populations of this common species, yet likely only from the northern tier of the state.

Agnetina flavescens (Walsh).—Elkhart, Harrison, Owen.

* Neoperla catharinae Stark & Baumann.—Harrison Co., Blue River, 6 km NE Leavenworth, HCSF, 6 August 2000, SAG and DEG, 1 ♂ , 1 ♀ .

* Neoperla clymene (Newman).—Daviess Co., East Fork White River, 14 km S Washington, 31 May 2001, SAG and DEG, 2 ♂ , 3 ♀ ; Harrison Co., Blue River, 6 km NE Leavenworth, HCSF, 9 June 2000, SAG, 2 ♀ ; Pike Co., White River, Petersburg, 4 June 1936, Mohr and Burks, 2 ♂ (INHS).

Neoperla gaufini Stark & Baumann.—Harrison, Jackson, Jefferson, Owen.

+ Neoperla harpi Ernst & Stewart (IL, OO).

+ Neoperla mainensis (Banks) (IL, OH).

Neoperla occipitalis (Pictet).—No literature records or museum material have been located and fresh specimens have not been collected, although it has been reported from adjacent Illinois, Kentucky, and Ohio. Only Stark (2001) listed N. occipitalis from Indiana.

* Neoperla osage Stark & Lentz.—Harrison Co., Ohio River, Leavenworth, 28 June 2002, SAG, 2 ♂ . This species is widespread within the Ozark-Ouachita Mountain region (Poulton and Stewart 1991). This record indicates a slight eastern range extension.

+ Neoperla robisoni Poulton & Stewart (IL, OO).

* Neoperla stewarti Stark & Baumann.—Harrison Co., Blue River, 6 km NE Leavenworth, HCSF, 9 June 2000, SAG, 4 ♂ , 5 ♀ .

Paragnetina kansensis (Banks).—Dubois, Monroe, Pike, Tippecanoe.

Paragnetina media (Walker).—No literature records or museum material have been located and fresh specimens have not
been collected. This species is distributed widely throughout eastern North America including adjacent Illinois, Kentucky, Michigan, and Ohio. Bednarik and McCafferty (1977), Stark (2001), Stark et al. (1986), and Stewart and Stark (2002) each listed this species from Indiana. I have collected *P. media* from a tributary (Dowagiac Creek) to the St. Joseph River in Berrien County, Michigan, a county that straddles the Indiana-Michigan border. Collecting in the northern part of the state will likely reveal populations of this species.

**Family Perlodidae**

**Subfamily Isoperlinae**

*Cliperla clio* (Newman).—Clark, Crawford, Fountain, Knox, Lawrence, Martin, Monroe, Montgomery, Parke, Pike, Tippecanoe.

*Isoperla bilineata* (Say).—Clark, Floyd, Fulton, Daviess, Dubois, Martin, Monroe, Owen, Perry, Pike, Posey, Tippecanoe, Washington.

*Isoperla burksi* Frison.—Monroe.

*Isoperla decepta* Frison.—Brown, Clark, Crawford, Dearborn, Dubois, Floyd, Franklin, Harrison, Jackson, Jefferson, Monroe, Morgan, Ohio, Perry, Pike, Ripley, Tippecanoe. This species is the most common *Isoperla* in intermittent streams in southern Indiana.

*Isoperla dicala* Frison.—Floyd, Starke.

*Isoperla frisoni* Illies.—Starke.

+ *Isoperla longiseta* Banks (IL).

*Isoperla marlynia* (Needham & Claassen).—Pike.

+ *Isoperla mohri* Frison (IL, OO).

*Isoperla namata* Frison.—Monroe, Owen.

*Isoperla nana* (Walsh).—Bartholomew, Kosciusko, Tippecanoe.

+ *Isoperla richardsoni* Frison (IL, KY).

+ *Isoperla signata* (Banks) (MI, OO).

**Subfamily Perlodinae**

*Diploterla robusta* Stark & Gaufin.—Clark, Floyd, Harrison, Jefferson, Parke, Ripley.

*Helopucus natalus* (Frison).—Although Ricker (1952) indicated a "southern Michigan to southern Indiana" distribution for *H. natalus*, no county records or museum material have been located in the literature and I have not collected fresh specimens. Bednarik and McCafferty (1977), Stark (2001), Stark et al. (1986), and Stewart and Stark (2002) listed this species from Indiana.

*Hydropsyche crosbyi* (Needham & Claassen).—Owen, Morgan, Tippecanoe.

*Hydropsyche fujitan* (Needham & Claassen).—Posey, Tippecanoe. The Posey County record refers to recently collected material (Wabash River, 8 km SSW New Harmony, Harmonie State Park. 8 April 2001, SAG and JMF. 1 ♀).

*Isogenoides varians* (Walsh).—Dubois, Pike, Tippecanoe. Similar to *Nemocapnia carolina*, with the exception of the Tippecanoe County locality, this species has been collected only from the White River. Recent trips have failed to produce fresh material.

**Family Pteronarcyidae**

*Pteronarcyys dorsata* (Say).—"Elkhart". The Elkhart record was documented by Nelson and Hanson (1971) and likely refers to either the Elkhart or St. Joseph River in north-central Indiana.

*Pteronarcyys pictett* Hagen.—Fountain, Martin, Monroe, Morgan, Pike, Tippecanoe.

**Species Removed from Indiana List**

Six species, *Allocapnia minima* (Newport), *Allocapnia pygmaea* (Burmeister), *Lencstra tenella* Provancher, *Alloperla atlantica* Baumann, *Alloperla imbecilla* (Say), and *Sweltsa naica* (Provancher) are removed from the state list. The previously published records of *Allocapnia minima* from Indiana (e.g., Stark et al. 1986) were likely in error. Ross and Ricker (1971), Finn (1973a), and Bednarik and McCafferty (1977) did not report this species from Indiana. This species is distributed mainly throughout the northern Great Lakes region...
and eastward to New England and the Canadian Maritime provinces.

There are no confirmed records of \textit{Allocapnia pygmaea} from Indiana. All previously published county records (Frison 1942, Ricker 1945) and state records (e.g., Fimm 1973a, Stewart and Stark 2002) are likely of \textit{A. nivicola}. \textit{Allocapnia pygmaea} is widely distributed throughout the upper Great Lakes and Appalachian regions with relict populations in Missouri (Poulton and Stewart 1991).

Bednarik and McCafferty (1977) listed \textit{Leuctra tenella} from Indiana, but its inclusion was based on nymphs. \textit{Leuctra tenella} displays an Appalachian distribution with a westward expansion to Wisconsin and Minnesota. Nymphs of \textit{Leuctra} are difficult to identify to species despite the taxonomic treatment by Harper and Hynes (1971). Examination of nymphs labeled as \textit{L. tenella} housed at PU was inconclusive.

Stark (2001), Stark et al. (1986), and Stewart and Stark (2002) listed \textit{Allocapnia atlantica} from Indiana. Bednarik and McCafferty (1977) listed this species from Indiana based on Baumann (1974). Baumann (1974), however, did not include Indiana in his description of \textit{A. atlantica}. This species displays an Appalachian-upper Piedmont distribution with a westward swing through the upper Great Lakes region.

Bednarik and McCafferty (1977), Stark (2001), Stark et al. (1986), and Stewart and Stark (2002) each listed \textit{Allocapnia imbecilla} from Indiana. This species displays an Appalachian distribution from Quebec south to West Virginia and Virginia. Surdeck (1985) did not study Indiana material of \textit{A. atlantica} or \textit{A. imbecilla} in her review of choeroperline genera. Additionally, Baumann (1974) did not study Indiana material of this species in his comparative analysis with \textit{A. atlantica}.

Sweltsa naica is mainly a central/northern Appalachian species, with relict populations in Virginia (Kondratieff and Kirchner 1987), and a highly unlikely member of the Indiana fauna. Bednarik and McCafferty 1977 listed this species from Indiana based on a poorly preserved female. Although I have been unable to find the specimen labeled as \textit{S. naica} to make a definitive determination, its identity is likely \textit{S. onkos}.

**DISCUSSION**

The comparatively higher species diversity values (Table 1) of the Patoka-White (051202) and Lower Ohio-Salt (051401) hydrologic units may reflect the collecting efforts during years 2000–2003. All collecting trips for this study were directed at unglaciated landscapes (Fig. 1). The opposite trend is realized with the Southeastern Lake Michigan (040500) and Western Lake Erie (041000) hydrologic units. In total, the four 'northern' units (Southwestern Lake Michigan, 040400; Southeastern Lake Michigan; Western Lake Erie; Upper Illinois, 071200) supported six species total. There is a dearth of museum and literature stonfly records for these four units. However, the third-highest diversity was supported in the Wabash hydrologic unit (051201), and this area was unvisited during this study. Whether these regional patterns of species richness are a reflection of (a) size, (b) collecting frequency, (c) anthropogenic disturbance, or (d) historical

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<th>Hydrologic Unit Code</th>
<th>Code Number</th>
<th>Species Richness</th>
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</tr>
<tr>
<td>Southeastern Lake Michigan</td>
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<td>Western Lake Erie</td>
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<tr>
<td>Middle Ohio—Little Miami</td>
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</tr>
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<td>Wabash</td>
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<td>36</td>
</tr>
<tr>
<td>Patoka—White</td>
<td>051202</td>
<td>58</td>
</tr>
<tr>
<td>Lower Ohio—Salt</td>
<td>051401</td>
<td>47</td>
</tr>
<tr>
<td>Lower Ohio</td>
<td>051402</td>
<td>17</td>
</tr>
<tr>
<td>Upper Illinois</td>
<td>071200</td>
<td>4</td>
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</tbody>
</table>

Table 1. Species richness counts of stonflies in Indiana by six-digit hydrologic unit codes. Species records include recent collections by the author, reliable literature, and examined museum material.
factors remains to be addressed. Alternatively, two additional grouping approaches need to be addressed: Level III/IV Ecoregions (Woods et al. 1998) and Homoya’s Natural Regions (Homoya et al. 1984). Concerted collecting in the northern half of Indiana and a comparative assessment of the three landscape classification schemes will be required.

ACKNOWLEDGMENTS

Cloyce Hedge and Roger Hedge, Division of Nature Preserves, Indiana Department of Natural Resources provided collecting permits on Indiana state lands. Dana King-Grubbs, Joseph Ferguson, and Jason Taylor assisted with fieldwork, and Robert Waltz extended advice on interesting collecting localities. Arwin Provonsha (Purdue University) and Colin Favret (Illinois Natural History Survey) kindly made material available for study. R. Edward DeWalt and an anonymous reviewer significantly improved the quality of this manuscript.

LITERATURE CITED


A COLLECTION OF NORWEGIAN FLEAS (SIPHONAPTERA) 
NORTH OF THE ARCTIC CIRCLE

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U.S.A.

Abstract.—Fleas (444 specimens) were collected from 8 species of small mammals 
north of the Arctic Circle in the northern Norwegian counties of Finnmark, Troms, and 
Nordland. These fleas represented 14 species belonging to 5 families. The most common 
flea, Palaeopsylla soricus soricus (Dale, 1878) found almost exclusively on Sorex araneus 
Linnaeus, 1758 comprised 31.7% of the total number. Ischnopsyllus hexactenus (Kolenati, 
1856) is reported for the first time in Norway, and Megabothris walkeri (Rothschild, 1902) 
and Peromyscopsylla bidentata bidentata (Kolenati, 1863) are reported north of the Arctic 
Circle for the first time. The zone of intergradation of the subspecies Amalaraeus penicilliger 
pedias (Rothschild, 1911) and Amalaraeus p. mustelae (Dale, 1878) in Norway is defined at 
~67°N latitude. Sorex araneus and Clethrionomys rutilus (Pallas, 1779) were each host to 9 
species of fleas.

Key Words: fleas, Siphonaptera, Norway

The Scandinavian Peninsula (Norway and Sweden) shares faunal affinities with 
Denmark, Finland, and in part with north central Europe and northwestern Asia. Smit 
(1969) provided a catalogue of fleas of Finland and reported their distribution to 
include some that extend into Norway, at the northern confluence of the 2 countries. 
Brink-Lindroth (1972, 1974) illustrated the subspecific differences and distribution of 2 
common species in Finland and Scandinavia (Palaeopsylla soricus ssp. and Amalaraeus 
penicilliger ssp.) and in western and central Europe (Amalaraeus penicilliger ssp.), respectively. Brink-Lindroth (1980) 
also compared the flea fauna of the mountains of Scandinavia to those of the Pyrenees of Spain. Other miscellaneous records 
and reports of Norway fleas include those of Cotton (1963), Dunnet (1962), Jellison 
(1962), Jordan (1932a, b), Marriott (1968), Mehl (1967a, b, c), Rothschild (1911), and 

This paper treats a collection of fleas primarily from common cricetid rodents and 
soricid shrews distributed throughout the three northern Norwegian counties north of 
the Arctic Circle (66°33’N). One species of bat flea is reported north of the Arctic Circle 
for the first time, the distribution of several species is expanded, and host-parasite 
relationships are discussed.

MATERIALS AND METHODS

Most of the small mammals were trapped in Ugglan Special® live traps, using dog 
chow and commercial rodent feed (various seeds) as bait. Traps were placed on line at
10 m intervals. The purposes of this study were to examine the distribution of small mammals in forested areas of northern Norway and to study morphological adaptations and population cycles in *Sorex araneus* Linnaeus, 1758. A few mammals were also trapped by Statskog-Fjellitenesten using snap traps as part of their annual trapping scheme at fixed localities, and a collection of water voles, *Arvicola terrestris* Linnaeus, 1758, was given to the Tromsø Museum by Nils-P. Thommesen. Trapping periods were completed during the summer and autumn months from July to November 1998–2001. To facilitate clarity and associate each flea species with UTM coordinates (ED50 system), general habitat types, and elevations (meters), the following data are presented by counties. Numbered collection localities are illustrated in Fig. 1 and appear in parentheses adjacent to the locality descriptions below.

**FINNMARK COUNTY**

Vestre Jakobselv (15) (35W 5885 77821)—Birch forest and meadow, 50–80 m

**NORDLAND COUNTY**

Balvatnet (3) (33W 5412 74302)—Subalpine birch forest to low alpine, 600–680 m.

Bliksvær (4) (33W 456 7462)—Meadow, 10–20 m.

Rándalen (6) (33W 5844 75746)—Birch forest, willow, rowan, etc., 20–60 m.

Saltdal (2) (33W 516 7311)—Pine forest, 120 m.

Skjomdalen (7) (33W 6068 75628)—Deciduous (birch, alder, etc.), and pine forest, 100 m; (33W 6105 75633)—Birch forest to low alpine, 400–480 m.

Sørøya (1) (33W 518 7396)—Birch forest to low alpine, 610–680 m.

Straumvatnet (5) (33W 528 74688)—Birch forest mixed with aspen, willows, etc., 10–50 m.

**TROMS COUNTY**

Budalen (8) (34W 3858 7619)—Birch forest, 200–240 m.

Fig. 1. Map of Norway illustrating mammal collection sites (see Materials and Methods for details).

Dividalen (10) (34W 436 7657)—Spruce forest, 90 m.

Kirkesdal (9) (34W 416 7654–7)—Deciduous forest (birch, alder, etc.), 40–60 m.

Kvaloya (13) (34W 4213 77373)—Pasture in birch forest, 40 m.

Skibotndalen (11) (34W 4728 76926)—Moist birch forest with some pine, 30 m;
(34W 4775 76875)—Birch and pine forest, each with dry and moist areas, 100 m;
(34W 4878 76781)—Willow thicket with birch, 330 m; and
(34W 4905 76723)—Deciduous forest (birch, willow), 500 m.
Tønsvikdalen (14) (34W 4295 77380)—Birch forest, 30 m.
Tromsø (12) (Museum)(34W 4189 77265)—Within museum, 30 m.

Table 1 provides the number of males/females of each flea species collected from each locality. Host/parasite records are listed in Table 2. A small disparity between the number of specimens in the 2 tables is attributed to some specimens for which the certainty of the host was unknown. In such cases, a count of those fleas was not included in Table 2.

**Ceratophyllidae**

*Amalaraeus penicilliger pedias* (Rothschild, 1911)

Populations of the 2 subspecies *A. p. pedias* and *A. p. mustelae* (Dale 1878) meet just north of the Arctic Circle, the former representing the northern population. Brink-Lindroth (1972) stated, "*A. p. pedias* and *A. p. mustelae* are indistinguishable in the male as regards the basimeres and telomeres and the location of the spinforms on the posterior margin of the telomeres" but indicated the hamuli (= crochets) are diagnostic. Morphometric studies by Brink-Lindroth (1974) confirmed these observations. All males from Straumvatnet north to Kvaløya/Tønsvikdalen are clearly *A. p. pedias* based on the hamuli. A deep sinus and extended dorsal lobe of st. VII is indicative of associated females also. A single female approximately 50 km south of Straumvatnet is either an intergrade of the 2 forms or *A. p. mustelae*. The dorsal lobe of the st. VII was very short and truncate with only a shallow subtending sinus. It appears from these data in conjunction with reports by Smit (1969) and Brink-Lindroth (1972) that the southern limit of *A. p. pedias* in Norway occurs north of 67°N latitude. Species associated with specific localities are listed in Table 1.

Most specimens were recovered from *Clethrionomys rutilus* (Pallas, 1779) with stragglers from *C. rufocanus* (Sundevall, 1846), *Sorex araneus* Linnaeus, 1758, and *Microtus agrestis* (Linnaeus, 1761). Smit (1969) and Brink-Lindroth (1972) suggested that the preferred host in Finland and Sweden, respectively, was *Clethrionomys glareolus* (Schreber, 1780). In our study area, *C. glareolus* and *C. rutilus* do not coexist except in the region of Skjomdalen. Populations of the former occur to the south of Skjomdalen and the latter to the north. Sixty-five *C. glareolus* specimens were examined without recovery of a single specimen of *A. p. pedias*, while 134 *C. rutilus* harbored 43 of the 65 specimens collected (66.1%) (Table 2). These data would suggest that *A. p. pedias* prefers *C. rutilus* (or their biohabitats) over that of *C. glareolus* in northern Norway and is displaced by *A. p. mustelae* on *C. glareolus*, particularly to the south of the Arctic Circle.

**Ctenophthalmidae**

*Corrodopsylla birulai* (Ioff, 1928)

This flea is confined to the northern Palaearctic Region from the Scandinavian Laplands, through northern Asia to Hokkaido, Japan. We found this flea distributed widely in low numbers from ~68°30'N to 70°N latitude on *S. araneus*. The zoogeography of this genus is of particular interest. *Corrodopsylla birulai* is Palaearctic, occurring only in northeastern Europe and Asia, while the other three species in the genus are restricted to the Nearctic Region. The southern limits of *C. birulai* appear to run from northern Norway to Sweden (66°N), Mongolia (47°48'N), Primorsky Kray (45°N) to Hokkaido, Japan (44°N). Ioff and Skalon (1954) report this species in the Arkhangelsk and Transbaikalia Regions as well.
Table 1. The number of males/females of each flea species listed by locality (county).

<table>
<thead>
<tr>
<th>Locality</th>
<th>Amalarius penicilliger pedius</th>
<th>Amphipsylla sibirica sibirica</th>
<th>Corrodopsylla birulai</th>
<th>Ctenophthalmus agyrtes agyrtes</th>
<th>Ctenophthalmus uncinnatus uncinnatus</th>
</tr>
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<td>Finnmark County</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Balvatnet</td>
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<td></td>
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<tr>
<td>Bliksvær</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
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<td></td>
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<td></td>
</tr>
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<td>12/7</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>Straunvatnet</td>
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<td>Kvaløya</td>
<td>22/18</td>
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<td>Skibotndalen</td>
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<td>4/1</td>
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<td>2/1</td>
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<tr>
<td>Tromsø</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

Sakaguti and Jameson (1962) illustrated the spermatheca and st. VII (fig. 23D) of an extreme eastern record of *C. birulai*. Although their illustration of the male (fig. 23G) is indistinguishable from that of *C. birulai* throughout its range, the spermatheca and st. VII of the female are unlike those of *C. birulai* or any species of *Corrodopsylla*. Females were reportedly not examined in their study and it is unclear what female specimen they used for their drawing. Possibly specimens from Hokkaido represent a new taxon.

**Ctenophthalmus** (*Ctenophthalmus*) *agyrtes agyrtes* (Heller, 1896)

A series (8 males, 10 females) was collected from 5 of 10 specimens of *Arvicola terrestris* on the island of Bliksvær (Nordland) on 15 November 1999. This extends the known range of this subspecies north to nearly 67°N.

**Megabothris walkeri** (Rothschild, 1902)

This was the dominant flea found on *Arvicola terrestris*, occurring on 8 of the 29 specimens examined with a mean number of 3.4 fleas per positive host. It was not collected from any other host species and was associated with *C. a. agyrtes* on 5 of the same 8 animals. *Ctenophthalmus a. agyrtes* was also found only on *A. terrestris*. The fact that *M. walkeri* and *C. a. agyrtes* were associated in the pelage of the same animals and that neither flea was found on the majority (21/29) of the *A. terrestris* examined, would suggest that these 2 fleas share common requirements of their microhabitat. Smit (1969) suggested that *M. walkeri* was not found north of the Arctic Circle because of its requirements for high relative humidity in nests. *Arvicola terrestris* often lives in humid conditions, i.e., rich soil close to small patches of fresh water or swamp, which may provide suitable developmental conditions in some but not all habitats inhabited by *A. terrestris*. This might explain why *M. walkeri* occurs north of the Arctic Circle. The discovery of *M. walkeri* at Bliksvær (Nordland) extends the known range of this species farther north in
Table 1. Extended.

<table>
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<tr>
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</tr>
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</tr>
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<td></td>
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<td>0/1</td>
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<td>0/3</td>
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<td>14/26</td>
<td></td>
</tr>
<tr>
<td>16/8</td>
<td>6/34</td>
<td></td>
</tr>
</tbody>
</table>

Norway than previous records from Trondheim (Mehl 1967c).

_Palaeopsylla soricus soricus_ (Dale, 1878)

This species commonly infests the shrew _Sorex araneus_. _Sorex araneus_ was the most abundant mammal collected in this study (376 specimens) and consequently accounted for 45% of the fleas. _Palaeopsylla s. soricus_ is reported only along the coast of Norway (Brink-Lindroth 1972, Smit 1969). It is replaced inland in southern Norway and Sweden by _P. s. rosickyi_ Smit, 1960 and to the north by _P. s. starki_ Wagner, 1930. _Palaeopsylla soricus_ subspecies are distinguishable only in the males. Females without accompanying males from Straumvattenet, Råndalen, Kirkesdalen, and Dividalen are considered _P. s. soricus_ based on their geographic distribution. Both males and females were taken from Skibotndalen, Kvaloya, and Tonsvikdalen. The apical dorsal sclerite of the aedeagus was typical of _P. s. soricus_ while reticulations of the distal portion of the apex of the lateral wall demonstrated an intergrade with _P. s. rosickyi_. Reticulations of the lateral wall were present in only one of 3 males from Tonsvikdalen. Two females (without accompanying males) from Vestre Jakobselv were considered _P. s. starki_ because of their extreme northern distribution.

_Rhadinopsylla integella_ Jordan and Rothschild, 1921

In the literature, _Clethrionomys glareolus_ is the most common host of _R. integella_. In our study, 6 of 11 specimens were collected from _A. terrestris_ from the island of Bliksvær (Nordland). No species of _Clethrionomys_ were collected during these studies on this island. Most, if not all members of this genus, are nest fleas, consequently, specimens are seldom collected and usually no more than 1 or 2 specimens are ever collected on a single animal. This is the first time this species has been taken from _A. terrestris_ in Norway.

<table>
<thead>
<tr>
<th>Flea Species</th>
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</tr>
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<tbody>
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<td></td>
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<tr>
<td>16/8</td>
<td>6/34</td>
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</tr>
</tbody>
</table>

3/2
Table 2. Host flea associations north of the Arctic Circle (number of males/number of females).

<table>
<thead>
<tr>
<th>Host Positive hosts/total hosts</th>
<th>Amulcerus penicilliger pedius</th>
<th>Amphipsylla sibirica sibirica</th>
<th>Ctenophthalmus agyretes agyretes</th>
<th>Ctenophthalmus uncinatus uncinatus</th>
<th>Hystriophyssa orientalis</th>
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</thead>
<tbody>
<tr>
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<td>8/18</td>
<td>3/2</td>
<td>1/1</td>
<td>0/1</td>
</tr>
<tr>
<td>Clethrionomys glareolus (2/65)</td>
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<td>1/4</td>
<td>0/2</td>
<td>7/3</td>
<td>0/1</td>
</tr>
<tr>
<td>Clethrionomys rufocanus (14/121)</td>
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<td>14/10</td>
<td>0/2</td>
<td>7/3</td>
<td>0/1</td>
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<td>Clethrionomys rutilus (14/134)</td>
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<td>Eptesicus nilssonii (1/1)</td>
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<tr>
<td>ratus norvegicus (1/1)</td>
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<td>0/1</td>
<td>1/3</td>
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<tr>
<td>Sorex araneus (?/376)</td>
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<td>8/6</td>
<td>7/4</td>
<td>2/4</td>
<td>1/3</td>
</tr>
</tbody>
</table>

Ischnopsyllidae

Ischnopsyllus hexactenus (Kolenati, 1856)

A single female of *I. hexactenus* was collected from a juvenile *Eptesicus nilssonii* (Keyserling and Blasius, 1839) in Kirkesdalen (several hundred kilometers north of the Arctic Circle) on 12 August 2001. Smit (1966) also reported *I. hexactenus* from *E. nilssonii* in Switzerland but considered it an accidental association. This bat flea is a common parasite of *Plectotus auritus* (Linnaeus, 1758) throughout Europe and the British Isles. Although *P. auritus* also occurs in the southern half of Norway, *I. hexactenus* has never been documented there. *Eptesicus nilssonii*, a very common bat throughout Norway, is undoubtedly associated with *P. auritus* where they are sympatric well below the Arctic Circle. Since *P. auritus* and *E. nilssonii* are considered non-migratory species, usually moving less than 100 km, it is puzzling how this flea is associated with *E. nilssonii* so far out of the range of its usual host. Perhaps either one or both of these bats migrate further, or *E. nilssonii* may be a more important host than records might indicate. Further ectoparasite studies of both these bat species in Norway, both north and south of the Arctic Circle, are warranted to resolve this question.

Leptopsyllidae

Amphipsylla sibirica sibirica

(Wagner, 1898)

Smit (1969) indicated that *A. s. sibirica* is an uncommon flea, although it is a widely distributed species. Our series of 51 specimens collected from both cricetid rodents and *S. araneus* might indicate otherwise. A sex ratio of 1:1 is noted.

Peromyscopsylla bidentata bidentata

(Kolenati, 1863)

Although *P. b. bidentata* has been recorded numerous times in Finland, there are no records in Sweden and only a single male was reported by Jellison (1962) from Hamar, Norway. This is the first record of *P. b. bidentata* in Norway north of the Arctic Circle. Only 6 specimens were collected. Smit (1969) indicated that this is a winter flea. This may explain why it is infrequently collected in its northern range. Jellison’s specimen was collected in the spring and ours in the late fall.

Acknowledgments

Thanks to Statskog-Fjelltjene and Nil-P. Thomsen who collected some of the mammals and kindly donated the fleas for inclusion in our study.

Literature Cited


Table 2. Extended.

<table>
<thead>
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<th>Flea Species</th>
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<th>Nodor-syllas fasciatus</th>
<th>Palaecopsylla soricis soricis</th>
<th>Palaecopsylla soricis starki</th>
<th>Peromyopsylla bidentata</th>
<th>Peromyopsylla xylotica</th>
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PRELIMINARY SURVEY OF THE CRANE FLIES OF LOUISIANA (DIPTERA: TIPULIDAE, PTYCHOPTERIDAE)

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Abstract.—The Tipuloidea of Louisiana have not come within the scope of earlier regional faunal studies of these flies. Fifty-two species (one of Ptychopteridae and 51 of Tipulidae) are recorded from Louisiana, 31 of them for the first time. This preliminary list somewhat overemphasizes the larger crane flies (Subfamily Tipulinae).

Key Words: Tipulidae, Ptychopteridae, Louisiana

Early in his amazingly productive career, C. P. Alexander published a two-volume treatise (1919, 1920a) on the crane flies of New York. Later (1942, 1966) he added a major publication on the Tipuloidea of Connecticut. The scope of both these works was much wider than the titles suggest, including most of northeastern United States and southeastern Canada, and extending well into the Upper Midwest. In dozens of shorter papers, many in numbered series, he described hundreds of species as specimens became available to him. In one series of papers published in The American Midland Naturalist between 1940 and 1954, Alexander dealt with the crane flies (Tipuloidea) of several regions of the United States that had provided specimens of greatest interest to him. In the eastern states, these included two papers on crane flies of the southern Appalachians in Tennessee (1940) and North Carolina (1941). But he never dealt with species—on a regional basis—from the Coastal Plain of southeastern United States (i.e., Georgia and Florida) westward into Texas.

As a matter of fact, there has been only one crane fly survey paper published in the past 90 years that covers any part of the Gulf Coastal Plain region—Rogers’ 1933 report, which focused on northern peninsular Florida, but also included some records from southern Georgia, southern peninsular Florida, and the Florida panhandle. Prior to our study, there have been no published reports of crane fly collections from Louisiana, only isolated locality records for a relatively modest number of species in the context of revisionary studies or catalogues.

Our report is based on: (1) tipulid specimens in the Louisiana State Arthropod Museum, Department of Entomology, Louisiana State University (LSU), Baton Rouge; (2) a collection assembled by the junior author (DAR) between August 1997 and May 1999, when he was living in Louisiana year round, plus a small sample acquired on subsequent visits to the state following his retirement from LSU and relocation to Iowa; and (3) a few specimens collected by the senior author (GWB) during visits to Louisiana in 1983 and 1993.
For the sake of completeness, in addition to the taxa identified in the three collections mentioned above, we have listed all of the species previously reported from the state but not represented in the collections we examined. This brings the total number of species known from Louisiana to 52, which more than doubles the number of species previously reported from the state. Since most of our material was collected in East Baton Rouge Parish (the Louisiana equivalent of a county), where LSU is located and where the junior author resided, one can only assume that future collecting focused on other parts of the state would yield still more previously unreported taxa.

Species List

Family Ptychopteridae

Bittacomorpha clavipes (Fabricius).—Washington Par.: Sheridan. Lee Memorial Forest, April 19. First state record; nearest previous records—NW Arkansas (Byers and Robison 1997) and Florida, Georgia, Tennessee (Alexander 1966). The specimen was fluttering in a hardwood corridor along a small stream running through a pine upland; sphagnum moss was abundant adjacent to the stream.

Family Tipulidae

Subfamily Tipulinae

Megistocera longipennis (Macquart).—East Baton Rouge Par.: Baton Rouge. June 22, September 11–24. First state record; nearest previous records—Texas and N Florida (Alexander 1965). The individual collected in late September was taken at an outdoor light.

Dolichopeza (Oropeza) subalbipes Johnson.—Natchitoches Par.: No specific locality or date (Byers 1961).

Brachypremna dispellens (Walker).—West Feliciana Par.: Tunica Hills Nature Preserve, September 6. First state record; nearest previous records—NW Arkansas (Byers and Robison 1997) and “... Tennessee southward to Florida and Texas” (Alexander 1966).

Nephrotoma abbreviata (Loew).—East Baton Rouge Par.: Baton Rouge. March 13, June 24, August 31–November 21; 3 mi. N of Baton Rouge. October 14. Livingston Par.: Denham Springs. February 28. Pointe Coupee Par.: Sherburne Wildlife Management Area, October 17. St. Charles Par.: Norco (Oosterbroek 1984). All but the St. Charles Par. specimen represent first parish records. Two specimens were collected at outdoor lights (August 31, September 24), and one was taken in a light trap on September 16.

Nephrotoma cornifera (Dietz).—East Feliciana Par.: Clinton, September 10. First state record; nearest previous record—panhandle Florida (Tangelder 1983).

Nephrotoma macroceria (Say).—East Baton Rouge Par.: Baton Rouge. September 20–October 13; Bluebonnet Swamp Nature Center, October 26. St. Charles Par.: Norco (Tangelder 1983). Winn Par.: Gum Springs. 13 km WSW of Winnfield, May 17. All but the St. Charles Par. specimen represent first parish records. A female specimen collected on a lighted window at night at the Bluebonnet Swamp Nature Center on May 3, 1998, may represent either this species or N. gnata (Dietz). If it is the latter species, it would be the first state record; the nearest previously reported records for N. gnata—NW Alabama and N Arkansas (Tangelder 1983).


Nephrotoma urocera (Dietz).—West Feliciana Par.: Tunica Hills Nature Preserve, October 18. First state record; nearest previous records—west-central Alabama and panhandle Florida (Tangelder 1983). The specimen was first observed flying, then hanging from vegetation, along a sandy creek bottom in deeply dissected, hardwood-covered loess bluffs.

Tipula (Nippotipula) abdominalis (Say).—De Soto Par.: Stonewall, October 18. First state record; nearest previous re-

*Tipula (Lunatipula) australis* Doane.—Louisiana: No specific locality (Alexander 1966).

*Tipula (Lunatipula) rossmanii* Byers.—East Baton Rouge Par.: Baton Rouge, January 9–February 2; Bluebonnet Swamp Nature Center, April 5. East Feliciana Par.: Port Hudson State Commemorative Area, January 18. This newly described species (Byers 2003) was the most frequently encountered crane fly during the month of January. Eight of the 12 Baton Rouge specimens were found flying low (less than two feet) above a lawn.


*Tipula (Platytipula) tennessa* Alexander.—East Baton Rouge Par.: Baton Rouge, November 1; 1.2 mi. S of Central. November 12. First state records: nearest previous record—Tennessee (Alexander 1920b). One specimen was netted by sweeping.

*Tipula (Platytipula) ultima* Alexander.—East Baton Rouge Par.: Baton Rouge, November 17. First state record; nearest previous record—Mississippi (Alexander 1966). This single female specimen closely resembles the female of *Tipula (P.) tennessa*.

*Tipula (Schummelia) sp. near hermannia* Alexander.—East Baton Rouge Par.: Baton Rouge, March 19. This female specimen would represent the first state record for *T. hermannia*; nearest previous records—Tennessee, Georgia, N Florida (Alexander 1966). The fly was collected on the outside of a window screen at 7 A. M.

*Tipula (Triplicipitula) umbrosa* Loew.—Caddo Par.: Louisiana Welcome Center on I-20, March 20. East Baton Rouge Par.: Baton Rouge, January 24–April 9, October 8; Bluebonnet Swamp Nature Center, March 12–May 3. Jackson Par.: Schoolhouse Springs, 6 mi. N of Eros, April 14. Livingston Par.: Denham Springs, March 19, Natchitoches Par.: LA 6 at I-49, March 20. St. Landry Par., I-49 rest area, March 20. St. Tammany Par.: 3 mi. E of Folsom, March 18–24. Terrebonne Par.: Schriever, October 15. West Baton Rouge Par.: Brusly, March 12; Port Allen, February 16. West Feliciana Par.: 6 mi. ESE of St. Francisville, Feliciana Preserve, April 16. First parish records (Loew’s type specimen was from Louisiana). This is probably the most ubiquitous, and unquestionably the most conspicuous, crane fly species in Louisiana during the late winter and early spring months. The collection of two specimens in October raises the possibility that *T. umbrosa* may have two generations per year in Louisiana. Most specimens were collected on the outside walls and windows of buildings (as high as the third story) during daylight hours, although one was sitting on a lighted window at night, and two others were collected at blacklights. Several were found in yard vegetation, and a copulating pair was collected on the surface of a concrete parking lot on a cool, sunny day (February 14, 1999).

*Tipula (Yamatotipula) eluta* Loew.—East Baton Rouge Par.: Baton Rouge, May 26 and October 10; Bluebonnet Swamp Nature Center, October 19–November 16. West Feliciana Par.: 6 mi. ESE of St. Francisville, Feliciana Preserve, September 28. First state records: nearest previous records—NW Arkansas (Byers and Robison 1997) and Tennessee, N Florida (Alexander 1966). The collecting dates suggest the possibility of two generations. Specimens were collected in a variety of situations: by sweeping, by hand amid logs on the forest floor, on the inside wall of a carport, on large window panes, and on a boardwalk railing at the edge of a cypress swamp.


*Tipula (Yamatotipula) furca* Walker.—East Baton Rouge Par.: Baton Rouge, May
12–June 15, September 16–October 20: Baker, October 24. St. Martin Par.: 4 mi. S of Belle River, January 31. First parish records. One specimen was collected on a patio wall, one was swept from weeds, and one was near a light.

*Tipula (Yamatotipula) jacobus* Alexander.—East Baton Rouge Par.: Bluebonnet Swamp Nature Center, November 16. Washington Par.: Sheridan, Lee Memorial Forest, April 19. First state records; nearest previous records—NW Arkansas (Byers and Robison 1997) and Tennessee, Georgia, and N Florida (Alexander 1966). The Bluebonnet Swamp specimen was on a boardwalk railing at the edge of a cypress swamp; the one from Lee Memorial Forest was found on herbaceous vegetation in a hardwood bog in pine uplands.

*Tipula (Yamatotipula) ludoviciana* Alexander.—Louisiana: No specific locality (Alexander 1965).

*Tipula (Yamatotipula)* sp. near osceloa Alexander.—East Baton Rouge Par.: Baton Rouge, November 24–25. If this tentative identification is correct, it would be the first state record for the species; nearest previous record—Florida (Alexander 1927).

*Tipula (Yamatotipula) sayi* Alexander.—East Baton Rouge Par.: Baton Rouge, October 5–November 20; 3 mi. N of Baton Rouge, US 61, October 14. East Feliciana Par.: Idlewild Research Station, July 20. Natchitoches Par.: no specific locality, October 30. First parish records. Two specimens were collected in buildings (one on the third story), and one was sitting on the door of a garage.

*Tipula (Yamatotipula)* sp. near sayi Alexander.—East Baton Rouge Par.: Baton Rouge, October 26–November 2; 2 mi. SE of Baton Rouge, November 20. These individuals may represent a variant of *T. sayi* in which the ninth tergum of the male differs slightly.

*Tipula (Yamatotipula) subeluta* Johnson.—East Baton Rouge Par.: Baton Rouge, August 29–October 14. First state record; nearest previous record—Florida (Alexander 1966). One specimen was collected near a porch light.

*Tipula (Yamatotipula) tricolor* Fabricius.—East Baton Rouge Par.: Bluebonnet Swamp Nature Center, October 26. Jefferson Par.: 8 mi. S of Marrero, April 4. First state records; nearest previous records—Arkansas, Tennessee, Alabama, Florida (Alexander 1966). Both localities are in or immediately adjacent to swamp forests. The specimen from Bluebonnet Swamp was collected on a large window pane of the nature center in the early morning.

**Subfamily Limonitinae**


*Limonia (Geranomyia) canadensis* Westwood.—Louisiana: No specific locality (Alexander 1966).


*Limonia (Geranomyia) rostrata* Alexander.—Louisiana: No specific locality (Alexander 1966).


*Limonia (Rhipidia) bryanti* (Johnson).—St. Tammany Par.: 10 mi. NE of Slidell, June 2. First state record; nearest previous
records—Texas and Florida (Alexander 1966).

**Limonia (Rhipidia) domestica** (Osten Sacken).—East Baton Rouge Par.: Baton Rouge, August 29—January 10; Bluebonnet Swamp Nature Center, December 6; 3 mi. N of Baton Rouge, US 61, October 14; Ben Hur Farm Research Station, August 27; 1.2 mi. S of Central, September 2. East Feliciana Par.: Clinton, September 10. St. Tammany Par.: 10 mi. NE of Slidell, May 23. First state records; nearest previous records—Texas and Mississippi (Alexander 1966). One specimen was netted by sweeping beneath a pecan tree; four others were taken at lights.

**Limonia (Rhipidia) fidelis** (Osten Sacken).—East Baton Rouge Par.: Baton Rouge, September 19; Zachary, September 16. First state records; nearest previous records—Tennessee and NW Florida (Alexander 1966). The Baton Rouge specimen emerged from rotting wood.

**Oritmarga (Diotrepha) mirabilis** (Osten Sacken).—East Baton Rouge Par.: 1.2 mi. S of Central, September 2; NE of Indian Mound, October 13. First state records; nearest previous records—N Florida and Texas (Alexander 1966).

**Helius (Helius) flavipes** (Macquart).—Acadia Par.: No specific locality, October 9. First state record; nearest previous records—Texas, Alabama, Florida (Alexander 1966).

**Pedicia (Tricyphona) inconstans** (Osten Sacken).—Jackson Par.: Schoolhouse Springs, 6 mi. N of Eros, April 14. First state record; nearest previous record—NW Arkansas (Byers and Robison 1997) and Georgia (Alexander 1966).

**Epiphragma fasciapenne** (Say).—Louisiana: No specific locality (Alexander 1966).

**Epiphragma solatrix** (Osten Sacken).—Caddo Par.: West Shreveport, September 18. East Baton Rouge Par.: Baton Rouge, March 26, September 23—November 3. West Feliciana Par.: Tunica Hills Nature Preserve, March 28. First parish records. It seems likely that there are two generations each year. One of the Baton Rouge specimens was sitting on the window of a building; the one from the Tunica Hills was sitting on a sandy creek bottom in a deeply dissected, bluffland hardwood forest.

**Pseudolimnophila luteipennis** (Osten Sacken).—East Baton Rouge Par.: Baton Rouge, April 4—May 16 and December 6. First parish record. The specimen collected in December was active on a large window in early morning.

**Pseudolimnophila** species.—East Baton Rouge Par.: 3 mi. N of Baton Rouge, US 61, March 24; 1.2 mi. S of Central, April 4. This species has the head conspicuously prolonged behind the eyes and vein 2A curved apically to the margin, but the male has blackened, bifurcate gonapophyses such as shown by Alexander (1966, fig. 461) for *Limnophila similis* Alexander. The Rs is short and curved as shown for *Astrolimnophila* Alexander: the thoracic color is similar to that of *Limnophila lutea* Doane.

**Pilaria recondita** (Osten Sacken).—East Baton Rouge Par.: Baton Rouge, April 4—26; Bluebonnet Swamp Nature Center, December 6. St. John the Baptist Par.: La Place, August 8. Vernon Par.: Rosepine, October 10. First parish records. One specimen was actively moving about on the inside wall of a carport, another was flying around porch lights, and a third was sitting on a large, lighted window pane of the nature center after dark.

**Atarba (Atarba) picticornis** Osten Sacken.—Louisiana: No specific locality (Alexander 1966).


**Gnophomyia (Gnophomyia) tristissima** Osten Sacken.—West Feliciana Par.: W of Weyanoke, Tunica Hills, May 8. “Magnolia” [no parish indicated, and there are four
communities of this name in the state). April 27. First state records; nearest previous records—Texas, Alabama, Florida (Alexander 1966).

_Teucholabis (Teucholabis) complexa_ Osten Sacken.—East Baton Rouge Par.: Baton Rouge, October 5. Iberville Par.: St. Gabriel Research Station, October 7. St. Tammany Par.: No specific locality. August 18. First state records; nearest previous records—Oklahoma, Alabama, Florida (Alexander 1966). The Baton Rouge specimen was found in a house, and the one from St. Gabriel was collected by use of a mercury vapor blacklight.


_Gonomyia (Lipophleps) bursessi_ Alexander.—Rapides Par.: Camp Claiborne (Alexander 1944).

_Gonomyia (Lipophleps) sulphurella_ Osten Sacken.—Louisiana: No specific locality (Alexander 1966).

_Erioptera (Psiloconopa) graphica_ Osten Sacken.—Louisiana: No specific locality (Alexander 1965).

_Erioptera (Mesocyphona) femoratra_ Alexander.—East Baton Rouge Par.: Baton Rouge, November 9–26. First state record; nearest previous record—Georgia (Alexander 1965).

_Erioptera (Mesocyphona) parva_ Osten Sacken.—East Baton Rouge Par.: Baton Rouge, November 9–27. First state record; nearest previous records—Alabama and Florida (Alexander 1966).


_Toxorhina (Toxorhina) magna_ Osten Sacken.—East Baton Rouge Par.: Baton Rouge. June 26. September 10–November 23: 1.2 mi. S of Central. June 16. First parish records. One of the June specimens was at a blacklight. the other was sitting on a wall just beneath the ceiling of a carport. One of the fall-collected flies was swept from weeds, and the other was on a lighted store window.

**ACKNOWLEDGMENTS**

We thank Dr. Victoria Moseley Bayless, Curator of the Louisiana State University Arthropod Museum, for the loan of specimens from the collection in her care. Our thanks also go to Dr. Jon K. Gelhaus of the Academy of Natural Sciences of Philadelphia, for his help in identifying some perplexing specimens of _Tipula_, and to two anonymous reviewers who offered helpful suggestions.

**LITERATURE CITED**


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A NEW SPECIES OF PSILOTUS FISCHER VON WALDHEIM
(COLEOPTERA: NITIDULIDAE: NITIDULINAE) FROM PERU, WITH NEW
DISTRIBUTION RECORDS FOR OTHER PSILOTUS SPECIES

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Abstract.—Psilotus is an endemic Neotropical genus of Nitidulidae occurring from Mexico and Trinidad to Argentina, Bolivia, and southeastern Brazil. These dorsoventrally flattened beetles are typically found in subcortical habitats. The addition of *Psilotus bicolor*, new species, brings the total number of species to 11. A thorough description, diagnosis, and habitus photograph are provided for easy identification. Comments are given on male mandibular morphology, and new distribution records for *P. atratus* Reitter, *P. carbonicus* Erichson, *P. corinus* (F.), *P. germaini* Grouvelle, and *P. ventralis* Erichson are provided.

Key Words: Coleoptera, Nitidulidae, Neotropical, *Psilotus*, sap beetle

The genus *Psilotus* (Fischer von Waldheim 1829) is a member of the subfamily Nitidulinae, the most diverse nitidulid subfamily in number of constituent genera (>115 worldwide) and modes of life (i.e., anthophily, herbivory, fungivory, predation, saprophagy, necrophagy, and inquiline with social Hymenoptera). Of these varied feeding behaviors, fungivory, whether obligate or facultative, is by far the most dominant, occurring in more than half of the nitiduline genera. Some nitiduline genera are specialists on particular fungal lineages such as *Pocadius* Erichson on puffballs and their kin (Lycoperdaceae), *Thalyaera* Erichson on hypogeous fungi such as truffles (Tuberaeaceae), and *Psilopyga* LeConte on stinkhorns (Phallaceae), whereas others are more general fungivores such as *Pallodes* Erichson, *Camptodes* Erichson, and *Cyllodes* Erichson (Donisthorpe 1935, Fogel and Peck 1975, Kirejtshuk and Leschen 1998, Leschen 1999). Members of *Psilotus* are found under bark and can be collected by fogging fungus covered logs, and using flight intercept traps and blacklights. I have also collected specimens in palm sheaths, where *P. atratus* Reitter was observed feeding directly on a black sooty mold under a rotting palm leaf sheath (*Iriartea deltoidea* Ruiz & Pav.) in southern Costa Rica.

*Psilotus* is one of only a few nitiduline taxa that exhibit extreme sexual dimorphism in mandible structure. The male mandibles are often as long as or longer than the length of the head with proliferation of the median tooth into a robust elongate process in some species and a flattened keel-like structure in others. Through direct observations, male mandibular morphology was shown to be species specific with little variation expressed across broad geographic areas. My current research is exploring the morphometrics and three-dimensional structure of male mandibles as well as other external features to provide a natural clas-
sification of the genus. The description of *Psilotus bicolor* is a first step in understanding this nitiduline genus and provides a framework for assessing its phylogenetic position within the Nitidulinae.

**Material and Methods**

Approximately 1000 specimens of *Psilotus* were examined from the following: American Museum of Natural History (AMNH), The Natural History Museum, London (BMNH), Canadian Museum of Nature (CMN), Field Museum of Natural History (FMNH), Florida State Collection of Arthropods (FSCA), Instituto Nacional de Biodiversidad de Costa Rica (INBio), Louisiana State Arthropod Museum (LSAM), and the National Museum of Natural History, Smithsonian Institution (USNM), and the Andrew R. Cline pers. coll. (ARCC) currently housed at the Louisiana State Arthropod Museum.

Label data were recorded from specimens bearing new distribution records. In the records below, a "::" denotes a line break in a label, and a "//" separates more than one label if present. All dissections were made with customized minuten pin tools and fine tip forceps under a WILD® Heerbrugg dissecting microscope. Genitalia were promptly placed on a glycerin slide mount and illustrated at 100× using a camera lucida attached to an Olympus® BX50 compound microscope. Measurements were made with a calibrated ocular micrometer. Total length is here defined as the distance from the center of the apical border of the pronotum to the elytral apex, width is the distance across the middle of the pronotum, and depth is equal to the distance from the elytral humeri to the metasternum when viewed laterally. Head width to length ratio is defined as the distance from the outer angles of the temples to the distance from the tips of the labrum to the posterior margin of the head. Pronotum width to length ratio is the distance between to middle of the lateral margins to the distance from the middle of the anterior margin to the middle of the posterior margin. Elytral width to length ratio is the distance between the latero-basal corners to the distance from the scutellar apex to the elytral apex.

*Psilotus bicolor* Cline, *new species*  
(Figs. 1–6)

Holotype.—Male, with the following data labels: Peru: Dept. Huanuco, 2500 m., Chinchao, 25 km. Below Carpish, Sept. 10, 1946. F. Woytkowski/HOLOTYPE; *Psilotus; bicolor*; A.R. Cline det. 2003. Deposited in AMNH.

Description of holotype (Fig. 1).—Length: 8.5 mm, width: 4.1 mm, depth: 1.2 mm. Body flattened, elongate oval, shining, and distinctly bicolored. Head, pronotum, scutellum, and underside reddish orange, underside more dull than pronotum and
head. Elytra griseous with metallic blue sheen, elytral margins and suture reddish. Mandibles exceedingly large and ornate, longer than length of head. Head large and transverse with relatively small eyes. Pronotum wide, more than two times wider than long, wider than elytra. Elytra slightly longer than combined width, distinctly costate and serially punctate. tips ending in dehiscent subapical apex.

*Head:* Large, transverse, width: length = 2.1:1.0. Temples produced laterally into sharp points that extend beyond lateral edge of eye. Lobes over antennal insertions only slightly produced. Occipital line faintly visible along medial ½ of head. Clypeus moderately prolonged anteriorly. Labrum distinctly bilobed with median incision deep, approaching clypeal border. Each labral lobe with a long stiff anteriorly projecting seta arising from anterior-medial region of the lobe. Mandibles greatly prolonged anteriorly, longer than length of head, two prominent teeth at apex, subapical tooth about ½ length of apical tooth (Fig. 2). Inner medial tooth (IMT) produced, subequal in size to apical tooth (AT). Broadly crenulate median keel (MK) extending from anterior base of inner median tooth to just before base of subapical tooth (SAT) (Fig. 3). Lateral mandible base broadly excavate (LBE) from base to ½ length of mandible. Inner edge of mandible with narrow flattened border. Mentum broad, posterior margin truncate, lateral margins evenly arcuate, anterior margin sinuate with distinct median projection. Maxillary palpus filiform, terminal segment as long as preceding segments combined, apex acute. Maxillary palpus with deep evenly arcuate groove for their reception along the ventro-lateral region of the head. Labial palpus filiform with terminal segment obtuse in apical third with almost truncate apex. Gula large and robust with somewhat swollen bulbous posterior-medial region. Mentum, submentum, and lateral region of the gula distinctly punctate. Punctures large, equal to large punctures on vertex, interspaces from ½–1 diameter apart, mentum and submentum alutaceous but gula with reticulation present. Medial region of gula with a few scattered small punctures, interspaces smooth to alutaceous. Antennal grooves deep, somewhat short, and distinctly convergent. Antenna eleven-segmented, slightly shorter than length of head. Scape large, longer than wide, convex anteriorly and slightly concave posteriorly, total length approximately 2.2 times as long as pedicel. Pedicel with narrow tapering base, becoming swollen apically. Antennomeres 3–5 similar in shape to pedicel but each individually longer than pedicel. Antennomeres 6 and 7 similar in size and shape to pedicel but with distinct laterally projecting setae. Antennomere 8 more robust, and wider than preceding two segments, with laterally projecting setae. Antennal club 3-segmented, somewhat loose, densely setose, elongate oval, equal in length to segments 3–5 combined. Antennomere 9 broadly triangular, widest at apex. Antennomere 10 slightly narrower than segment 9, and chevron-shaped. Terminal antennomere somewhat hexagonal with lateral sides broadly rounded. Each club segment with several long projecting setae. Head surface with large deep medial impression extending between antennal lobes and from clypeal region to middle of vertex, broadly triangular. Surface of impression and clypeal region with large irregular shallow punctures, interspaces ½–1/2 diameter apart, alutaceous with some microreticulation. Anterior region of clypeus and rest of vertex with small scattered punctures, approximately ½–1/4 diameter of large punctures, interspaces alutaceous and between 4–5 diameters apart becoming diffusely separated along occipital region of head.

*Thorax:* Pronotum large, transverse, width: length 2.5:1.0. Anterior margin trapzoidal with the median region somewhat convex. Anterior and posterior angles acutely rounded. Posterior margin with broad indentations in lateral ½, median ½ nearly truncate. Pronotum nearly glabrous
with no elaboration of punctures except for diffuse small irregular punctures near anterior margin, punctures similar in size to small punctures on head, interspaces smooth. Pronotal disc entirely glabrous. Pronotal and elytral lateral margins not smooth, broadly crenulate with raised regions obsoletely curved posteriorly. Prosternal process narrow between procoxae, greatly expanded behind coxae with broadly convex apical margin. Prosternum with few scattered small punctures primarily anterior and lateral, interspaces with transverse reticulation. Prosternal process with shallow indistinct punctures, equal in size to those on lateral margin of gula, interspaces alutaceous and approximately $\frac{1}{2}$ diameter apart. Scutellum shaped like an obtuse triangle with apex broadly rounded, with small punctures, equal in size to those on pronotum and head, interspaces alutaceous and 2–3 diameters apart. Mesosternum bulbous medially, posterior margin broadly rounded, anterior margin occluded by prosternal process. Mesocoxal lines strongly divergent posteriorly from coxae. Mesosternum with similar punctation as prosternal process but more diffusely spaced, interspaces alutaceous with faint microreticulation. Metasternum strongly transverse, medial line extending from posterior margin to $\frac{1}{2}$ length of structure, anterior margin protruding anteriorly almost to anterior margin of meso Coxae. Metacoxal lines strongly diverging posteriorly from coxal cavities. Metasternum with scattered small punctures similar in size to small punctures on head, interspaces 2–10 diameters apart and smooth to alutaceous.

**Abdomen:** Sternite 1 as long as sternites 2 and 3 combined, abdominal process extending anteriorly to near level of metacoxae. Sternites 2–4 subequal in length. Sternites 1–3 with similar punctation as metasternum. Sternites 4 and 5 as well as hypopygidium with short golden setae arising from small punctures, punctures more closely spaced, interspaces 2–3 diameters apart. Hypopygidium broadly triangular with a somewhat prolonged acute apex, densely fimbriate along apical border.

**Elytron:** Entire, completely covering the pygidium, broad, widest at middle, width: length = 1.0:1.2. Anterior border feebly
bisinuate, lateral border rounded and widest at anterior third, apex dehiscent. Elytral humeri moderately produced. Lateral explanation of elytra broad, equal to \( \frac{1}{4} \) total elytral width. Eight rows of longitudinal costae present on each elytron, extending from base to apex. Each elytron with eight distinct longitudinal costae, each costa with a row of small fine punctures, equal in size to those on head and pronotum, extending to elytral apex. Intercostal regions with a single row of longitudinal large regular punctures, each bearing a short stiff gray seta. Punctures round, equal to 1.5 times width of large punctures on head, interspaces alutaceous with some faint microreticulation. Lateral explanation of elytra with diffuse irregular punctuation. Punctures small, equal to size of small punctures on head, interspaces 5–10 diameters apart and alutaceous with some faint microreticulation.

**Legs:** Femora of normal shape, elongate, widest at middle, profemur larger than other femora. Protibia finely crenulate along lateral edge. Lateral margin terminating apically into a laterally projecting process. Apical border with multiple small protuberances and small flattened teeth, anterior apical edge with several small short spines, inner apical margin with one small spine projecting downward, spine equal in size to lateral process. Mesos- and metatibiae well armed. Mesotibia with medial edge with numerous short spines in apical \( \frac{1}{2} \). Lateral edge with numerous dense spines along entire edge. Spines also present in a longitudinal row on ventral surface projecting posterior-laterally. Inner apical spine similar in length to that on protibia. Metatibia with armature similar to that as mesotibia except for an additional row of longitudinal spines near medial edge on ventral surface. Tarsomeres 1–3 deeply bilobed with dense setose pad beneath. Tarsomere 4 small and completely obscured ventrally. Terminal tarsomere elongate, longer than preceding tarsomeres combined. Claws simple with bisetose empodium.

**Genitalia:** Aedeagus moderately sclerotized. Tegmen rather short, apex truncate, large robust setae extending from lateral margins, sensillar area present near apical margin (Fig. 4). Median lobe with distinctly bifid apex (Fig. 5). Internal sac with two large curved spines present (Fig. 6).

Female.—Unknown.

Diagnosis.—This is the only known species of *Psilotus* that is distinctly bicolored, the head, scutellum and pronotum being reddish orange and the elytra a glaucous black with metallic blue sheen. The mandibles are unique in having a large medially projecting tooth that is similar in size to the apical tooth. The glabrous condition of the pronotal disc is known from only one other species, *P. levis* Grouvelle, which is much smaller at only 5 mm in length and not bicolored. The above combination of external characters as well as the large impressed region of the head, the well-armed meso- and metatibiae, the ventrally protruding mesosternum, produced apex of the hypopygium, almost completely glabrous dorsum, and the suite of surface punctuation given above, easily differentiate this species from others in the genus. The male genitalia also provide excellent characters for species delimitation, including the development of the internal sac spines, the truncate tegmen.

Figs. 4–6. Male genitalia of *Psilotus bicolor*. 4. Ventral view of the tegmen spiculum gastrale (100×); 5. ventral view of the median lobe (100×); and 6. ventral view of internal sac spines (100×).
apex, the distribution of setae on the tegmen, and the degree of indentation of the tegmen apex.

Etymology.—The species epithet is derived from the notably bicolored dorsal habitus.

Distribution.—The species is known only from the type locality in central Peru (Huanuco Province) on the eastern slope of the Cordillera Central of the Andes Mountains. Coordinates for Carpish Pass are 9°42′S, 76°04′W, and those for Chinchoa are 9°42′S, 79°09′W (latitude/longitude coordinates source: Geographic Names Database of the National Imagery & Mapping Agency at: http://gnpswww.nima.mil/geonames/GNS/index/jsp.).

MANDIBLE MORPHOLOGY

Sexual dimorphism of the mandibles is evident in all members of Psilotus. Males have elaborate modification of both the size and shape. Besides the overall size of the mandibles in comparison to the overall width and length of the head, other key features are noticeably useful for delimiting species within the genus. Descriptors (and abbreviations) for each of the key mandibular features are shown in Figs. 2–3. The development of the medial tooth (MT) and the medial keel (MK) are the most distinguishing mandible characters at the species level. In P. bicolor, the median tooth is extremely well developed, being almost as long and robust as the apical tooth (AT), whereas the median keel is less developed. However, these two traits do not appear to be negatively correlated, as both can be reduced and/or developed depending on the species. The inner medial ledge (IML) of P. bicolor is more developed than in any other Psilotus species, and the lateral basal excavation (LBE) is also well developed for a Psilotus species. The above combination of mandibular characters, in their varied degrees of development, are all useful for defining species in the genus.

NEW DISTRIBUTION RECORDS

Until now, distribution records for Psilotus were known from scattered records by Erichson (1843), Reitter (1875), Grouvelle (1896, 1913), and Sharp (1901). Blackwelder (1945) compiled a list of country records for the known species of Psilotus in his catalog; however, no documentation exists of specific locality records. The records below document new country records, new records within countries, and significant range extensions for three species. Psilotus atratus Reitter.—This species was previously known to have a mainly Central American distribution from Mexico and Nicaragua to Panama. New records: (A) July 23, 1957; Golfito, Costa Rica; Truxal & Menke. (B) COSTA RICA: Alajuela; E.B. San Ramon. R.B. San Ramon; 27 km N. & 8 km W. San Ramon. 810 m: 10°13′4"N, 84°35′46"W; 8 JUL 2000, J. Ashe, R. Brooks, Z. Falin; ex: flight intercept trap. (C) HONDURAS: Cortez; Yojoa Lake, Deer Island; 670 m; 22–26 June 1994; 14°55′N, 87°58′W; J. Ashe, R. Brooks; ex: flight intercept trap. (D) COSTA RICA: San José/Cartago; km.45, Int. Amer. Hwy.; 6 km N.E. El Empalme. 1975 m: 9°45′0"N, 83°58′30"W; 8–26 JUN 1997, S&J Peck; ex: flight intercept trap. (E) COSTA RICA: Guanacaste; Patilla Biological Station, 610 m: 10°59′22″N, 85°25′33″W; 13–15 JUL 2000. J. Ashe, R. Brooks, Z. Falin; ex: flight intercept trap. (F) COSTA RICA: Puntarenas; Wilson Botanical Garden; Las Cruces Biol. Stn.; 1200 m; 27 May 1993. J.S. & A.K. Ashe, ex. E.L.T. (G) COSTA RICA: Puntarenas; Prv., Monteverde; June 5–7. 1983. J. E. Wappes.

More complete records from Nicaragua and Panama include the following: (A) NICARAGUA: Rio San Juan Dept.: 60 km SE San Carlos, Refugio; Bartola. 100 m. 10°58′40″N, 84°20′30″W; 25-V-2002. R. Brooks, Z. Falin; S. Chatzimanolis, ex: on bark, downed; logs. (B) PANAMA: Chiriqui Prov.: La Fortuna. “Hydrolog.: Trail”, 08°42′N, 82°14′W; 1050 m, 9–12-VI-1995.


Psilotus cornutus (F).—This is the most wide ranging species in the genus with known records from Honduras, Nicaragua, Panama, French Guiana, Brazil, and Argentina. The new record is a small range extension; however, it indicates that this species may extend into the Lesser Antilles. New record: TRINIDAD: N. Range; Ari ma-Blanchisseuse; Rd. mi. 10. V-11-1985, C.W. & L.B. O’Brien.

Consuelo, Manu rd, km 165, 11-X-1982/under bark, L.E. Watrous and G. Mazurek.

*Psilotus germaini* Grouvel. —This species known from Brazil and Bolivia. The following records are specific localities: (A) BOLIVIA: Cochabamba; Cochabamba, 117 km E; Yungas, (Cochabamba--; Villa Tunari Rd.), 1040 m; 17°6′32″S, 65°41′12″W; 6–8 FEB 1999; R. Hanley; ex: flight intercept trap. (B) BRAZIL: Rondônia, 62 km SW Añiquemes, nr; Fzda. Rancho Grande; 3–15-XII-1996, JE Eger; black light trap.

*Psilotus ventralis* Erichson. —Like *P. carbonicus, P. ventralis* previously was known only from Brazil. The following records extend this range into Peru: (A) Utucuacu, Tarma; Junin, PERU: MARCH 1948/F. Woytkowski; coll.;—Donor; Wm. Procter. (B) Tingo, Maria; HUAN, PERU: X-10-1946; Alt. 2200 ft./J.C. Pallister; Coll., Donor; Frank Johnson. (C) PERU: Madre de Oros; Pantiacollis Lodge, 5.5 km NW; El Mirador Trail, Alto Madre de; Dios River, 500 m; 12°39′10″S, 71°15′28″W; 23–26 OCT 2000, R. Brooks; ex: flight intercept trap. (D) FRENCH GUIANA: Emerald Jungle Village; junc. Rtes. N2 & D5; 15–18 APR 1999, G.B. Edwards; secondary forest, flight trap.

The following establishes a specific locality for this species in Brazil: Corupa; (Hansa Humbolt); S. Cath., Brazil; 1945/A. Maller, Coll.; Frank Johnson; Donor.

**CONCLUSIONS**

One new species of the endemic Neotropical nitidulid genus *Psilotus* is described. The new species increases the number of described *Psilotus* from ten to eleven. Distribution records for *P. atratus, P. carbonicus, P. cornutus, P. germaini, and P. ventralis* expand the ranges of these species, and demonstrates that species in this genus are not as isolated from each other as indicated by Blackwelder’s checklist (1945). From these new records, it also appears that there are two "groups" of species, a Central American group consisting of *P. atratus, P. cornutus, and P. mimetes* Sharp, with *P. cornutus* extending southward and becoming sympatric with the South American group, which consists of *P. carbonicus, P. convexus* Grouvel, *P. costatus* Blanchard, *P. germaini, P. levis* Grouvel, *P. musophagus* Esch., *P. ventralis*, and the new species *P. bicolor*. These geographic ranges also give tentative support for *Psilotus* originating in South America and radiating into Central America and the Lesser Antilles following the migration of the Cocos plate as it passed between North and South America and after the subsequent formation of the Panamanian Isthmus in the late Tertiary (Rosen 1976). This conclusion is supported by 1) the lack of *Psilotus* in northern Mexico and 2) the lack of *Psilotus* from any of the Greater Antilles. Current research should further elucidate the above hypotheses. From the new records given and observations of other label data not provided, it is also evident that species of *Psilotus* are infrequently collected by active hand collecting but can be obtained in high numbers via passive methods such as flight intercept traps and blacklights. Finally, a suite of mandible features were given that demonstrate species level variation and which will be used in future work to produce a more natural classification of members of the genus.

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LITERATURE CITED


A REMARKABLE NEW SOLVA WALKER (DIPTERA: XYLOMYIDAE)
FROM NORTHERN BORNEO

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Abstract.—Solva kinabalu, new species, is described from northern Borneo (Malaysia: Sabah, Mt. Kinabalu). It has a remarkably modified first antennal flagellomere in the male. The new species is most similar to S. furcicera Adisoemarto which also has a modified first antennal flagellomere. This is the first time male that a male secondary sexual character is reported in the Xylomyidae.

Key Words: Borneo, Solva, xylomyid fly, Xylomyidae, secondary sexual characters

The genus Solva Walker is the largest in the Xylomyidae, with 96 valid species currently recognized (Woodley, in press). Although the genus is poorly studied in most tropical regions, a tabulation of known species indicates that Solva is most diverse in the Oriental Region, where 45 species are known.

I discovered the species described here in the backlog materials at The Natural History Museum (BMNH) in London. It is of particular interest because of the sexual dimorphism present in the antennal structure, which is previously unreported in the Xylomyidae.

Solva kinabalu Woodley, new species (Figs. 1–5)

Diagnosis.—This species belongs to a small group of elongate, darkly colored Solva sometimes accorded generic rank by previous authors as Ceratosolva de Meijere (1914; type species Ceratosolva cylindricornis de Meijere). Solva kinabalu is most similar to S. furcicera Adisoemarto, also from Borneo, which shares a modified first antennal flagellomere (Adisoemarto 1973: fig. 4). In S. furcicera, the second flagellomere is inserted about one-third of the way from the base of the first, and the apical two-thirds of the first flagellomere is conically tapered to a sharp apex. Solva kinabalii also differs from S. furcicera in having the color of the anteroventral surface of the hind femur and the entire hind tibia except the basal fourth black.

Description.—Male: Head (Fig. 1) black, 1.49 times higher than long; dichoptic, eye large, bare, ommatidia uniform in size; ocellar tubercle only slightly prominent; face convex, separated from eye margins by narrow groove; frons concave, narrow, 0.14 head width at ocellar tubercle, gradually widening ventrally, margins weakly notched just above antennae; frontal margins, upper part of face, and posterior part of head weakly grayish tomentose; pilosity semi-appressed on frons, erect on genital region, present but inconspicuous on posterior part of head, pale grayish, other areas bare; antenna 3.0 times length of head, ratio of segments 7:4:72[3:10:9:9:9:9:
Figs. 1–2. Head and antenna of *Solva kinabalu*. 1. Head, left lateral view. 2. Detail of antennal base, showing modified first flagellomere.
tergite; terminalia (Figs. 3–4) with gonoco- 
coxites elongate, evenly rounded laterally, 
with slightly arcuate posterolateral process- 
svs ventrally; hypandrium divided medially, 
posterior margin narrowly bilobed, the 
lobes with minute spicules; gonostylus con- 
ically tapered toward apex, small digitate 
process anterodorsally may also be part of 
gonostylus; phallic complex bulbous on an- 
terior half, narrowly tubular and slightly ta- 
pered posteriorly, slightly arcuate ventrally; 
epandrium (Fig. 5) elongate, moderately ta- 
pered posteriorly, weakly sclerotized except 
anteromedially; cercus small, about as long 
as wide, very slightly expanded laterally, 
posterior margin truncate. Length 8.1 mm.

Female: Differs from male as follows: 
Head 1.38–1.50 times higher than long; 
frons 0.12–0.14 width of head at ocellar tu- 
bercle; antenna 2.6 times as long as head, 
and ratio of segments 6:3:54.5[4:8:7.5:7:6:6:6: 
10]; first flagellomere short but unmodified; 
second segment of palpus thicker, more 
ovooid; wing with anal lobe very vaguely to 
not emarginate; abdomen with cercus yel- 
lowish, segments about equal in length, first 
segment thicker. Length 6.5–9.1 mm.

Type material.—The holotype ♂ 
[BMNH] is labeled: “N. BORNEO Mt. 
Kinabalu./Mesilau Trail 20.iii.1964./Roy- 
al.Soc.Exped. col. S. Kueh. B.M. 1964-
250./HOLOTYPE ♂ Solva kinabalu N. E. 
Woodley 2004.” The type locality is in the 
present day state of Sabah in Malaysia. The 
specimen is in good condition but is miss- 
ing the right hind leg beyond the trochanter, 
most of the left halter, and the apical half 
of the right wing. The right antenna is glued 
to a paper point on the specimen pin. The 
terminalia are preserved in glycerin in a mi- 
croval on the specimen pin. The allotype ♀ 
[BMNH] is from MALAYSIA: Sabah [as 
“British North Borneo”], Mt. Kinabalu, 
Kenokok, 3300 feet, 23 April 1929, H. M. 
Pendlebury. One paratype ♀ [BMNH] has 
the same data as the allotype except that is 
was collected 25 April 1929.

Etymology.—The species name is a noun
Remarks.—There is slight variation in the two female specimens examined. The female paratype is conspicuously larger than the allotype. It is also more darkly colored, which may only reflect maturity of the specimen. The paratype has the anal lobe of the wing vaguely emarginate, while in the allotype no modification is visible.

Two images of the genital capsule are presented (Figs. 3, 4). Figure 4 was slightly flattened in a temporary slide mount, and shows some additional details of spatial orientation of structures.

This is the first time that an obvious dimorphism in secondary sexual characters has been reported in the Xylomyidae. The functional significance of the male antennal process in *S. kinabalu* is not known, but perhaps it is involved in male-male head to head behavior of some sort, as in other Diptera with male head modifications (McAlpine 1975, Moulds 1977). It is likely that dimorphism also exists in *Solva furcicera* (also from Borneo), although only a unique male of that species is known.

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LITERATURE CITED


ADRYAS, A NEW GENUS OF TRICHOGRAMMATIDAE (HYMENOPTERA: CHALCIDOIDEA) FROM THE NEW WORLD TROPICS

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Abstract.—The new genus Adryas, with eight new species, is described from the Central and South American tropics. Included are A. albicerata, A. bochica, A. erwini, A. incompta, A. iris, A. lioptera, A. magister, and A. plurifumosa. The genus occurs from Costa Rica south to Bolivia and the species show a relatively high level of sympatry, at least in certain parts of the genus range. Included is a key to species and a discussion of relationships.

Key Words: Hymenoptera, Trichogrammatidae, Adryas, new genus, new species, New World tropics

The Trichogrammatidae remains one of the most poorly known families of Hymenoptera. One reason for this is that current concepts of generic limits and diversity are based largely on Holarctic and Australian faunas. Recent collections from tropical areas throughout the world promise to expand and modify our understanding of the family considerably. In this paper we take the opportunity to describe the new genus Adryas, one of the more distinctive new taxa encountered from the Central and South American tropics. Male genitalia place Adryas in the tribe Chaetostrichini according to the classification of Viggiani (1971). Although uncommonly collected, the genus is already known to be widely distributed, occurring from Costa Rica to Bolivia, and moderately speciose, with eight new species currently assigned. Its hosts remain undiscovered, however. In addition to introducing the new genus, we include descriptions of all of its species, a key to species, and brief discussions of generic placement and species relationships.

TERMINOLOGY AND METHODS

Most descriptive anatomical terms follow Doult and Viggiani (1968). Terms and acronyms associated with antennal sensilla and setation follow, or are modifications of, those utilized for Trichogramma by Vincent and Goodpasture (1986) [= V/G], Olson and Andow (1993) [= O/A], and Pinto (1999) [= P]. These are as follows: APB = aporous sensillar trichodea B (socketed) [O/A]; PLS = placoid sensilla [P]; BPS = basiconic peg sensilla [P]; FS = flagelliform setae (unsocketed) [V/G, P] (also known as multiporous pitted sensilla trichodea A [O/A]); UPP = uniporous pit pore sensilla trichodea D [O/A]; APA = aporous setae A (O/A) (also called unsocketed setae [P]). We use the term recurved sensilla (RS) as in an earlier paper (Pinto and George 2004). Similar structures in female Trichogramma are termed multiporous pitted sensilla trichodea C [O/A]. As in Trichogramma, RS occur ventroapically on the antennal club in females. They also are similar in general shape and have characteristic oblique surface grooves (Fig. 8). RS differ, however,
in lacking a distinct type C base (a shallow socket). As in flagelliform setae (FS), RS have a type A basal insertion (sensilla and antennal surfaces contiguous).

Sensillar terms, as applied to Adryas, stem from a comparison of structures with those in Trichogramma. Comparisons are based on examination of all species with the light microscope and three of the species (A. magister, A. bochica, and A. incompta) with the scanning electron microscope. It is recognized that their utilization implies ultrastructural features and function which have not been verified in Adryas.

The antennal club segments often are only partially separated from one another in Adryas. Also, the suture dividing certain segments may be obsolescent. For this reason numbering club segments is not straightforward. We have taken a five segmented club to be the ground plan state for the genus. This is based on the occurrence of five segments in males (known for two species) and five partial segments in females of all species except A. lioptera and A. plurifilosa. BPS generally occur at the apex of each club (and funicular) segment in trichogrammatids, and often are retained even when segments are partially or completely fused. They never are associated with anelli. Placement of the BPS is helpful in identifying club segments and segment fusion. The first club segment (C1), although reduced and anelliform, occurs in all species. It is partially fused to C2 in two of the species examined with SEM (Fig. 7) but we are unsure if this is the case in all. The other club segments vary in the degree of fusion. To facilitate interspecific comparison of homologous segments, all are identified by number even if fused. Thus, C3/4 refers to the complete or partial fusion of C3 and C4. Relative club segment lengths are given only for C2–C5. The transverse, plate-like shape of C1 (Fig. 7) precludes a length measurement. The antennal club of females of several Adryas species has a cylindrical apical process. This process is a continuation of the last club segment and the UPP sensillum is mounted at its apex (Fig. 3B). In determining the length of the process, its base is marked at the point where the extension of the apical-most PLS leaves the surface of the club.

Acronyms for fore wing venation in the descriptions are as follows: PM = premar-
Figs. 3–8. Antennae of Adryas. 3A, A. magister, ♀, lateral [arrows to FS (a) and RS (b)]; 3B, as 3A, enlargement of club apex showing apical process (arrow) and UPP inserted at its apex. 4, A. magister, ♂, lateral. 5, A. incompta, ♀, lateral. 6A, A. bochica, ♀, lateral (arrow at one of two RS at apex of club); 6B, as 6A, except dorsomedial, enlargement of base of club showing narrow, subfusiform BCP sensilla. 7, A. magister, ♀, basal view of club with arrows at A1 (a), A2 (b) and C1 (c), also showing clavate BCP sensilla on C1 and C2. 8, A. bochica, ♀, detail of RS (see arrow in Fig. 6A), showing oblique ridges characterizing these structures.

ginal vein; MV = marginal vein; SV = stigmal vein. The division between PM and MV is not as obvious in Adryas as in many other trichogrammatids because the two veins are broadly confluent. We use the position of the two PM campaniform sensilla (or apical-most sensillum if they are disjoint) as the boundary between these two veins (Figs. 18, 20). Setation on the fore wing veins varies interspecifically. Most of this variation is on the dorsal surface. On the MV a distinction is made between anterior and posterior setae. The anterior setae are at the margin of the wing and are slight-
ly longer than the row of posterior setae situated only slightly behind (Fig. 18). The PM has two dorsal setae, and their position relative to one another varies. A field of foliate and apically attenuate structures (= foliate sensilla) occur in Adryas on the ventral surface of the fore wing anterior to the retinaculum (Fig. 10). They appear to be modified setae and also may replace setae along certain posterior setal tracks. An additional field of structures, minute cuticular nub-like projections, also on the wing’s ventral surface, occurs in most species near the base of the PM. We refer to these as alar acanths.

All measurements for length and width represent maximum dimensions. Unless indicated, body length measurements are taken from card-mounted, hexamethyldisilazane-dried specimens (Heraty and Hawks 1998). Measurement is taken from the front of the head (in a hypognathous position) to the apex of the metasoma. Fore wing length is taken from the apex of the tegula to the apex of the wing. Quantitative data are means derived from specimens representing the sampled geographic range; the range also is given when variation is possibly significant. Unless indicated, these data are based on three specimens.

Material studied of all species included slide- and card-mounted specimens. The number of specimens mounted on slides is given in the material examined section of each species. To better assure conspecificity, types are restricted to slide-mounted individuals. Acronyms used for collections are as follows: BMNH, The Natural History Museum, London; CNC, Canadian National Collection of Insects, Ottawa; IAVH, The Humboldt Institute, Villa de Leyva, Colombia; NMNH, National Museum of Natural History, Smithsonian Institution, Washington, DC; UCRC, University of California, Riverside (Department of Entomology). The acronym PN and PNN associated with several of the collecting localities indicate Parque Nacional and Parque Nacional Natural, respectively.

Taxonomy

Adryas Pinto and Owen, new genus

Type species.—Adryas magister Pinto and Owen, n. sp.

Diagnosis.—The structure of the antenna and fore wing distinguishes Adryas. Antenna without a funicle, C1 anelliform, asymmetrical and closely appressed to base of C2 (Fig. 7). Females with number of club segments varying from 3–5 but never with 5 complete segments, instead segments variously fused, completely or in part; club with at least a few RS ventrally on apical segment. Fore wing fumate behind venation, MV and PM confluent. PM distinctly wider than MV with a distinct gap between submarginal vein and PM; gap also reflected in fumation. PM shape characteristic (Fig. 20): subtriangular, with anterior margin deviating minimally, if at all, from wing margin but posterior margin diverging from posterior border of marginal vein resulting in a gradual widening to its base; the basal margin of the PM is its widest aspect and is perpendicular to the wing’s longitudinal axis. Male genitalia (Fig. 28) as in the Chaetostrichini (see Description).

Description.—Body robust, compact, convex dorsally; surface smooth (Fig. 9), dorsum of mesosoma weakly reticulate. Body length 0.4–0.6 mm. Eyes red. Head (Fig. 1) wider than mesosoma, with a distinct smooth plate on vertex; vertex flat, on same plane as mesoscutum, perpendicular to face; lateral ocelli placed adjacent to compound eyes. Malar sulcus present. Antenna (Figs. 3–8, 11–16) laterally compressed with 1 distinct anellus, and a 3–5 incompletely segmented club in females (club completely 5 segmented in male); second anellus incomplete, almost completely fused to club; C1 transverse, anelliform, strongly asymmetrical, produced medially; club always with at least two RS ventrally on apical segment; FS relatively few on C2–C5; at least 1APB on C1, C2 and at apex of C5; PLS absent on C1, a single curved PLS on C2, variable in num-
ber on other segments. Mandible with 5 teeth. 3 posterior most teeth well sclerotized and distinct, 2 anterior-most teeth smaller, less obvious. Maxillary palp 1-segmented (Fig. 2) with a well developed elongate peglike sensillum usually slightly below apex. Pronotum narrowly divided medially. Midlobe of mesoscutum with 1 or 2 pair of setae: scutellum with 2 pair. Mesopleural suture present. Fore wing venation (Figs. 17–27) elongate, extending 0.6–0.8 wing length; MV elongate, confluent with the considerably shorter PM; SV distinct: PM subtriangular, distinctly wider than MV, widening toward base due to marked divergence of posterior margin, basal margin of PM subperpendicular to longitudinal axis of wing; with a distinct gap between PM and submarginal vein, gap coinciding with a narrow but distinct clear (non-fumate) zone extending at least partially across base of wing; costal cell narrow, with 0–2 setae in narrow apical extension of cell; disk distinctly fumate beneath venation, with several setal tracks apical to fumate area; an RS1 present or absent; basal vein track of two setae present: a field of foliate sensilla on ventral surface near base of wing anterior to retinaculum (Fig. 10). Hind wing with 3 setal tracks. Male genitalia of the chaetostrichine type (Viggiani 1971): elements fused into a single structure with a large anterodorsal aperture but without parameres, volsellae or a distinct aedeagus (Fig. 28). Ovipositor not extending appreciably beyond apex of metasoma. Hypopygium present, variable in length, extending from 0.2–0.8 length of ovipositor.

Etymology.—This genus was known in our laboratory as “A” previous to this description. We couple this with Dryas (gender feminine), Latin for a wood nymph or dryad, in reference to the forested sites from which collections of the genus originated.

Geographic distribution.—Adryas is known to occur from Costa Rica south to Bolivia. Most collections are from Costa Rica, Colombia, Venezuela and Ecuador. The level of sympathy within the genus is relatively high. For example, four of the species have been collected at La Selva Biological Station in Costa Rica; four also have been taken in fogging samples from the Reserva Etnica Waorani in Ecuador, with a fifth collected at the Tiputini Biological Station nearby; and three species are known from Amacayacu National Park in Colombia (see Material Examined in the species treatments). All collections appear to be at low elevations and from mesic forested habitats.

Discussion.—Adryas is tentatively placed in the Chaetostichini as defined by Viggiani (1971, 1984) and based primarily on male genitalia. Few genera of chaetostichines that lack a funicule have a very short anelliform first club segment. Those that do may be confused with Adryas and include Uscanoidea, Lathrogramma and one or two other undescribed New World genera. All are separated by wing venation. In these genera the premarginal is narrower than the marginal vein or subequal in width, not wider, and a gap between the submarginal and premarginal veins does not exist. The extensive fumation of the fore wing and the presence of recurved setae ventroapically on the female club further distinguishes Adryas from these genera. The presence of foliate sensilla (Fig. 10) on the underside of the fore wing, although apparently not common in Trichogrammatidae, does occur in Trichogramma (Schmidt and Smith 1988, as flattened hairs) and in certain other genera as well (unpubl.).

The monotypic Uscanopsis Girault, known only from its poorly preserved types of U. carlylei Girault (examined), may also be close to Adryas. Unlike the other chaetostichines mentioned, the premarginal vein is wider than the marginal vein in this genus. However, its shape is not comparable. In Uscanopsis the premarginal vein is more elongate, not subtriangular and it is widest at the middle not at its basal margin. The greatly enlarged apical spur of the hind tibia, absence of a submarginal/premarginal vein gap, and densely setose fore wing that lacks distinct setal tracks and fumation pro-
vide additional separation from Adryas. Also, it appears that the female antenna in Uscanopsis lacks the short anelliform first club segment that characterizes Adryas. Illustrations of these features in Uscanopsis are provided by Doutt and Viggiani (1968, fig. 46).

Interspecific variation in Adryas is considerable for a genus of Trichogrammatidae. Features commonly used to diagnose genera such as number of club segments, club shape, presence or absence of the RS1 setal track, and number of setae on the mesoscutum all vary. Because all species share distinct features and because intermediate states bridge the extremes of some of the features that do vary, subdividing the genus is not a practical option.

The presence of recurved setae (RS) on the club, characteristic of many Trichogrammatini genera, is not reported for many Chaetostrichini. In addition to Adryas these sensilla are known also in the recently described Kyuwia from Africa (Pinto and George 2004), and in Brachista (Pinto 1994).

KEY TO THE SPECIES OF ADRYAS
(females)

1. Club with last segment symmetrical, cylindrical, with no more than 2–3 recurved setae (RS) on ventro-apical surface (Figs. 5, 6, 15, 16) .................................................. 2
   – Club with last segment asymmetrical, ventral surface convex and dorsal surface straight or concave, with a distinct patch of 10 or more RS on ventro-apical surface (Figs. 3, 11, 13, 14) ........................................................... 5

2. Midlobe of mesoscutum with one pair of setae. Club with basiconic peg sensilla (BPS) relatively narrow for entire length, subfuniform (Fig. 6B) .................................................. 3
   – Midlobe of mesoscutum with two pair of setae (Fig. 9). Club with BPS expanded apically, eiliate or subglobose (Fig. 7) .................................................. 4

3. Fore wing without a distinct RS1 setal track (Fig. 25). Club with last segment elongate, longer than remaining segments combined (Fig. 6A) .................................................. bochtica, n. sp.
   – Fore wing with an RS1 setal track (Fig. 27). Club with last segment shorter, not longer than remaining segments combined (Fig. 16) .................................................. iris, n. sp.

4. Club with last segment bearing an apical process (Fig. 5). Antenna brown in color. Ovispositor distinctly longer than hind tibia .................................................. incompta, n. sp.
   – Club with last segment lacking an apical process (Fig. 15). Antenna white, suffused with brown. Ovispositor shorter than hind tibia .................................................. albicerata, n. sp.

5. Fore wing with a distinct RS1 setal track (Fig. 17). Marginal vein (MV) with 6 setae on dorsal surface (3 anterior and 3 posterior), the two basal-most posterior setae distinctly thicker than others (Fig. 18). Maxillary palp with peg-like sensillum arising distinctly below apex .................................................. erwinii, n. sp.

6. Fore wing with a large circular clear area in basal 2/5 of wing behind venation (Fig. 19). Club with last segment bearing an apical process (Fig. 3B) .................................................. magister, n. sp.
   – Fore wing uniformly fumate behind venation (Figs. 22, 23). Club with last segment lacking an apical process (Figs. 13, 14) .................................................. 7

7. Fore wing venation elongate, with stigmal vein (SV) extending 0.8 distance from base to apex of wing. Fore wing fumation extensive but not reaching beyond the stigma in anterior portion of disk (Fig. 22). Propodeal disk rounded apically with a mediolongitudinal ridge on its surface .................................................. lioptera, n. sp.
   – Fore wing venation not as elongate, with SV only extending 0.6 distance from base to apex of wing. Fore wing fumation extending beyond level of the stigma over entire width of disk (Fig. 23). Propodeal disk attenuate apically, without a mediolongitudinal ridge on its surface .................................................. plurifimosa, n. sp.

Adryas albicerata Pinto and Owen, new species
(Figs. 15, 24)

Diagnosis.—This species can be distinguished by the pale antennae, the anterior pair of scutellar setae which are distinctly shorter than the posterior pair, and the subconical club lacking an apical process.

Description.—Female. Body length ca. 0.5 mm (slide-mounted specimens). Color brown with antennae, apex of tibiae and tarsomeres I and II distinctly lighter; antenna white, suffused with brown. Fore wing fu-
mation extending to apical \(1/4\) of wing, fusion lighter immediately behind vena-
tion.

Maxillary palp ca. \(2\times\) as long as wide with peglike sensillum as long as palp and
more than half length of apical seta. Measurements of antennal scape, pedicle and
club: length/width ratio—2.9 (2.8–3.0), 1.2
(1.1–1.3), 3.0, resp.; relative length—8: 5:
13, resp.; relative width—7: 9: 11, resp.
Club almost symmetrical in outline, sub-
conical, incompletely 5-segmented as in
bochica (C3 + C4 partially fused) but C2
and C3/4 distinctly more asymmetrical,
their length varying with surface; relative
maximum length of C2–C5 = 2: 5 (C3/4):
6; C5 narrow, elongate, ca. 0.8 the length
of remainder of club, gradually narrowing
to apex, without an apical process. Club
sensilla: with only 2 RS ventroapically on
C5; BPS subglobose; PLS on C2 (1), C3/4
(3) and C5 (4), those at apex of C5 extend-
ing slightly beyond segment apex; UPP
sensilla at apex of C5 setiform; 2–3 APA
on C2 and at base of C3/4.

Midlobe of mesoscutum with 2 pair of
setae; scutellum with anterior pair consid-
erably shorter, only ca. 2/5 length of pos-
terior pair. Propodeal disk subtriangular,
with apex narrowly to moderately broadly
rounded. Fore wing ca. 1.8 (1.7–1.9) as
long as wide, fringe setae 0.14–0.17 wing
width; venation extending 0.6 wing length;
MV ending abruptly at apex, SV arising
from its posteroapical corner and directed
slightly toward apex of wing; relative
length of PM, MV, SV = 12: 27: 11; PM
2.0–3.0\(\times\) as wide as MV, diverging slightly
from wing margin and with a single seta in
membrane anterior to vein, PM with pos-
terior seta at basal margin of vein, distinctly
more basal than anterior seta, campaniform
sensilla in contact; MV with 4 dorsal setae
(3 anterior, 1 posterior) and 6–7 shorter
ventral setae, basal-most anterodorsal seta
not adjacent to PM; SV with a short seta
slightly posterior to uncus. Fore wing disk
moderately densely setose with ca. 16 setal
tracks, tracks distinct in non-fumate section
of wing, posterior tracks continuing basally
into fumate area; RSI present; membrane
behind venation with scattered setae except
anteriorly; distal seta in basal track antero-
apical to basal seta; alar acanthea ca. 10
in number. Hind wing with anterior and
middle setal tracks complete, posterior track
not extending beyond half distance from
level of hamuli to wing apex.
Ovipositor slightly shorter than hind tibia (OL/HTL = 0.90, n = 2); outer plate widening considerably posteriorly, maximum ovipositor width to length = 0.70. Hypopygium extending 0.5–0.6 (n = 2) length of ovipositor.

Male. Unknown.

Type.—Holotype ♀: PERU. Loreto: Teniente Lopez (220 m); vii–22–1993: R. Leschen, coll.: deposited in CNC.

Etymology.—In reference to the pale antenna of this species.

Material examined.—3 ♀ (all on slides). COLOMBIA. Magdalena: Zaino (PNN Tayrona, 50 m); 11°20’N, 74°02’W; v–13/30–2000: ‘M136’; 1 ♀; R. Henriquez. COSTA RICA. Heredia: ‘Est. Biol. La Selva’ (75 m); 10°26’N, 84°01’W; ii–27/28–2003; 1 ♀; J. S. Noyes; 1 ♀. PERU. Loreto: 1 ♀ (see Type).

**Adryas bochica** Pinto and Owen, new species
(Figs. 6, 25)

Diagnosis.—The symmetrical, subconical club, the elongate last club segment (longer than the remainder of club), and the absence of an RS1 setal track on the fore wing separate this species from congeners.

Description.—Female. Body length 0.4 mm (n = 5). Color light brown with mesosoma and apex of metasoma slightly darker, and tarsi and apex of tibiae lighter; antennal pedicel bicolored, dark brown dorsally, considerably lighter ventrally. Fore wing uniformly fumate beneath venation, fumation extending somewhat beyond level of venation in posterior half of disk.

Maxillary palp ca. 3\(\times\) as long as wide with peglike sensillum ca. one third palp length and a fourth apical seta length. Measurements of antennal scape, pedicle and club: length/width ratio—3.5 (3.0–4.0) 1.3, 3.6 (3.5–3.8), resp; relative length—7: 5: 22, resp.; relative width—7: 10: 15, resp. Scape elongate, linear, narrowing slightly to apex. Club almost symmetrical in outline, subconical, with C3 and C4 incompletely separated; segments only slightly asymmetrical; relative maximum length of C2–C5 = 16: 32 (C3/4): 57; C5 abruptly narrower than other segments, elongate, longer than C1–C4 combined, abruptly narrowing further at apical third, with a relatively short apical process. Club sensilla: C5 with only 2 RS on ventral surface at apical third; PLS on C2 (1), C3/4 (3) and C5 (4), one PLS on C3/4 extending entire length of combined segment; BPS narrow and fusiform; UPP on apical process short, only slightly longer than process itself, apparently truncate at apex; 2 APA at base of C3/4.

Midlobe of mesoscutum with only posterior pair of elongate setae present; scutellum with 2 pair of elongate subequal setae. Propodeal disk not appreciably produced, its posterior border arcuate. Fore wing 1.8\(\times\) as long as wide; fringe setae relatively short, ca. 0.15 wing width. Fore wing venation attaining apical 0.6 of wing; MV abruptly curved at apex to form SV, which is distinctly constricted at base and almost perpendicular to MV; relative length of PM, MV, SV = 5: 13: 7: PM ca. 2.5\(\times\) as wide as MV, diverging slightly from wing margin but without setae in membrane anterior to vein; PM with posterior seta at basal margin of vein, more basal than anterior seta, campaniform sensillum not separated; MV with 5 dorsal setae (3 elongate anterior; 2 shorter posterior) and 5–6 shorter ventral setae; basal-most anterodorsal seta adjacent to PM; SV with a short seta medial to uncus. Fore wing disk moderately densely setose, with ca. 16 setal tracks obvious in clear apical area of wing, scattered setae in apical section of fumate area; a distinct RS1 not present (setae present in area of RS1 but not differentiated from neighbors); two basal track setae subparallel to longitudinal axis of wing; alar acanthae few in number (<10). Hind wing with anterior and middle setal tracks complete, posterior track not extending beyond half distance from level of hamuli to wing apex.

Ovipositor subequal in length to hind tibia (OL/HTL = 1.02); outer plate widening posteriorly, maximum ovipositor width to
length = 0.50. Hypopygium extending 0.6 length of ovipositor.

Male. Unknown.

Types.—Holotype ♂: COSTA RICA. Heredia: La Selva Biol. Station; 50 m; ii-1991; Malaise trap: J. S. Noyes, collr; deposited in BMNH. Two female paratypes, same data as holotype; UCRC.

Etymology.—Bochica, the solar god of the Chibcha people of ancient central Colombia, an area included in the range of this species.

Material examined.—18 ♂ (10 on slides). BELIZE. Las Cuevas (550 m): 16°44’N, 88°59’W; v-1999; Malaise trap: 1 ♂; C. Minty. COLOMBIA. Magdalena: Zaino (PNN Tayrona, 50 m); 11°20’N, 74°02’W; v-29/vi-14-2000: ”M241”: 1 ♂; R. Henriquez. COSTA RICA. Alajuela: Reserva Rincón Forestal (Est. Caribe, 400 m): 10°53’N, 83°18’W; ii-19/20-2003; sweep: 1 ♂; J. Noyes. San Ramon (Estac. Biol., 800 m); vii/viii-1995; 1 ♂; P. Hanson. Heredia: Chilamate (75 m); vii/x-1990; 1 ♂; P. Hanson. La Selva Biological Station (50 m); ii-1991; Malaise trap: 6 ♂; J. Noyes (includes Types). Same except: 75 m; 10°26’N, 84°01’W; ii-27/28-2003: 1 ♂. OTS-La Selva (100 m): ix-14-1995; Malaise trap (M11.456); 1 ♂: ALAS Project. Same except: x-16-1995: Malaise trap (M01-471); 1 ♂. Puntarenas: R. F. Golfo Dulce: 24 km W. Piedras Blancas (200 m); xii-1992; 1 ♂; P. Hanson. ECUADOR. Napo: Onkone Gare Camp, 1 km S. (Reserva Etnica Waorani, 216.3 m): 00°39’25.7”S, 76°27’10.8”W; x-4-1996: “fogging in terre firme forest”: 1 ♂; Lot 1755; T. Erwin, et al. Tiputini Biodiversity Sta. (nr. Yasuni Nat’l Park, 220-250 m): 00°37’55”S, 76°08’39”W; vii-4-1998: “fogging terre firme forest”: 1 ♂; Lot 1875; T. Erwin, et al. Napo River (Sacha Lodge): 0°30’S, 76°30’W, vii-18/23-1994; Malaise trap: 1 ♂; P. Hibbs.
Remarks.—The specimen from Reserva Rincón Forestal, Costa Rica, is a molecular voucher (D#1227; Owen, et al., in prep.). Only a fore wing and one antenna are preserved, mounted on a slide.

**Adryas erwini** Pinto and Owen, new species

(Figs. 11, 12, 17, 18)

Diagnosis.—The insertion of the peglike maxillary sensillum at the middle of the palpal segment rather than just below its apex is unique. Also, unlike congeners, the dorsum of the marginal vein bears six setae rather than five or fewer, and the two posterior and basal-most of these setae are considerably thicker than the others. The fore wing venation of the male is not inflated in this species.

Description.—Female. Body length 0.4–0.5 mm (slide mounted specimens). Color apparently uniformly brown except apex of scape and venter of pedicel obviously lighter; fore wing uniformly fumate behind veination.

Maxillary palp unique for genus, ca. 3× as long as wide, abruptly and asymetrically narrowed at middle with peg-like sensillum arising at middle, at point of abrupt palpal narrowing, its apex only slightly surpassing apex of palp; sensillum elongate, ca. half length of palp and 0.4× length of apical seta. Measurements of antennal scape, pedicle and club: length/width ratio—2.8: 1.3: 2.6 (2.3–2.8), resp.; relative length—7: 4: 11, resp.; relative width—3: 4: 5, resp. Scape not inflated but distinctly wider in basal half. Club asymetrically tapering from base to apex; 5-segmented but with C3 and C4 incompletely separated over most of circumference; segments asymmetrical, C3/4 longest dorsally. C5 longest ventrally, C5 with ventral surface convex, dorsal surface relatively straight; relative maximum length of C2–C5 = 15: 35 (C3/4): 33; C5 slightly less than 0.5× length of entire club, with a short apical process. Club sensilla: C5 with fewer RS than in *magister* (ca. 10) and confined to apical half of segment; PLS on C2 (1), C3/4 (2), C5 (5), apical PLS on C5 extending slightly beyond apical process; BCP subglablose; UPP on apical process setiform, ca. 3× length of process itself; several APA on C2 and base of C3/4.

Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae, anterior pair of scutellar setae ca. 0.7× length of posterior pair. Propodeal disk subtriangular, with a fine mediolongitudinal ridge at center, rounded at apex. Fore wing 2.2 (2.1–2.3) as long as wide. fringe setae ca. 0.4× wing width. Fore wing venation attaining apical 0.6–0.7 of wing; MV abruptly curving at apex to form SV, the latter almost perpendicular to MV, with only a slight constriction between MV and stigma; relative length of PM, MV, SV = 6: 14: 7; PM ca. twice as wide as MV, diverging slightly from wing margin with two setae in membrane anterior to vein; PM with posterior seta slightly more basal than anterior seta, both apical to basal margin of vein and both thicker than in other species, campaniform sensilla adjacent; MV with 6 dorsal setae (3 anterior, 3 posterior) and 4 slightly shorter ventral setae, all anterodorsal setae on MV elongate, the two basal-most posterior setae slightly shorter than anterior setae but considerably thicker than all other MV setae, the apical-most posterior seta short and thin; SV with a short seta medial to uncus. Fore wing disk moderately densely setose with 12–13 longitudinal setal tracks in nonfumate area of wing, only posterior tracks extending basally into fumate area; RS1 present, its setae stouter than others in membrane; two basal track setae subparallel to longitudinal axis of wing; alar acanthae 10–15 in number. Hindwing with 3 complete setal tracks.

Ovipositor 1.47 (n = 1) as long as hind tibia; outer plate narrow not appreciably widening posteriorly, maximum width to length = 0.20. Hypopygium extending 0.7 (n = 1) length of ovipositor.

Male. Single male as in female except antennal club subconical and almost symmetrical in outline (cf. Figs. 11, 12); C5...
lacking RS, without an apical process; C3 and C4 incompletely separated, as in female. Fore wing venation as in female, not modified but with the two campaniform sensilla at apex of PM separated from one another by a distance of ca. twice sensillar diameter. Genitalia short, 0.30 length of hind tibia.

Types.—Holotype ♂: ECUADOR. Napo: Tiputini Biodiversity Sta. (nr. Yasuni Nat’l Park); 220–250 m; 00°37’55”S, 76°08’39”W; x-22-1998; “fogging terre firme forest”; Lot #1971; T. Erwin, et al. collrs. Allotype ♂: ECUADOR. Napo: Onkone Gare Camp, 1 km S. (Reserva Etnica Waorani); 216.3 m; 00°39’25.7”S, 76°27’10.8”W; x-5-1995; Lot 1194; T. Erwin, et al. Paratype ♂: Same data as holotype except collected ii-8-1999; Lot #2024. All types deposited in the NMNH.

Etymology.—After Dr. Terry Erwin of the Smithsonian Institution (Washington, DC), thus far the sole collector of this species.

Material examined.—2 ♂, 1 ♂ (all on slides). ECUADOR. Napo: (see Types).

Adryas incompta Pinto and Owen, new species
(Figs. 5, 26)

Diagnosis.—This species can be distinguished by the following combination of features: relatively dark colored antennae, subconical club with a terminal projection, two pair of setae on the mesoscutal midlobe, anterior pair of scutellar setae subequal to posterior pair, and subglobose BPS sensilla.

Description.—Female. Body length ca. 0.5 mm (slide mounted specimens). Color brown except tarsi and apex of tibiae lighter; also base and apex of scape, and ventral surface of pedicel distinctly lighter. Fore wing fumation relatively light, extending to apical ½ of wing.

Maxillary palp ca. twice as long as wide, with peglike sensillum elongate, almost as long as palp itself and slightly more than half length of apical seta. Measurements of antennal scape, pedicle and club: length/width ratio—2.5 (2.4–2.9), 1.4 (1.3–1.5), 3.1, resp.; relative length—5: 3: 11, resp.; relative width—16: 17: 28, resp. Club almost symmetrical in outline, subconical, incompletely 5-segmented, C3 and C4 almost completely fused with only an obsolescent suture obvious dorsomedially, segments asymmetrical in lateral view (as in abicerrata); relative maximum length of C2–C5 = 4: 7 (C3/4); 7: C5 narrow, elongate, with a moderately long apical process comprising ca. ½ total segment length. C5 0.7 length of remainder of club. Club sensilla: 2 gradually curved RS ventropetally on C5; PLS on C2 (1), C3/4 (4) and C5 (3); BPS subglobose; UPP on apical process very short, setiform, less than half length of process; several APA on C2 and C3/4.

Midlobe of mesoscutum with two pair of setae; scutellum with 2 pair of setae, anterior pair only slightly shorter than posterior pair. Propodeal disk subtriangular, with a very faint mediolongitudinal ridge, rounded at apex. Fore wing 2.0× as long as wide; fringe setae ca. 0.2 maximum width of wing; venation attaining ca. 0.6 length of wing; MV abruptly ending apically. SV arising from its apicoposterior corner and directed slightly toward wing apex; relative length of PM, MV, SV = 14: 26: 13; PM ca. 2.5× as wide as MV, diverging slightly from wing margin and with a single seta in membrane anterior to vein; PM with posterior seta distinctly basal to anterior seta; MV with 3 elongate dorsal setae on anterior margin (no posterior setae) and 6 shorter ventral setae, basal-most dorsal seta not adjacent to PM; SV with stigmatic seta slightly posterior to uncus. Fore wing disk moderately densely setose, with ca. 16 setal tracks in non-fumate region of wing, posterior tracks continuing basally into fumate area; RSI present; basal track setae subparallel to longitudinal axis of wing; with 10 or fewer alar acanthae. Hind wing with posterior track incomplete, extending only ca. half the distance from level of hamuli to wing apex.

Ovipositor 1.3–1.5× length of hind tibia; outer plate widening posteriorly, maximum
Fig. 25-27. Fore wings of Adryas. 25, A. bochica. 26, A. incompata. 27, A. iris. 28. Male genitalia, A. magister (circular anterodorsal aperture at base).

width to length of ovipositor = 0.53 (n = 2). Hypopygium apparently short, extending 0.25 (n = 1) length of ovipositor.

Male. Unknown.

Type.—Holotype ♂: COSTA RICA. Limón: PN Tortugero (0 m); iv/v-1989; J. Solano, collr.; deposited in BMNH.

Etymology.—Incompata, Latin for unadorned or simple; in reference to the absence of highly distinguishing features in this species.

Material examined.—3 ♀ (all on slides). COSTA RICA. Heredia: La Selva Biological Station (75 m); 10°26'N, 84°01'W; ii-27/28-2003; 1 ♀; J. Noyes. Limón: (See Type); 1 ♀. GUANTANAMO. Nuevitas: 1 km N, 10°13'N, 81°16'W; x-18-1995; ‘fogging in terere firme forest’; 1 ♀; Lot 1192; T. Erwin, et al.

Adryas iris Pinto and Owen, new species (Figs. 16, 27)

Diagnosis.—The following combination of traits separates this species: Club sub-conical, symmetrical, with its last segment shorter than the remainder of club; RS1 setal track present; midlobe of mesoscutum with only a single pair of setae.

Similar to A. bochica; differing as follows:

Description.—Female. Color similar but pedicel not as distinctly bicolored; surface of antenna somewhat more wrinkled. Antennal club with C5 shorter, only ca. 0.4 length of entire club and 0.8-0.9 length of segments C1-C4 combined; C5 evenly narrowed from base to apical process, not abruptly so at apical third. Measurements of antennal scape, pedicle and club: length/width ratio—3.2 (3.1-3.6), 1.3, 3.3 (3.1-3.5), resp.; relative length—41. 25. 87. resp.; relative width—13. 20. 28. resp.; relative length of C2-C5 = 9: 17 (C3/4); 20. Fore wing with MV somewhat shorter, no more than twice the length of PM; MV not evenly curving at apex, ending abruptly and SV arising from its posteroapical corner; MV with only 4 ventral setae; SV with a
short seta posterior or lateral to uncus. RS1 present, distinct. Ovipositor longer, 1.25× (1.2-1.3, n = 2) length of hind tibia. Hypopygium somewhat shorter, extending 0.5 (n = 2) length of ovipositor.

Male. Unknown.

Type.—Holotype ♀: BOLIVIA. Santa Cruz: Gral. [= General] Saavedra; 1-1/30-1994; ‘yellow pan trap under natural vegetation’; J. C. Monje, collr; deposited in NMNH.

Etymology.—Iris, ancient Greek goddess of the rainbow.

Material examined.—5 ♀ (4 on slides). BOLIVIA. Santa Cruz: See Type; 1 ♂. COLOMBIA. Amazonas: PNN Amacayacu, Matamata (150 m); 03°23’S, 70°06’W; vii-12/19-2000; 1 ♀; A. Parente. COSTA RICA. Guanacaste: Santa Rosa National Park (Hacienda 2-c); i-10/31-1987; 1 ♀. Same except: Hacienda 1-0; i-31/ii-21-1987; 1 ♀. Puntarenas: PN Corcovado; Golfito (Sector La Bonanza, 500m); iv-20-2002; sweep; 1 ♀; J. Azofeifa Zuñiga.

*Adryas lioptera* Pinto and Owen, new species
(Figs. 13, 22)

Diagnosis.—The narrower fore wing with its broadly arcuate anterior margin, the considerably longer fore wing venation (extending 0.8 the wing length), the subglabrous membrane behind the fore wing venation and the distinct mediolongitudinal ridge on the propodeal disk are diagnostic. The antennal club also is distinctive in consisting of only 3 segments and having a large number of APA.

Description.—Female. Body length = 0.4 mm (n = 1). Color dark brown, with dorsum of metasoma and tibiae/tarsi somewhat lighter. Fore wing fumation extensive, covering basal 9/10 of wing, but not extending beyond stigmal vein at apex of venation.

Maxillary palp ca. 2.5× as long as wide with peglike sensillum elongate, only slightly shorter than palp and ½ length of apical seta. Measurements of antennal scape, pedicle and club: length/width ratio—2:7. 1:2: 1.5, resp.; relative length—10: 5: 11, resp.; relative width—10: 11: 18, resp. Scape widest near middle, narrowing considerably to apex. Club asymmetrically tapering to apex, only 3 segmented (C3, C4 and C5 fused = C3/4/5), without partial separation of C3 and C4, suture between C2 and C3/4/5 obsolescent; segments asymmetrical, C3/4/5 with ventral surface convex and dorsal surface straight, relative maximum length of C2–C5 = 3: 10; without an apical process. Club sensilla: C3/4/5 with RS relatively short, numerous, forming a ventral pilose area extending almost half club length and ca. 0.6× length of segment; PLS on C2 (1) and C3/4/5 (7), apical ones extending somewhat beyond club apex, another (along dorsum) extending almost entire length of last segment; BPS clavate; UPP elongate, setiform; APA numerous on medial surface of C2 and C3/4/5 (ca. 20 in basal half), also with scattered APA on lateral surface of both segments.

Midlobe of mesoscutum and scutellum each with two pair of elongate setae. Propodeal disk subtriangular with a distinct mediolongitudinal ridge, rounded at apex. Fore wing 2.3× as long as wide, widest at apex of venation; fringe setae ca. 0.3× wing width; venation elongate, extending 0.82 wing length; MV curving at apex to form narrow elongate SV; anterior margin of wing broadly arcuate; relative length of PM, MV and SV = 6: 16: 7; SV directed toward apex of wing; PM ca. 3.0× as wide as MV, contacting anterior margin of wing (i.e., lacking narrow apical extension of costal cell anterior to PM); PM with setae at same level near base, campaniform sensilla adjacent; MV with 4 dorsal setae (3 elongate anterior, 1 slightly shorter posterior) and 6 shorter ventral setae, basal-most anterodorsal seta distant from PM; SV with elongate stigmal seta anterior to uncus. Fore wing disk sparsely setose, ca. 8 very short setal tracks in narrow non-fumate area at apex of wing; few scattered setae in extensive fumate area behind venation primarily
near posterior section of wing; RS1 absent; two basal track setae almost perpendicular to longitudinal axis of wing; alar acanthae apparently absent. Hind wing with 3 complete setal tracks.

Ovipositor apparently somewhat shorter than hind tibia [single slide-mounted specimen not well positioned for measuring]. Hypopygium extending at least half the length of ovipositor.

Male. Unknown.

Type and material examined.—Holotype ♀: COLOMBIA. Amazonas: Amacayacu N. P.; 03.82°S, 70.26°W; iii-8/12-2000; Malaise trap #5: B. Brown/G. Kung/M. Sharkey, collrs; deposited in IAVH. One card-mounted ♀ with same data as type except: sweep; iii-9-2000; M. Sharkey.

Etymology.—In reference to the smooth (‘pto’., Gr.) appearance of the wing (‘ptero’, Gr.) in this species.

Adryas magister Pinto and Owen, new species
(Figs. 1–4, 7, 9, 10, 19–21, 28)

Diagnosis.—Distinguished by the non-fumate oval area behind the venation of the fore wing, the moderately inflated scape, and the completely divided C3 and C4. The inflated wing venation in males may also be diagnostic.

Description.—Female. Body length 0.5–0.6 mm. Color uniformly light to moderately dark brown, dorsum of mesosoma and ventral half of scape somewhat darker; fore wing fumate behind venation except for a relatively large clear oval area behind PM and base of MV.

Maxillary palp ca. 3× as long as wide with peglike sensillum elongate, ca. half palp length and half apical seta length. Antenna noticeably compressed laterally. Measurements of antennal scape, pedicle and club: length/width ratio—2.1 (1.8–2.3): 1.3 (1.2–1.4): 2.4 (2.3–2.8), resp.; relative length—12: 7: 22, resp.; relative width—10: 9: 15, resp. Scape moderately inflated at middle. Club asymmetrically tapering from base to apex, 5-segmented with C4 and C5 incompletely separated but only along dorsal surface, suture between C3 and C4 complete; segments asymmetrical, C4 longest dorsally, C5 longest ventrally, C5 with ventral surface convex and dorsal surface slightly concave; relative maximum length of C2–C5 = 12: 25: 46: 65; C5 0.6 as long as entire club, produced into a moderately long apical process. Club sensilla: C5 with numerous RS, forming a distinct pilose area occupying almost entire ventral surface of segment; PLS on C2 (1), C3 (1), C4 (1) and C5 (3); BCP clavate; UPP on apical process elongate, slightly longer than process itself, subspatulate apically; a few APA on C2–C4.

Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae. Procockel subtriangular, apex narrowly rounded. Fore wing, 2.1× as long as wide, fringe setae ca. 0.3 wing width. Fore wing venation extending to apical 0.6–0.7 of wing; MV gradually curving to form narrow and elongate SV which gradually widens to stigma, SV distinctly directed toward apex of wing; unique in that MV slightly but noticeably wider in basal half; relative length of PM, MV, SV = 2: 6: 3; PM slightly more than twice as wide as MV, diverging slightly from wing margin but without setae in membrane anterior to vein; PM with setae placed at same level near base, campaniform sensilla unique, widely separated by a distance of ca. 4× sensillar diameter (Fig. 20); MV with 4 dorsal setae (3 elongate, anterior; 1 short, posterior) and 7–9 shorter ventral setae, basal-most anterodorsal setae distant from PM; SV with a moderately long stigmatic seta placed well anterior to uncus. Fore wing disk sparsely setose, with ca. 14 setal tracks beyond fumate area in apical fourth of wing, only posterior tracks extending basally into fumate area; RS1 absent; two basal track setae subparallel to longitudinal axis of wing; region behind venation acetose anteriorly; alar acanthae < 10 in number. Hindwing with 3 complete setal tracks.

Ovipositor 1.38 (1.34–1.45) as long as
hind tibia; outer plate narrow, not appreciably widening posteriorly, maximum width to length = ca. 0.25. Hypopygium relatively long, extending 0.5–0.7 length of ovipositor.

Male. As in female except antennal club subconical and almost symmetrical in outline (Fig. 4); C4 and C5 apparently completely separated; C5 without RS, without an apical process, with PLS extending beyond apex of segment. Fore wing venation noticeably modified (Fig. 21): PM and MV considerably inflated, completely confluent; PM and basal ½ of MV of similar width; MV gradually narrowing to SV; width of SV and apical section of MV as in female; PM shorter relative to MV (relative length of PM, MV, SV = 2: 11: 5). Genitalia (Fig. 28) short, 0.3 length of hind tibia.

Types.—Holotype ♂ and allotype ♀. VENEZUELA. Aragua: Cuyagua (cacao plantation); 50 m; v-13-1999; J. L. Garcia/R. Montilla, collrs.; deposited in CNC. Two female paratypes, same data, deposited in UCRC. Two additional card-mounted females with same data as types in UCRC and CNC.

Etymology.—Magister, Latin for master or chief.

Material examined.—27♀ (11 on slides), 4♂ (3 on slides). COSTA RICA. Heredia: La Selva Biological Station (75 m); 10°26'N, 84°01'W; ii-27/28-2003; 1♀; J. Noyes. Pto. Viejo, 3 km S. (OTS—La Selva, 100 m); i-1993, iii/iv-1993; 3♀; P. Hanson. Guanacaste: Santa Rosa National Park (350 m); iii-11/20-1996; 1♂; L. Masner. ECUADOR. Napo: Tiputini Biodiversity Sta. (nr. Yasuni Nat'l Park. 220–250 m); 00°37'55"S, 76°08’39"W; i-9-1999, x-23-1998, x-26-1998; “fogging terre firme forest”; 9♀. 2♂; Lots 1915, 1916, 1917, 1942, 2016: T. Erwin, et. al. Rio Napo (Sacha Lodge) (220–230 m); 0.30'S, 76.30°W; ii-22/iii-4-1994; Malaise trap; 1♀; P. Hibbs. PERU. Loreto: Iquitos, 40 km NE (Explorana Inn on Amazon River); vi-25-1990; 1♀; Menke/Awertschenko. VENEZUELA. Aragua: Choroni (Cacao Plantation, 120 m); v-11-1999; 1♀; J. Garcia/R. Montilla. Cumboto (Cacao Plantation, 50 m); v-13-1999; sweep/yellow pan trap/Malaise trap; 6♀; J. García/R. Montilla. Cuyagua (see Types); 5♀, 1♂.

Remarks.—In the allotype male, the two campaniform sensilla at the apex of the PM are adjacent to one another on one wing and disjunct on the other.

Adryas plurifunosa Pinto and Owen, new species
(Figs. 14, 23)

Diagnosis.—The extension of the fore wing fumation beyond the level of the stigmal vein and across the entire wing width, the distinctly acuminate apex of the propodeal disk, and the absence of an RS1 setal track in the fore wing distinguishes this species.

Description.—Female. Body length = 0.4 mm (n = 1). Color entirely light brown. Fore wing uniformly fumate behind venation except slightly lighter behind PM and base of MV: fumation extensive, unique for genus in that darkened area extends beyond the level of stigmal vein and across the entire wing width, covering basal 4/5 of wing.

Maxillary palp ca. 2X as long as wide with peglike sensillum elongate, ca. 0.75 length of palp and ca. half apical seta length. Measurements of antennal scape, pedicel and club (n = 2): length/width ratio = 3.0: 1.1: 2.0, resp.; relative length—10: 5: 12, resp.; relative width—3: 4: 5, resp. Scape somewhat tumid but not inflated at middle, subequal in width throughout. Club asymmetrically tapering to apex, incompletely 4-segmented with suture between C3 and C4 incomplete and obsolescent, and C5 apparently completely fused to C3/4 (i.e., club with only 3 complete segments: C1, C2, and C3/4/5), all segments asymmetrical; C3/4/5 with ventral surface convex; relative maximum length of C2–C5 = 2: 5 (C3/4/5); club lacking an apical process. Club sensilla: RS numerous on ventral surface of C3/4/5, weakly S-shaped, forming a pilose area occupying ca. ½ club
length; APB more numerous than in other species. ca. 5 on both C2 and C3/4/5 basal to pilose area; PLS on C2 (1) and C3/4/5 (6 or 7), the two apical-most PLS extending beyond club apex; BPS clavate; a few APA on C2 and base of C3/4/5.

Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae. Propodeal disk subtriangular with apex acuminate. Fore wing 1.9–2.0× as long as wide, fringe setae ca. 0.25× wing width, veination extending 0.6 length of wing; MV curving at apex to form a relatively short SV. SV directed toward apex of wing; relative length of PM. MV and SV = 12: 35: 11: PM ca. 2.8× as wide as MV, diverging slightly from wing margin and with 1–2 short setae in membrane anterior to vein; PM with its two setae at same level near base of vein, campaniform sensilla adjacent; MV with 4 dorsal setae (3 elongate, anterior; 1 short, posterior) and 7–8 relatively short ventral setae, basal-most anterodorsal seta distant from PM; SV with seta medial to uncus. Fore wing disk moderately densely setose, with 12–13 setal tracks beyond fumate area, with numerous scattered, short setae basally except directly behind vein; RS1 absent: two basal tract setae subperpendicular to longitudinal axis of wing; alar acanthea < 10 in number.

Ovipositor length variable (OL/HTL = 0.85 in specimen from Ecuador, 1.02 in the type from Colombia); outer plate broader. width to length of ovipositor = 0.50. Hypopygium extending 0.4–0.6 length of ovipositor.

Male. Unknown.

Type.—Holotype ♂: COLOMBIA. Amazonas: PNN Amacayacu. San Martin (150 m); 03°23’S, 70°06’W; ix-8/16-2000, x-18/26-2000; 2♀; B. Amado (see Type). PNN Amacayacu: 03.82°S, 70.26°W; iii-8/12-2000; Malaise trap: 1♀; B. Brown/G. Kung/M. Sharkey. ECUADOR. Napo: Onkone Gare Camp, 1 km S. (Reserva Etnica Waorani. 216.3 m); 00°39’25.7”S, 76°27’10.8”W; x-4-1996; ‘fogging in terre firme forest’; 1♀; Lot 1757; T. Erwin, et al.

Relationships

Adryas can be informally divided into two groups of species based on the structure of the antennal club in females and wing structure. In one (Group A) the club is distinctly asymmetrical with a pilose patch of recurved setae ventrilocopically on the terminal segment (Figs. 3A. 11, 13, 14); also the fore wing is narrower with longer fringe setae (Figs. 17–23) and the hind wing has three complete setal tracks. Included are A. magister, A. erwini, A. plurifumosa, and A. lioptera. The other group (Group B) has a more symmetrical, subconical club with only two recurved setae apically (Figs. 5, 6A. 15, 16); and in this group the fore wing is wider, obliquely rounded apically, with considerably shorter fringe setae (Figs. 24–27), and the posterior-most setal track on the hind wing is incomplete. This group includes A. bochica, A. iris, A. albicerala and A. incompta. The characters of the club in Group A as well as the fore wing features are derived based on comparisons with related genera. There are no features that clearly point to the monophyly of Group B. The incomplete posterior setal track of the hind wing may represent a synapomorphy but this state differs minimally from that in Group A.

Within Group A, A. magister and A. erwini, and A. plurifumosa and A. lioptera, respectively, are most similar. The first two species have an apical process at the apex of the antennal club, and the outer plates of the ovipositor do not widen posteriorly. In
these species the apical and basal widths of the ovipositor are subequal. *A. plurifunosa* and *A. lioptera* lack an apical process on the club and the apical width of the ovipositor is considerably greater than the basal width. There also is greater fusion of the club segments in the latter two species. The least amount of claval segment fusion occurs in A. *magister*. It is the only species of *Adryas* having C3 and C4 completely separated. In all other species these two segments are at least partially fused.

Males of *Adryas* are known only for two species, *A. magister* and *A. erwini*. The considerable inflation of the fore wing venation in males of *A. magister* (Fig. 21) does not characterize those of *A. erwini*. *A. magister* females are unique in that their marginal vein, although not inflated as in the male, is perceptibly wider basally than apically (Fig. 19). The fact that the marginal vein is uniform its entire length in all other species of the genus, suggests that this sexual dimorphism is unique to *A. magister*.

Within Group B, *A. bochica* and *A. iris* are most similar as are *A. albicerata* and *A. incompta*. The former two are probably sister species based on the reduced number of setae on the midlobe of the mesoscutum and the narrow fusiform BPS sensilla on the club (Fig. 6B). *A. albicerata* and *A. incompta* have subglobose BPS sensilla and two pair of setae on the mesocutal midlobe, as do all species of Group A. The relationship of these two species to each other and to *A. bochica* and *A. iris* is questionable. Features readily separating the species of *Adryas* are provided in the key to species and in the species diagnoses.

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LITERATURE CITED


DESCRIPTION OF *EVALLJAPYX LIMPIA*, N. SP. (DIPLURA: JAPYGIDAE) FROM THE DAVIS MOUNTAINS OF WESTERN TEXAS

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Abstract.—A new species of Japygidae from the Davis mountain region of western Texas is described and illustrated. *Evalljapyx limpia*, n. sp., represents the first described species within the genus *Evalljapyx* from Texas. Based on the body length and number of antennal segments, this new species is included in the *diversiplura* group. A key is provided to separate *Evalljapyx limpia* from other species within the *diversiplura* group.

Key Words: *Evalljapyx limpia*, new species, Diplura, Japygidae

The genus *Evalljapyx* Silvestri represents the most diverse assemblage of species within the North American japygid fauna. Members of this genus have been collected from Arizona, California, and Nevada in the United States and several states in Mexico. Members of this genus have also been described from Canada, Guatemala, Costa Rica, Ecuador, Cuba, and Jamaica (Reddell 1983, Paclt 1976, Pagés 1996). Silvestri (1911) erected the genus *Evalljapyx* with *E. sonoranus* Silvestri as the type species. He characterized the genus by plumose or pinnate body setae, apical lamina pectinate, stylus with two setae, cerci asymmetrical, sexual dimorphism of the cerci, and setose lateral frontal sinuses absent.

Adult members of *Evalljapyx* vary considerably in body length and the number of antennal segments. Smith (1959, 1960a, b) noted this and, in a series of publications, described new species of *Evalljapyx* into species groups based primarily on the number of antennal segments. He also noted that smaller species tended to possess fewer antennal segments (Smith 1959). These groups are as follows: *E. sonoranus* group with 30 ± 1 antennal segments. *E. diversiplura* group with 24 antennal segments, and *E. leechi* group with 26 antennal segments. Here I describe a new species of *Evalljapyx* belonging to the *diversiplura* group, and present a key to separate the five species in this group.

*Evalljapyx limpia* Muegge, new species

(Figs. 1–6)

Male.—Length 7.1 mm. Greatest width at tergite VII, 0.6 mm. Integument unpigmented except progressively more sclerotized tergites VII–X and cerci.

Antenna with 23 segments, segments 1–3 with several scattered setae of various lengths, larger setae generally faintly pinnate, remaining segments with irregular whorls of long and short simple setae. Lateral projection of setae absent; terminal segment of antenna with placoid sensilla in a single whorl of four.

Head: Most M plumose. Dorsum with 13+13 macrosetae (M) and 15+16 sub-macrosetae (m) uniformly distributed; adnentum with 8+7M and 6+5m uniformly distributed. Prementum with 19+22 M+m.
Figs. 1-2. *Evalljapyx* limpia. 1. Lacina of male showing falciform 1st lamina. \( L = 0.05 \text{ mm} \). 2. Chaetotaxy of abdominal tergites VI–IX of male. \( L = 0.25 \text{ mm} \).

Most restricted to apical \( \frac{1}{2} \) of sclerite; postmentor with \( 2+2 \text{M} \) and \( 6+6 \text{m} \), smaller \( \text{m} \) restricted medially; submentor \( 2+2 \text{M} \) and \( 4+5 \text{m} \). Labial palpus conical, slightly longer than wide, with \( 2+2 \) long and \( 2+2 \) short apical setae. Longest 2 times longer than palpus, apex of palpus with sensory cones absent. Maxillary palpus basal segment \( 1+1 \text{m} \), apical segment \( 11+11 \text{m} \) restricted to apical one-half of segment. Longest seta 1.5 times length of segment; galea with \( 1+1 \text{m} \) on lateral margin, thumb of galea slightly sclerotized with \( 4+4 \) long and \( 1+1 \) short apical sensory cones; lacinia sclerotized and falciform, lamina I falciform (Fig. 1). II–V with \( 15, 5, 12, 13+15, 8, 11, 15 \) teeth respectively. Basal spur absent.

**Thorax:** Pronotum \( 6+6 \text{M} \), and several scattered microsetae, prescutum \( 1+1 \) median \( \text{M} \), few micro and anteromedian and posterolateral patches of friction setae; mesonotum \( 9+8 \text{M} \), several microsetae and anteromedian and posterolateral patches of friction setae.

**Legs:** Dorsal apex of pro-, meso-, and metafemora with 2 large plumose setae and 1 simple small seta; pro-, meso-, and metatibiae with 3 ventral subapical calcar setae. Longest \( \frac{1}{2} \) length of tarsus; pro-, meso-, metatarsi with 2 ventral rows of robust setae \( \frac{1}{2} \) to \( \frac{3}{5} \) tarsal length, numerous smaller scattered \( \text{m} + \) microsetae. All segments with numerous variously sized setae, becoming denser apically. Pro-, meso-, and metatarsal empodia \( \frac{1}{2} \) length of pretarsus.

**Abdomen:** Prescutum \( 1+1 \text{M} \), scutum \( 6+6 \text{ M} \) and \( 13+9 \) scattered \( \text{m} + \) microsetae; tergite II \( 10+10 \text{M} \), III \( 8+11 \text{M} \), IV \( 10+10 \text{M} \), V \( 10+10 \text{ M} \), VI \( 10+11 \text{M} \), VII
row of plumose sensory setae slightly longer than styli and 4 rows of glandular setae approximately ¼ length of sensory setae; 17+14 hair-like sensory setae set in large setal sockets (Fig. 4); median glandular organ absent. Sterna apotomes II–VI 5+5M, VII 4+4M plumose and progressively smaller medially. Sternite II 17+18M, III 15+14M, IV and V 16+16M, VI 16+17M, VII 15+15M uniformly distributed in four irregular rows, scattered m and microsetae; sternite macrosetae plumose. Sternite VIII 8+8 uniformly distributed plumose M, scattered m and microsetae; sternite X 9+9 uniformly distributed plumose M, scattered m and microsetae. Male sac present, opening at sternite of abdominal sternum III, sac extending nearly to anterior margin of sternum III. Sac with numerous bilaterally plumose setae, setae restricted to distal ⅔ of sac (Fig. 5).

Genitalia: Genital papillae absent, sensory pegs absent, genital orifice surrounded by scattered long simple setae, setae progressively longer distally.

Cerci: Left cercus inner margin with 4 small denticles followed by a large blunt premedian tooth; postmedian margin with 2 small denticles becoming crenulate, ending with distinct hook (Fig. 3). Right cercus inner margin with distinct premedian sinus and biseriate denticles, dorsal row with 3 denticles, ventral row with 4 denticles; postsinus margin with 4 small denticles ending in a tooth-like prominence followed by a sharply crescentic hook (Fig. 3).

Female.—Resembling male except: Length, 6.4 mm; width at tergite VII, 0.54 mm; sternite I with 6+7 antecedent setae in one row immediately anterior to LSO, lateral subcoxal organ with 46+48 GS in two irregular rows, SS 13+13 in a single row. Genital orifice oval surrounded with numerous scattered simple setae, setae progressively longer distally, papillary area and sensory pegs absent. Cerci slightly shorter and more robust; left cercus premedian margin uniserrate with 2 denticles, medium premedian tooth, postmedian mar-

9+10M. VIII 9+9 M, IX posterior margin 3+4 M. and X 6+6 sublateral M and 1+1 medial M (Figs. 2–3). Scattered m+microsetae present on all tergites. Posterolateral margins of tergite VII projected posteriorly into blunt heavily sclerotized points; anteromedian pair of M present on tergites I–VII and subequal in size to other M. Pleurite I glabrous, pleuron 1+1 M and a few scattered m and microsetae; pleurites II–VII 1+1M and 1+1m, pleurae II–VII 2+2M and 1+1m. Tergite IX pleurae meeting in midventral line and with 4+4 M: tergite X as long as wide, sublateral carinae absent, pygidium distinct and rounded (Fig. 3).

Sternum I apotome 5+5 plumose M becoming progressively shorter medially, sternite 18+19 plumose M uniformly distributed, few scattered microsetae. Antecedent setae plumose, 15+15 restricted to posterior ¼ of sclerite, subequal in length to styli; lateral subcoxal organs occupying nearly entire distance between styli, each with 1

Fig. 3. Evalljapyx limbipax, tergite X and cerci of male, L = 0.25 mm.
gin with 2 distinct denticles becoming crenulate. Right cercus premedian margin with distinct sinus and biserrate denticles, dorsal margin smooth, ventral margin with 2 denticles; postsinus margin smooth, ending in a tooth-like prominence followed by a crescentic hook (Fig. 6).

Type material.—Holotype ♂ and allotype ♀ collected by the author from humus beneath a large Quercus sp. near Limpia Creek in the Davis Mountains State Park, Jeff Davis County, TX; VI-3-2001; elevation approximately 1524 m. The holotype and allotype are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Etymology.—Spanish limpia ("clear or clean") referring to the proximity of the collected specimens to Limpia Creek in Davis Mountains State Park.

Remarks.—Evalljapyx limpia possesses 23 antennal segments, thus is placed in the diversipleura group. Interestingly, contrary to Silvestri’s generic description, three of the known Evalljapyx species possess a falconiform apical lamina, including E. limpia. Other generic characters hold for E. limpia, thus I believe this new species should be placed in the genus Evalljapyx; however, I emend the generic description to reflect the condition of this character.

Key to Evalljapyx Species in the Diversipleura Group

1. Right cercus with distinct crescentic hook (Fig. 3); pleurites II–VI 1+1M

2
- Right cercus without distinct crescentic hook (Fig. 7); pleurites II–VI 2+2M
- 23 antennal segments; lamina I falciform; right cercus with distinct premedian sinus; lateral subcoxal organ with 2–4 rows of glandular setae (Fig. 4) .............................. E. limpid. n.sp.
- 24 antennal segments; lamina I pectinate; right cercus without premedian sinus; lateral subcoxal organ with 8 rows of glandular setae .................................................. E. brevica Smith 1959

3. Right cercus with distinct postmedian dilation .............................. E. helfer. Smith, 1959
- Right cercus without postmedian dilation ..............................

4. Tergite X 7+7M; lateral subcoxal organ with 5–6 rows of glandular setae; basal 3 antennal segments with simple setae; tergite VII with 13+13M .............................. E. facetus Smith, 1959
- Tergite X 6+6M; lateral subcoxal organ with 3–4 rows of glandular setae; basal 3 antennal segments with plumose setae; tergite VII with 10+10M .............................. E. diversiplura (Silvestri, 1911)

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LITERATURE CITED


Note

Characters Differentiating Male from Female
Anoplophora glabripennis (Motschulsky) (Coleoptera: Cerambycidae)

The Asian longhorned beetle, Anoplophora glabripennis (Motschulsky) (Cerambycidae: Lamiinae) is native to China but was first discovered in North America in Brooklyn in 1996 (Cavey et al. 1998). This beetle is well known as a major pest of hardwoods in China and is able to kill healthy trees, usually after several generations of repeated attacks (Lingafelter and Hoebeke 2002). Since 1996, A. glabripennis has been found in Manhattan and surrounding areas of New York City, Long Island, and New Jersey and numerous areas in and around Chicago. In 2003, trees infested with A. glabripennis were found in Toronto. Since 1996, this beetle has also been intercepted in numerous ports and warehouses and was also found infesting trees in Austria in 2001 (Lingafelter and Hoebeke 2002). Eradication efforts have successfully decreased the numbers of beetle-attacked trees in many infested areas but new infestations are still being found. Whenever adult A. glabripennis are found, it can be difficult to determine sexes in the field because no quantitative morphological features have been reported that readily differentiate males from females. Our laboratory has maintained a quarantine colony of A. glabripennis since 1998, and, although we regularly work with adult A. glabripennis, it still can be difficult to differentiate males from females. It is important to simplify making this distinction both for field-collected and laboratory-reared individuals. Therefore, several of the most obvious sexually dimorphic characteristics were measured to develop a scheme for differentiating sexes.

Anoplophora glabripennis used for this study were initially obtained from China and Chicago, and a colony has been reared in the USDA, ARS quarantine facility in Ithaca, New York. Rearing methods are described in Dubois et al. (2002), but most of the reared beetles no longer require a chill period to develop to adult. Adults that eclosed and hardened from late September through early December 2003 were randomly chosen for this study. We differentiated males from females by placing pairs of individuals assumed to be opposite sexes together and occurrence of copulation was used to confirm gender. In seven instances when characters were intermediate and beetles did not readily begin mating, sex was determined by dissection to observe internal reproductive structures.

Characters chosen for quantification were based on the most readily visible or easily measured features potentially differing between males and females. All individuals were weighed after hardening and before being fed twigs. The length of an antenna, beginning at the base of the scape, the length of the insect and the width of the anterior end of the elytra were measured in mm. Because individuals varied in length and so did antennae, the ratio between antennal length and body length was calculated. Log-transformed measurements were analyzed using Student’s t-test (SAS 1999). All variables measured differed between males and females although for all variables ranges overlapped (Table 1). Due to the great variability, all characters except the ratio of antennal length:body length are of little value for sexing beetles. For example, although females were generally larger in weight, length and width, some males were just as long and wide as fe-
males and could weigh just as much. The external morphological features measured with the least overlap were antennal length and the ratio of antennal length:body length. Although the ranges of these characters varied for each sex and there was still overlap between sexes, overlap was least for the ratio. While the female antennae were usually less than 1.5 times the body length, male antennae were usually closer to 2 times the body length. For the individuals collected with antennal length: body length ratios that overlapped between male and female ranges, 10 of the 11 were males.

For individuals collected with antennal lengths that were close to 1.5 times the body length, it was difficult to know with certainty whether the beetle was male or female. In these instances, magnification can be used to look at the ventral side of the small terminal antennomere, which is annulated with white in females. In males, this annulation is mostly missing so that the ventral side of the terminal antennomere is predominantly black. However, dissection of specimens is suggested for a definitive answer because sclerotized reproductive structures give a definite sexual identity (Fig 1). The features most easily seen were the sclerotized male aedeagus near the apex of the abdomen and the ovipositor complex of the female that extends much of the length within the abdomen.

In summary, although no external morphological feature always resulted in correct determination of sex, the ratio of antennal length to body length provided the closest prediction. Male antennae were often nearly twice the length of the body whereas female antennae were often less than 1.5 times the body length. It is characteristic of many cerambycid species for males to have longer antennae than females. In some species the elongate antennae are spread by males as they walk on bark, thus improving chances of contacting a female when antennae are longer, suggesting a reason for this observed sexual dimorphism (Hanks 1999).

Acknowledgments.—We thank E. R. Hoebeke for advice early in this study. Funding for this study was provided by Alphawood Foundation.

Table 1. Measurements of Anoplophora glabripennis adults. Females, n = 59; males, n = 73.

<table>
<thead>
<tr>
<th>Character</th>
<th>Mean</th>
<th>SE</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Weight (mg)</td>
<td>67.3</td>
<td>2.3</td>
<td>37.9–125.4</td>
</tr>
<tr>
<td>Females</td>
<td>49.7</td>
<td>1.9</td>
<td>24.4–128.1</td>
</tr>
<tr>
<td>Males</td>
<td>2.50</td>
<td>0.03</td>
<td>2.1–3.0</td>
</tr>
<tr>
<td>Body length (cm)</td>
<td>2.17</td>
<td>0.03</td>
<td>1.8–3.1</td>
</tr>
<tr>
<td>Females</td>
<td>0.82</td>
<td>0.01</td>
<td>0.6–1.1</td>
</tr>
<tr>
<td>Males</td>
<td>0.69</td>
<td>0.01</td>
<td>0.5–1.0</td>
</tr>
<tr>
<td>Anterior elytral width (cm)</td>
<td>3.49</td>
<td>0.03</td>
<td>2.9–4.1</td>
</tr>
<tr>
<td>Females</td>
<td>3.94</td>
<td>0.05</td>
<td>3.3–5.4</td>
</tr>
<tr>
<td>Males</td>
<td>1.40</td>
<td>0.01</td>
<td>1.22–1.77</td>
</tr>
<tr>
<td>Antennal length:body length ratio</td>
<td>1.82</td>
<td>0.01</td>
<td>1.62–2.10</td>
</tr>
</tbody>
</table>

*Within each type of character, means followed by different letters are significantly different (p < 0.05).
Fig. 1. Internal sclerotized reproductive structures of male and female *Anoplophora glabripennis*. A. Female, ventral view: bc, bursa copulatrix; co, common oviduct; hg, hindgut; sa, sternal apodeme; sg, spermathecal gland; sp, spermatheca; sVIII, sternite 8; ta, tergal apodeme; v, vagina; vp, vaginal plaque; sIX, segment 9. B. Male, ventral view: ba, basal apophysis; is, internal sac; ml, median lobe; p, paramere; t, tegmen; vat, ventral apophysis of tegmen (after Hernández 2000). For additional figures of male and female reproductive structures see Lingafelter and Hoebeke (2002).

**Literature Cited**


Synoditella bisulcata (Kieffer) (Hymenoptera: Scelionidae) parasitizing Orphulella punctata (DeGeer) (Orthoptera: Acrididae) in the Dominican Republic

A recent survey of the Hispaniolan orthopteroid insects has given us the opportunity to obtain more detailed knowledge of the distribution, ecological preferences, and natural enemies of the grasshopper fauna of this Caribbean island. Grasshopper populations are regularly parasitized or preyed upon by insects of several other orders (flies, beetles, and wasps) (Greathead 1963). Several genera of the family Scelionidae specialize on parasitizing grasshopper eggs (Dysart 1996). In phoretic scelionids, females attach to female grasshoppers in order to be transported to the host oviposition site. In North America two scelionid genera are known to develop as parasites in the eggs of grasshoppers: Scelio Latreille, which contains 19 species, and Synoditella Muesebeck, with two species (Muesebeck 1972). Synoditella bisulcata (Kieffer) was reported from Texas, Kansas, South Carolina, Tennessee, Michigan, Illinois, South Dakota, Arizona, California, and Mexico, parasitizing the eggs of eight different grasshopper species (six in the genus Melanoplus, Dichromorpha viridis Scudder, and Chortophaga viridifasciata (DeGeer) (Muesebeck 1972). Masner (1976) recorded the genus Synoditella without specifying the species from Dominican Republic, Jamaica, Panama, and Mexico. The entomological survey of Navarro and Bastardo (1993) conducted on the beachfront of Santo Domingo (Parque Litoral Sur) recorded several specimens of these wasps, then identified as Macroteleia cf. erythropus Cameron.

This note is to report that S. bisulcata appears to be widespread in the Dominican Republic. This species is found sporadically attached to females of the gomphocerine grasshopper Orphulella punctata (DeGeer).

We have occasionally observed these small wasps attached by their mandibles (up to three individuals on a host) to the dorsal abdominal cuticle under the wings of female O. punctata (Fig. 1). In 2001, we sent one specimen to Dr. Lubomir Masner, who identified the species as S. bisulcata. Females of this species are 3–3.6 mm in length, have a generally black body, clubbed antenna, disk of scutellum shiny and legs yellowish with brown to black coxae. We have never noticed these wasps on females of the two other Orphulella species (O. decisa (Walker) and O. nesicos Otto) endemic to the island. This could be related to the fact that both of these species are brachypterous grasshoppers.

Fig. 1. Female of Synoditella bisulcata attached by its mandibles to the dorsal abdominal area of an Orphulella punctata female grasshopper.

varro, R. Bastardo.” [Collection of R. Bastardo]. All eight individuals were taken from O. punctata females.

The wide-ranging distribution of these localities in the Dominican Republic suggests that S. bisulcata is widely distributed throughout grassy areas in Hispaniola’s lowlands, which are the preferred habitats of O. punctata.

Acknowledgments.—We thank Dr. L. Masner, Canadian National Collection of Insects, Ottawa, for his graceful willingness to identify our scelionid specimen. DEPG acknowledges the support of National Science Foundation grant DEB-0103042 to survey the Hispaniolan fauna of orthopteroid insects.

LITERATURE CITED


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Pyrochroa daglariensis: Replacement Name for Dendroides cyanipennis Pic 1896, Primary Junior Homonym of Dendroides cyanipennis Latreille 1817 (Coleoptera: Pyrochroidae: Pyrochroinae)

Latreille (1810) described the pyrochroid genus Dendroides from Canada; the type species is, by monotypy, Dendroides canadensis. Later Latreille (1817) described Dendroides cyanipennis, a name that has subsequently been considered to be synonymous (Young 1975, 1983). In 1896, Pic described Dendroides cyanipennis from "Haute Syrie: Akbès." The homonymy apparently went unnoticed in part because no additional "cyanipennis Pic" specimens have turned up in collections and Latreille’s (1817) name went unnoticed by catalogers (e.g., Leng 1920, Blair 1928). Another con-

Figs. 1–2. Pyrochroa daglariensis, adult female. 1, Habitus, dorsal view. 2, Head, dorsal view.
tributing factor, perhaps, was the error made by Blair (1928) in reporting the original generic placement by Pic as Hemidendroides Ferrari. Blair (1914) transferred Pic’s “cyanipennis” to Pyrochroa Geoffry where it appears to be correctly placed for the present. Discovery of males would allow better assessment of important characters such as the cranial pit apparatus and genitalia.

While examining material from the Pic collection at the Muséum National d'Histoire Naturelle, Paris (MNHN), I discovered two females of what was cryptically labeled as “cyanipennis Pic.” The lead specimen (Figs. 1–2) bears two handwritten labels; the first appears to read “Ockbes, Hte Syrie”; the second reads “cyanipennis Pic.” The second specimen is unlabeled. Given that these are the only specimens of this species in the Pic material, and in fact the only specimens of the species I have seen, and because of the close similarity in the specimen locality label (“Ockbes, Hte Syrie”) and Pic’s (1896) published data (“Haute Syrie: Akbêš”), I believe these specimens are syntypes of Dendroides cyanipennis Pic and I have labeled them as such, along with the proposed replacement name, Pyrochroa daglariensis, new name.

The proposed replacement name refers, albeit indirectly, to the only known locality: "Ockbes" = "Akbêš" = Akbez. The city is located in northeast Hatay [36°52'60"N/36°27'0"E, elevation 1841 m (6043 ft)] near the Turkey–Syria border, in the Nur Dağlari mountains. Historically, the region has been under control of either Turkey or Syria: it was considered part of Syria near the time of Pic’s description, thus accounting for the “Syrie” label.

Acknowledgments.—I thank Claude Girard (MNHN) for the loan of material under his care. Preliminary digital images and final figures were captured and produced by Michael Young and electronic formatting of the plates was produced by Craig Brabant; I am most grateful for their assistance. This research was supported in part by grants from the National Science Foundation (BSR-9006342), the University of Wisconsin Graduate School (900159), and the University of Wisconsin’s Natural History Museums Council Small Grants Program.

LITERATURE CITED


Daniel K. Young, Department of Entomology, University of Wisconsin, Madison, WI 53706, U.S.A (e-mail: young@entomology.wisc.edu)
Note

New Name for a Generic Homonym in Caenidae (Ephemeroptera)

Sun and McCafferty (2001) established a new genus in the mayfly family Caenidae (Ephemeroptera) that is presently known from one species from Madagascar. The name given to this genus was Callistina Sun and McCafferty. This genus is uniquely characterized among the family Caenidae, for example in the larvae, by the lack of ocellar tubercles, development of the maxillary and labial palps, extensive ridges and pits on the head, a general absence of long marginal setae, extremely minute ventral microtrichiae on the operculate gills, and a posterior mediolongitudinal abdominal ridge. Unfortunately, we recently learned from J. G. Peters of Florida A&M University that the name Callistina had been proposed previously for a fossil genus of Mollusca by Jukes-Browne (1908). Because our original name is therefore preoccupied, we propose Callistellina Sun and McCafferty, new name, to replace the junior homonym Callistina Sun and McCafferty, 2001:8, nec Callistina Jukes-Browne, 1908: 156. The new name is a slight modification of the original, meaning a “most beautiful sea nymph,” which alludes to the highly contrasting color pattern of the larva, which is unusual among the Caenidae.

Literature Cited


Lu Sun and W. P. McCafferty, Department of Entomology, Purdue University, West Lafayette, IN 47907, U.S.A. (e-mail: sunl@purdue.edu)
1,079th Regular Meeting—January 8, 2004

The 1,079th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby room of the National Museum of Natural History, Washington, D.C., by President Eric Grissell, at 7:05 p.m. The meeting was attended by 19 members and 10 guests. The minutes of the 1,078th meeting were approved as read.

There were no new applicants for membership or new members present. Four visitors were introduced.


Dave Furth introduced the speaker, Dr. Jonathan Mawdsley, of the National Fish & Wildlife Foundation, and deposed ESW president. His presentation was entitled “Beetles: Overlooked Pollinators” and broke our preconceptions of beetles as being inefficient gluttons. The sheer species richness of beetles associated with flowers indicates that they probably account for the majority of the pollinators and are apparently responsible for pollination of 75–85% of the plants. Furthermore, experiments have shown that beetles are more efficient than honeybees in pollinating commercial sunflowers, and beetles are also responsible for pollinating oil palms, and are therefore of huge economic impact. Dr. Mawdsley’s own work in this vein has been to examine museum specimens of clerids, which actively move among plants. Virtually every specimen in the National Museum is loaded with pollen on its head pubescence. The full importance of beetles as pollinators surely warrants further study.

The meeting was adjourned at 8:00 p.m. Refreshments were provided by the Society.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

1,080th Regular Meeting—February 5, 2004

The 1,080th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby room of the National Museum of Natural History, Washington, D.C., by President Eric Grissell, at 7:03 p.m. The meeting was attended by 15 members and 4 guests. The minutes of the 1,079th meeting were approved with modification.

There were no new applicants for membership or new members present. The visitors declined to introduce themselves.

For exhibits, Dave Furth had three books: “Catalog of the Mythicomyiidae of the World (Insecta: Diptera)” by N. Evenhuis; “Los Hemipteros de la Pílica Superior del Agua en Colombia. Parte 1. Familia Gerridae” by H. Aristizábal García; and “Iconographia tribus Gnorymoscemin (Lepidoptera, Gelechiidae)” by D. Povolny.

Dave Furth introduced the speaker, Dr. Jeremy Miller, postdoctoral fellow of the Smithsonian. His presentation was entitled “The unbearable lightness of being monophyletic: clade stability & the addition of data in the erigonine spiders.” This was a summary of his recently completed dissertation on a subfamily of sheet web spiders, the Linyphiidae. This is the largest family of true spiders, with some 560 genera and over 4,200 species worldwide and are often distinguished by weird dorsal extensions of the cephalothorax. The erigonines show
greatest diversity at nonequatorial latitudes and, within the tropics, at higher altitudes. Dr. Miller expanded the data from the only previous cladistic analysis of the taxon, by Hormiga in 2000, to include 82 taxa and over 100 new characters. He investigated and quantified the effect of adding data, both characters and taxa, concluding that adding characters was much more important. To further investigate his results, Dr. Miller developed a novel measure of robustness of phylogenetic hypotheses, the Continuous Jackknife Function Analysis. This measure is more exploratory than others, such as the consistency and retention indices, which simply generate one number for the entire data set. In Dr. Miller's new measure, cumulatively larger subsets of characters from the original data are obtained, and the per cent recovery of the original hypothesis is graphed against the number of characters in each of those data sets. This yields graphs ideally resembling asymptotic cumulative curves of species richness. In one striking example, Dr. Miller applied his method to an existing cladistic analysis of a mammal genus based on molecular data, effectively showing that much more data was collected than needed to arrive at that particular hypothesis. Sadly, with his own data, and with Hormiga's, there was essentially a linear approach to recapturing the hypothesis, suggesting that much more data are needed before the hypothesis of erigonine relationships will stabilize, even if his results are accurate.

The meeting was adjourned at 8:05 p.m. Refreshments were provided by the Society.

Respectfully submitted,

Stuart H. McKamey
Recording Secretary

1,081st Regular Meeting—March 4, 2004

The 1,081st regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby room of the National Museum of Natural History, Washington, D.C., by President Eric Grissell, at 7:03 p.m. The meeting was attended by 18 members and 9 guests. The minutes of the 1,080th meeting were approved as read.

There were no new applicants for membership or new members present. Two visitors were introduced.


Dave Furth introduced the speaker, Dr. Frank Carle of Rutgers University, who summed up his work on "The Evolution of Dragonflies." Dragonflies date back to 320 million years ago, reaching wingspans up to 27 inches. The origin of birds doubtlessly drove these giants extinct. Dr. Carle's research using molecular and/or morphological features suggests that dragonflies are not the sister-group to damselflies, but rather to all other flying insects. He noted that the secondary genitalia (intermittent organs) of the three Odonata suborders are not even homologous but have nevertheless given rise to many similar and correlated features. Additional correlated features have resulted from the multiple origins of endophytic oviposition. Dr. Carle then walked the audience through the distributions, relationships, and the major wing features of well known and lesser known dragonfly fami-
lies, giving us a greater appreciation of the world diversity in this group.

The meeting was adjourned at 8:12 p.m. Refreshments were provided by the Society.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

1,082nd Regular Meeting—April 1, 2004

It was a drizzly, miserable night in Washington—not the night for a leisurely stroll through the cherry blossoms. Unadulterated by the foul weather, a sizeable crowd of entomophiles (21 members and 8 guests) had gathered in the Kerby Room. At a little after 7, Eric Grissell, a slender man with a somewhat presidential demeanor, swaggered to the podium; and with three swift, firm blows of the gavel, like the sound of a downy woodpecker on an oak, the crowd was subdued. The minutes of the previous meeting were read and accepted.

Notes and exhibitions followed the norm—books, tee-shirts, and insect specimens. As a rare and unusual treat, Edd Barrows shared a plant whose odor was so pungent that it brought tears to the eyes of those brave enough to indulge deeply in its aroma (a remarkably accurate imitation of something very dead).

As usual, Dave Furth introduced the evening’s speaker, Caroline Chaboo, a Ph.D. student at Cornell University and the American Museum of Natural History. Her talk, entitled “Untangling Fecal Shield Architecture in Tortoise Beetles: Behavior, Ecology, Morphology and Phylogeny (Coleoptera: Chrysomelidae: Cassidinae),” provided interesting insights into the bizarre use of their own frass and exuviae to construct elaborate posterior structures. Chaboo overlaid these and other biological and behavioral features on a phylogeny derived using morphological characters. To no one’s surprise, the term “anal retentive” found its way into the question and comment session.

Refreshments followed the meeting, and you could almost hear Grissell thinking to himself, “Oreos without milk? What heathens.”

Submitted by,
John W. Brown
Pinch-hitting Recording Secretary

1,083rd Regular Meeting—May 6, 2004

Orange eyes underground
Stare at roots through chitin brown,
Up breast of willow, elm, or oak
‘neath Moth Nature’s loamy cloak.

Years pass—seven and ten—
Then to sing your song again.
One last molt, and you fly;
Your lesser family green envy.

Keening love—cicada future,
Or will you just as bird food nurture?
Do you end in some cat’s gullet
Or tangled in a unkempt mullet?

Oh noble exoskeletoid race,
Keep hook and wing from off my face.
Fifty days you sing your song,
Does to you seem o’er long?

Then split those twigs and soon be found.
Orange eyes underground.

—By Gaye Williams

Attendees of the 1,083rd meeting of the Entomological Society of Washington (18 members and 8 guests) were all a-buzz as they were called to order in the Cathy Kerby Room at a little after 7:00 p.m. With so many pinch-hitters, it was reminiscent of a ninth inning at Camden Yards. There was Jason Hall, leading off and pinch-hitting for Eric Grissell, Gabby Chaverria for Dave Furth, and John Brown for Stu McKamey. The minutes of the previous meeting were read and met with approval. The names of two new members were read by Holly Williams; Donald Weber of USDA, Beltsville, and Önder Çalmasur, possibly our first Turkish member. President-elect Hall announced that the banquet would be a little later this year—in July—and the speaker would be Keith Wilmott, a fellow butterfly-
er currently post-doc-ing at the BM. There was a plethora of cicada trivia presented by Edd Burrows, Warren Steiner, Gabby Chaverria, and Gaye Williams, including t-shirts, bumper-stickers, riker mounts of adults, exit tunnels, photographs, etc. Alma Solis shared her recent article in the News of the Lepidopterists’ Society regarding the dreaded cactus moth, *Cactoblastis cactorum*.

The evening’s speaker, Leeanne Alonso of Conservation International, was introduced by Dr. Chaverria. Dr. Alonso’s talk, entitled “Contributions of Rapid Assessment of Insects to Biodiversity Conservation,” provided a glimpse into the identification of “Hotspots” and “Major Tropical Wilderness Areas,” which are the primary focus of the group’s conservation efforts. Dr. Alonso presented examples of habitat assessments from around the world, most of which pay little attention to invertebrates. She is hoping this will change.

The usual refreshments were augmented by a delicious cake provided by Wayne Mathis. Mmmm—good stuff! Davis and Brown were looking forward to more cake for lunch the following day, and were deeply distressed to find that the cake had vanished overnight! Another unsolved mystery.

Submitted by,
John Brown
*Acting Recording Secretary*
TABLE OF CONTENTS, VOLUME 106

ARTICLES

ADAMSKI, DAVID—A new Holcocera Clemens (Lepidoptera: Gelechioidea: Coleophoridae) from mountainous southeastern Arizona ................................................................. 649
ADAMSKI, DAVID—See WAGNER, DAVID L. ........................................... 1
ADAMSKI, DAVID—See NISHIDA, KENJI .................................................. 133
ADLER, LYNN S.—See GAIMARI, STEPHEN D. .......................................... 501
ARCE-PÉREZ, ROBERTO—Psephenopalpus browni, a new genus and species of Psepheninae (Coleoptera: Byrrhoidea: Psephenidae) from Mexico ........................................... 90
ARCE-PÉREZ, ROBERTO—A new species of Psephenotarsis Arce-Pérez (Coleoptera: Byrrhoidea: Psephenidae) from Guatemala ................................................................. 826
ALLISON, D. W.—See PIKE, K. S. ................................................................. 801
BARRERA, ERNESTO—See BRAILOVSKY, HARRY ..................................... 424
BARTLETT, CHARLES R.—See DEITZ, LEWIS L. ......................................... 586
BICKEL, DANIEL J.—Maipomyia (Diptera: Dolichopodidae), a new genus from Chile ................................................................. 844
BISSELL, J. K.—See COLEMAN, B. K ........................................................... 217
BORKENT, ART—See SPINELLI, GUSTAVO ................................................ 361
BRAILOVSKY, HARRY—The tribe Colpurini (Hemiptera: Heteroptera: Coreidae) of the Philippine Republic, with descriptions of four new species and a synonymical note ... 606

BRAILOVSKY, HARRY and ERNESTO BARRERA—Two new genera and four new species of Colpurini (Heteroptera: Coreidae: Coreinae) from New Guinea ... 424

BROWN, ALEX E.—See POINAR, GEORGE, JR. ... 339

BROWN, ALEX E.—See POINAR, GEORGE, JR. ... 789

BROWN, BRIAN V.—See KUNG, GIAR-ANN ... 751

BROWN, JOHN W. and RICHARD L. BROWN—A new species of Cryptaspasma Walsingham (Lepidoptera: Tortricidae: Olethreutinae) from Central America, the Caribbean, and southeastern United States, with a catalog of the world fauna of Microcorisini ... 288

BROWN, RICHARD L.—See WAGNER, DAVID L. ... 1

BROWN, RICHARD L.—See BROWN, JOHN W. ... 288

BUENO-SORIA, JOAQUIN and ALICIA ROJAS-ASCENSIO—New species and distribution of the genus Marilla Müller (Trichoptera: Odontoceridae) in Mexico and Central America ... 679

BUFFINGTON, MATTHEW L.—Taxonomic notes on Nodlandiella Diaz and Gamaspidium Weld (Hymenoptera: Figitidae: Eucoilinae) ... 192

BYERS, GEORGE W. and DOUGLAS A. ROSSMAN—Preliminary survey of the crane flies (Diptera: Tipulidae, Ptychopteridae) of Louisiana ... 884

ÇAĞIRAN, N.—See CANDAN, S. ... 811

ÇALMASUR, ÖNDER and HIKMET ÖZBEK—Heterarthrus ochropoda (Klug) (Hymenoptera: Nentheridinae), a new record and new pest of Populus spp. (Salicaceae) in Turkey ... 717

CANDAN, S., Z. SULUDERE, A. HASBENLI, N. ÇAĞIRAN, R. LAVIGNE, and A. SCARBROUGH—Ultrastructure of the chorion of Dioctria flavipennis Meigen, 1820 (Diptera: Asilidae: Stenopogoninae) compared with those of fourteen asilid species from the mid-Atlantic region of North America ... 811

CHAMORRO-LACAYO, MARIA LOURDES, and RALPH W. HOLZENTHAL—Seven new species of Polystictopus Ulmer (Trichoptera: Polycentropodidae) from Costa Rica ... 202

CHEN, XUEXIN, J. B. WHITFIELD, AND JUNHUA HE—Revision of the subfamily Cardiochilinae (Hymenoptera: Braconidae) in China. I. The genera Austerocardiociles Dangerfield, Austin, and Whitfield, Eurycardiochiles Dangerfield, Austin, and Whitfield and Psilotominaeus Enderlein ... 35

CIHA, J.—See COLEMAN, B. K. ... 217

ÇİLABROGLU, EBÜRÜ GÜL, and ALİ GÖK—Flea beetles (Coleoptera: Chrysomelidae) of Isparta, Turkey, with habitat use and host plant associations ... 858

CLINE, ANDREW R.—A new species of Psilotes Fischer von Waldheim (Coleoptera: Nitidulidae: Nitidulinae) from Peru, with new distribution records for other Psilotes species ... 891

COLEMAN, B. K., J. K. BISSELL, J. CIHA, P. MACKREIGN, and J. B. KEIPE—The moths (Lepidoptera) and associated flora of Kelleys Island, Lake Erie ... 217

COSTA, L. A. A., AUGUSTA GAGNE, J. R. MCDONALD, J. JR.—See MAU, RALPH P. ... 305

COSTA, LUIZ A. A. and THOMAS J. HENRY—Fulvius chagenuis Carvalho and Costa (Heteroptera: Miricinae: Cylapinae: Fulviiini): Redescription and recognition of type specimens ... 417


DEWALT, R. EDWARD—See HEIMDAL, DENNIS P. ... 761

ECKERLIN, RALPH P.—See LEWIS, ROBERT E. ... 757

ETNIEER, DAVID A., CHARLES R. PARKER, and IAN C. STOCKS—A new species of Rhycaphila Pictet (Trichoptera: Rhyacophilidae) from Great Smoky Mountains National Park, with illustrations of females of R. appalachia Morse and Ross and R. myctea Ross ... 396

FAVRET, COLIN, JOHN E. TOOKER, and LAWRENCE M. HANKS—Jowana fronsi (Hottes (Hemiptera: Aphididae) redescribed, with notes on its biology ... 26

FLORES-MENDOZA, CARMEN, E. L. PEYTON, RICHARD C. WILKERSON, and RICARDO LOURENÇO DE OLIVEIRA—Anopheles (Nyssorhynchus) konderi Galvão and Damasceno: Neotype designation and resurrection from synonymy with Anopheles (Nyssorhynchus) oswaldoi (Peryassu) (Diptera: Culicidae) ... 118

FOOTE, B. A.—Acalyptate Diptera associated with stands of Carex laevis and C. stricta (Cyperaceae) in northeastern Ohio ... 166

FOOTTIT, R. G.—See PIKE, K. S. ... 801
FRAFJORD, KARL—See HASTRITER, MICHAEL W. ........................................... 877
GAGNÉ, RAYMOND J. and CELIA dR. MEDINA—A new species of Prococtaria (Diptera: Cecidomyiidae), an important new pest of mango in the Philippines ........................................... 19
GAGNÉ, RAYMOND J., FRANCISCO POSADA, and ZULMA NANCY GIL—A new species of Brugmanniella (Diptera: Cecidomyiidae) aborting young fruit of avocado, Persea americana (Lauraceae), in Colombia and Costa Rica ........................................... 547
GAGNÉ, RAYMOND J., ALEJANDRO SOSA, and HUGO CÓRDO—A new Neotropical species of Cliondiploptis (Diptera: Cecidomyiidae) injurious to alligatorweed, Alternanthera philoxeroides (Amaranthaceae) ........................................... 305
GAIMARI, STEPHEN D., LYNN S. ADLER, and SONJA J. SCHEFFER—Plant host affiliation and redescriptions of Phytomyza subtenuella Frost (Diptera: Agromyzidae) ........................................... 501
GE, SI-QIN and XING-KE YANG—Two new Chinese species of Tenemorga Neboiss (Coleoptera: Cupedidae), with a world catalog of the genus ........................................... 631
GEORGE, JEREMIAH—See PINTO, JOHN D. ........................................... 531
GIL, ZULMA NANCY—See GAGNÉ, RAYMOND J. ........................................... 547
GÖK, ALİ—See ÇİLBIROĞLU, EBRU GÜL ........................................... 858
GONZALEZ, VICTOR H. and CHARLES D. MICHENER—Application of specific names and association of sexes in Cadegualina Michener (Hymenoptera: Colletidae: Diphaglossini) ........................................... 851
GRAF, G.—See PIKE, K. S. ........................................... 801
GRANARA DE WILLINK, MARIA CHRISTINA, and DOUGLASS R. MILLER—Two new species of mealybugs (Hemiptera: Coccoidea: Pseudococcidae) from Patagonia, Argentina ........................................... 140
GRUBBS, SCOTT A.—Studies on Indiana stoneflies (Plecoptera), with an annotated and revised state checklist ........................................... 865
GRUBBS, SCOTT A. and BILL P. STARK—Acroneuria coevii (Plecoptera: Perlidae), a new stonefly species from eastern North America ........................................... 797
HALL, JASON P. W. and GERARDO LAMAS—A new cloud forest species of Calydna (Lepidoptera: Riodinidae) from Peru, with a revised phylogeny for the C. hiria group ........................................... 733
HANKS, LAWRENCE M.—See FAVRET, COLIN ........................................... 26
HARRINGTON, RICHARD C. and JOHN C. MORSE—A new species of Brachycerus Curtis (Trichoptera: Brachyceridae) from the southern Appalachian Mountains and variation in the caddisfly B. spinae Ross ........................................... 453
HASBENLI, A.—See CANDAN, S. ........................................... 811
HASTRITER, MICHAEL W., KARL FRAFJORD, and MICHAEL F. WHITING—A collection of Norwegian fleas (Siphonaptera) north of the Arctic Circle ........................................... 877
HE, JUNJUA—See CHEN, XUEXIN ........................................... 35
HEIDEMAA, MIKK and ALEXEY ZINOVJEV—Dolerus anatoili, n. sp., the first Paleartic member of the subgenus Neodolerus Goulet (Hymenoptera: Tenthredinidae) ........................................... 159
HEIMDAL, DENNIS P. R. and THOMAS F. WILTON—Annotated checklist of the stoneflies (Plecoptera) of Iowa ........................................... 761
HENRY, THOMAS J.—Raglitus alboacuminatus (Goeze) and Rhyparochromus vulgaris (Schilling) (Lycaeoidea: Rhyparochromidae): Two Paleartic bugs newly discovered in North America ........................................... 513
HENRY, THOMAS J.—See COSTA, LUIZ A. A. ........................................... 417
HOEBEKE, E. RICHARD—See WHEELER, A. G., JR. ........................................... 176
HOEBEKE, E. RICHARD—See WHEELER, A. G., JR. ........................................... 298
HOEBEKE, E. RICHARD—See WHEELER, A. G., JR. ........................................... 784
HOLZENTHAL, RALPH W.—Three new species of Chilean caddisflies (Insecta: Trichoptera) ........................................... 110
HOLZENTHAL, RALPH W.—See CHAMORRO-LACAYO, MARIA LOURDES ........................................... 202
ISHIKAWA, TADASHI and SHUJI OKAJIMA—A new species of the saicine assassin bug genus Carayamia Villiers (Heteroptera: Reduviidae) from Indochina ........................................... 319
IVIE, MICHAEL A.—See POLLOCK, DARREN A. ........................................... 697
KEUPER, J. B.—See COLEMAN, B. K. ........................................... 217
KENNEDY, JAMES H.—See WANG, YI-KUANG ........................................... 523
KIMSEY, LYNN S.—Taxonomic changes and new generic synonomy in the tiphiid wasp subfamily Thynninae (Hymenoptera: Tiphidiidae) ........................................... 508
KIMSEY, LYNN S.—Illustrated keys to genera of the male wasps in the subfamily Thynninae (Hymenoptera: Tiphidiidae) ........................................... 639
KONDATIEFF, BORIS C. and ROBERT E. ZUELLIG—A new species of Zealeuctra Ricker (Plecoptera: Leuctridae) and confirmation of Hydroperla fugitans (Needham and Claassen) (Plecoptera: Perlodidae) from Texas .......................... 840
KONDATIEFF, BORIS C.—See STARK, BILL P. .................................................. 747
KONSTANTINOV, ALEXANDER S. and BORIS A. KOROTYAEV—Sexual dimorphism and size of aedeagi in apionid weevils (Coleoptera: Apionidae) and flea beetles (Coleoptera: Chrysomelidae): Why some masculine males have small aedeagi .................................................. 324
KOROTYAEV, BORIS A.—See KONSTANTINOV, ALEXANDER S. ....................... 324
KUNG, GIAR-ANN and BRIAN V. BROWN—Two new species of Megaselcia Rondani (Diptera: Phoridae) from Costa Rica .................................................. 751
LAMAS, GERARDO—See HALL, JASON P. W. .................................................. 733
LAVIGNE, R.—See CANDAN, S. ................................................................. 811
LEWIS, ROBERT E. and RALPH P. ECKERLIN—A new species of Hystrichopsylla Taschenberg, 1880 (Siphonaptera: Hystrichopsyllidae) from Guatemala .................. 757
LIU, ZHIWEI—A new species of Xestophanes Förster (Hymenoptera: Cynipidae) from Azerbaijan ................................................................. 779
MACKAY, WILLIAM P.—A new species of the ant genus Acanthostichus Mayr (Hymenoptera: Formicidae) and a descriptions of the gyne of A. brevicornis Emery .................... 97
MACKAY, WILLIAM P.—See PACHECO, JOSÉ ............................................. 434
MACEIGAN, P.—See COLEMAN, B. K. ......................................................... 217
MATHIS, WAYNE N.—See SUEYOSHI, MASAIRO ........................................... 74
MATHIS, WAYNE N. and TADEUSZ ZATWARIKCI—A revision of the shore-fly genus Cressonomyia Arnaud (Diptera: Ephydridae), with comments on species that have been excluded .................................................. 249
MATHIS, WAYNE N. and TADEUSZ ZATWARIKCI—A review of two Nearctic shore-fly species in the genus Psilopa Fallén that were included in the genus Cressonomyia Arnaud (Diptera: Ephydridae) .................................................. 639
MATHIS, WAYNE N. and TADEUSZ ZATWARIKCI—Description of a new species of Hyadina Haliday (Diptera: Ephydridae) from southern California ............. 705
MAW, H.E.L.—See PIKE, K. S. ................................................................. 801
MAWDSLEY, JONATHAN R.—Pollen transport by North American Trichodes Herbst (Coleoptera: Cleridae) .................................................. 199
MCCAFFERTY, W. P.—See ZHOU, CHANG-FA ........................................... 312
MENDES, LUIS E. and GEORGE O. POINAR, JR.—A new fossil Nicoletiidae (Zygentoma, "Apterygota") in Dominican amber .................................................. 102
MEDINA, CEILIA dR.—See GAGNÉ, RAYMOND J. ........................................ 19
MICHENER, CHARLES D.—See GONZALEZ, VICTOR H. .............................. 851
MILLER, DOUGLASS R.—See GRANARA DE WILLINK, MARIA CHRISTINA .......... 140
MORGAN, CYNTHIA—See PACHECO, JOSÉ ............................................. 434
MORÓN, MIGUEL ANGEL—See OCAMPO, FECERICO C. ............................... 412
MORSE, JOHN C.—See HARRINGTON, RICHARD C. ..................................... 453
MORSE, JOHN C. and LIANFANG YANG—The world subgenera of Glossosoma Curtis (Trichoptera: Glossosomatidae), with a revision of the Chinese species of Glossosoma subgenera Synaphophora Martynov and Proteglossos Ross ................................. 52
MUEGGE, MARK A.—Description of Evalljapyx limpia, n. sp. (Diplura: Japygidae) from the Davis Mountains of western Texas .................................................. 923
NEUNZIG, H. H. and M. A. SOLIS—Exguiana, a new genus of Neotropical phycitines (Lepidoptera: Pyralidae) .................................................. 554
NICKLE, DAVID A.—Commonly intercepted thrips (Thysanoptera) from Europe, the Mediterranean, and Africa at U.S. ports-of-entry, Part II. Frankliniella Karny and Iridothrips Priesnzer (Thripidae) .................................................................................. 438
NISHIDA, KENJI and DAVID ADAMSKI—Two new gall-inducing Saphenista Walsingham (Lepidoptera: Tortricidae: Cochylini) from Costa Rica .................................................. 133
OCAMPO, FECERICO C. and MIGUEL ANGEL MORÓN—Description of the third instar larva of Hemiphileurus dispar Kolbe (Coleoptera: Scarabaeidae: Dynastinae: Phileurini) .................................................. 412
OKAKIMA, SHÜI—See ISHIKAWA, TADASHI ............................................. 319
OLIVEIRA, RICARDO LOURENÇO DE—See FLORES-MENDOZA, CARMEN .......... 118
OWEN, ALBERT K.—See PINTO, JOHN D. .................................................. 905
ÖZBEK, HIKMET—See ÇALMASUR, ÖNDER ........................................... 717
PACHECO, ILIANA—See PEREDO, LUIS CERVANTES .............................. 654
PACHECO, JOSÉ, WILLIAM MACKAY, and CYNTHIA MORGAN—A new species of Gnamptogenys Roger of the saleata group (Hymenoptera: Formicidae) from Bolivia ................................................................. 434
PARKER, CHARLES R.—See ETNIER, DAVID A. ........................................ 396
PEREDO, LUIS CERVANTES—Alloecorychus trimacula (Stein) (Heteroptera: Nabidae): Prosternmatinae), a predator of Rhyparochromidae (Lygaeoidea) associated with figs in Mexico ................................................................. 346
PEREDO, LUIS CERVANTES, ILIANA PACHECO, and AARON SANCHEZ—Immature stages and life cycles of five species of Ozophora Uhler (Hemiptera: Rhyparochromidae): Ozophorini) associated with figs in Mexico ................................................................. 654
PEYTON, E. L.—See FLORES-MENDOZA, CARMEN .................................. 118
PINTO, JOHN D.—A review of the genus Doirania Waterston (Hymenoptera: Trichogrammatidae), with a description of a new species from North America ................................................................. 352
PINTO, JOHN D. and JEREMIAH GEORGE—Kyuuvia, a new genus of Trichogrammatidae (Hymenoptera) from Africa ................................................................. 531
PINTO, JOHN D. and ALBERT K. OWEN—Adryas, a new genus of Trichogrammatidae (Hymenoptera: Chalcidoidea) from the New World tropics ................................................................. 905
POINAR, GEORGE, JR.—Palaeomyia burnittis (Diptera: Phlebotomidae), a new genus and species of Cretaceous sand flies with evidence of blood-sucking habits ................................................................. 598
POINAR, GEORGE, JR. and ALEX E. BROWN—A new genus of primitive crane flies (Diptera: Tanyderidae) in Cretaceous Burmese amber, with a summary of fossil Tanyderids ................................................................. 339
POINAR, GEORGE, JR. and ALEX E. BROWN—A new subfamily of Cretaceous antlike stone beetles (Coleoptera: Scydmaenidae: Hapsomelinae) with an extra leg segment ................................................................. 789
POINAR, GEORGE, JR.—See MENDES, LUIS E. ........................................... 102
POLLOCK, DARREN A. and MICHAEL A. IVIE—Description of the larva of Phaeogala rufa Abdullah (Coleoptera: Mycteridae: Lacconotinae), with nomenclatural notes for the genus Phaeogala ................................................................. 697
POSADA, FRANCISCO—See GAGNÉ, RAYMOND J. ......................................... 547
REEVES, W. K.—See WHEELER, A. G., JR. .................................................. 627
ROJAS-ASCENSIO, ALICIA—See BUENO-SORIA, JOAQUIN .................................. 679
ROSSMAN, DOUGLAS A.—See BYERS, GEORGE W. ..................................... 884
SANCHEZ, AARON—See PEREDO, LUIS CERVANTES .................................. 654
SCARBROUGH, A.—See CANDAN, S. .......................................................... 811
SCHAEFER, CARL W.—Key to the genera of New World Alydidae (Hemiptera: Heteroptera) ................................................................. 280
SCHAEFFER, SONJA J.—See GAIMARI, STEPHEN D. ....................................... 501
SOLIS, M. A.—See NEUNZIG, H. H. .......................................................... 554
SMITH, DAVID R.—The Nematus "magus group" (Hymenoptera: Tenthredinidae) in North America ................................................................. 592
SMITH, DAVID R.—A new species of Derecyrta Smith (Hymenoptera: Xiphidiidae) from Colombia and Ecuador ................................................................. 675
SPINELLI, GUSTAVO and ART BORKENT—New species of Central American Culicoides Latreille (Diptera: Ceratopogonidae) with a synopsis of species from Costa Rica ................................................................. 361
SONG, HOJUN—Post-adult emergence development of genitalic structures in Schistocerca Stal and Locusta L. (Orthoptera: Acrididae) ................................................................. 181
SOSA, ALEJANDRO—See GAGNÉ, RAYMOND J. ............................................. 305
STEINER, WARREN E., JR.—New distribution records and recent spread of Hymenopus farri Campbell (Coleoptera: Tenebrionidae: Alleculinae) to Florida and in the Caribbean region ................................................................. 739
STEINLY, BRUCE A.—Primary consumer and detrivore communities (Diptera: Ephydridae) in newly restored and constructed wetlands ................................................................. 460
STARK, BILL P.—See GRUBBS, SCOTT A. ................................................... 797
STARÝ, P.—See PIKE, K. S. ......................................................... 801
STOCKS, IAN C.—See ETNIER, DAVID A. ..................................... 396
SUEYOSHI, MASAHIRO and WAYNE N. MATHIS—A new species of Cyaneops Melander 1913 (Diptera: Periscelididae) from Japan and a review of Japanese Periscelididae .................................. 74
SULUDERE, Z.—See CANDAN, S. .................................................. 811
SUN, LU—See ZHOU, CHANG-FA .................................................. 312
TENNESSEN, KENNETH J.—Cordulegaster talaria, n. sp. (Odonata: Cordulegastridae) from west central Arkansas .......................................................... 830
TENNESSEN, KENNETH, J. and T. E. VOGT—Ophitogramphus smithi, n. sp. (Odonata: Gomphidae) from Wisconsin and Iowa .......................................... 540
TOGASHI, ICHIJI—Description of a new species of the genus Eriocamopsis Takeuchi (Hymenoptera: Tenthredinidae) from Japan ............................... 421
TOOKER, JOHNN E.—See FAVRET, COLIN .................................... 26
VANDENBERG, NATALIA J.—Contributions to the knowledge of Olla Casey (Coleoptera: Coccinellidae: Coccinellini): New species from the Galapagos Islands, updates on the distribution of O. xing-kei (Mulsant) ......................................................... 619
VOGT, T. E.—See TENNESSEN, KENNETH, J. ................................. 540
WAGNER, DAVID L., DAVID ADAMSKI, and RICHARD L. BROWN—A new species of Mompha Hübner (Lepidoptera: Coleophoridae: Momphinae) from buttonbush (Cephalanthus occidentalis L.) with descriptions of the early stages ........................................ 1
WANG, YI-KUANG and JAMES H. KENNEDY—Life history of Mayatrixia ponta Ross (Trichoptera: Hydropsilidae) in Honey Creek, Oklahoma ........................................ 523
WHEELER, A. G. JR.—Largidea davisi Knight, a rarely collected plant bug (Hemiptera: Miridae: Deraeocorinae) associated with pitch pine in the northeastern United States ..................................................... 85
WHEELER, A. G., JR.—Keltonia rubrofemorata Knight and K. wheeleri Henry (Hemiptera: Miridae): Distribution, host plants, habitats, and seasonality of specialists on Polygonella spp. (Polygonaceae) ........................................................................ 564
WHEELER, A. G., JR. and E. RICHARD HOEBEKE—New North American records of the European broom psyllid Arytaina genistae (Latreille) (Sternorrhyncha: Psyllidae) ................................................................. 176
WHEELER, A. G., JR. and E. R. H. HOEBEKE—New records of Palearctic Hemiptera (Sternorrhyncha, Cicadomorpha, Heteroptera) in the Canadian maritime provinces .......................................................... 298
WHEELER, A. G. JR. and E. R. H. HOEBEKE—An introduced knapweed gall fly, Urophora quadrifasciata (Meigen) (Diptera: Tephritidae) in North America: Northeastern and southeastern range extensions ................................................. 784
WHEELER, A. G. JR. and W. K. REEVES—New distribution records and moss associations of the lace bugs Acalypta duryi Drake and A. liliialis Torre-Bueno (Hemiptera: Tingidae) ......................................................... 627
WHITFIELD, J. B.—See CHEN, XUEXIN ........................................... 35
WHITING, MICHAEL E.—See HASTRITER, MICHAEL W. .............. 877
WILKerson, RICHARD C.—See FLORES-MENDOZA, CARMEN .......... 118
WILTON, THOMAS F.—See HEIMDAL, DENNIS P. ............................. 761
WOODLEY, NORMAN E.—A remarkable new Solva Walker (Diptera: Xyloxyidae) from northern Borneo ............................................................... 900
YANG, LIANFANG—See MORSE, JOHN C ......................................... 52
YANG, XING-KE—See GE, SI-QIN .................................................... 631
YASUNAGA, TOMOHIDE—A new genus and new species of mirid plant bug (Heteroptera: Miridae: Mirini) from the Ryukyus, Japan ........................................... 407
ZATWARNICKI, TADEUSZ—See MATHIS, WAYNE N. ......................... 249
ZATWARNICKI, TADEUSZ—See MATHIS, WAYNE N. ......................... 639
ZATWARNICKI, TADEUSZ—See MATHIS, WAYNE N. ......................... 705
ZHOU, CHANG-FA, LU SUN, and W. P. MCCAFFERTY—A new species of Brachycercus Curtis (Ephemeroptera: Caenidae) from China ........................................ 312
ZINOVJEV, ALEXEY—See HEIDEMAA, MIKK ................................ 159
ZUELLIG, ROBERT E.—See KONDRATIEFF, BORIS C. ..................... 840

NOTES
BANGS, MICHAEL J.—See ROBBINS, RICHARD G. ......................... 472
BARNES, JEFFREY, K.—Overwintering cave mosquitoes (Diptera: Culicidae) of the Arkansas and Missouri ozarks ................................................................. 235
BASTARDO, RUTH H.—See PEREZ-GELABERT, DANIEL E. ............ 932
BROWN, JOHN W., MARC E. EPSTEIN, and ERIC R. DAY—First report of Pryeria sinica Moore (Lepidoptera: Zygaenidae) in North America ........................................ 239
CORTEZ-AGUILAR, JESÚS.—See NAVARRETE-HEREDIA, JOSÉ LUIS 481
CURTISS, ROBERT—See HAJEK, ANN E. ................................. 928
DAY, ERIC R.—See BROWN, JOHN W. ...................................... 239
EPSTEIN, MARC E.—See BROWN, JOHN W. ............................. 239
GELHAUS, J.—See POINAR, GEORGE, JR. ......................... 478
GULLAN, P. J.—See LAFLIN, H. M. .................................. 475
HAJEK, ANN E., ROBERT CURTISS, and JAMES K. LIEBHERR—Characters differentiating male from female Anoplophora glabripennis (Motschulsky) (Coleoptera: Cerambycidae) .................................................. 928
KEIRANS, JAMES E.—See ROBBINS, RICHARD G. ................. 472
KORECKI, J. A.—See REEVES, W. K. ................................ 233
LAFLIN, H. M., P. J. GULLAN, and M. E. PARRELLA—Mealybug species (Hemiptera: Pseudococcidae) found on ornamental crops in California nursery productions ................. 475
LATTIN, JOHN D.—Solenomotus augustatus Poppius, a synonym of Dufourrielles ater Fieber (Hemiptera: Heteroptera: Anthocoridae) ........................ 722
LIEBHERR, JAMES K.—See HAJEK, ANN E. ......................... 928
McCAFFERTY, W. P.—See SUN, LU .................................. 936
NAVARRETE-HEREDIA, JOSÉ LUIS and JESÚS CORTEZ-AGUILAR—Beetles (Coleoptera) associated with the external debris of Atta mexicana (F. Smith) (Hymenoptera: Formicidae) from Ojuelos, Jalisco, México ........................................ 481
PARRELLA, M. E.—See LAFLIN, H. M. ................................. 475
PEREZ-GELABERT, DANIEL E. and RUTH H. BASTARDO—Synoditella bisulcata (Kieffer) (Hymenoptera: Scelionidae) parasitizing Orphulella punctata (DeGeer) (Orthoptera: Acrididae) in the Dominican Republic ........................................ 932
POINAR, GEORGE, JR. and JON GELHAUS—Larval development of Cylindrotoma distinctissima americana Osten Sacken, 1865 (Tipulidae: Cylindrotominae) on Maleanthemum dilatatum (Liliaceae) in California ........................................ 476
REEVES, W. K. and J. A. KORECKI—Ocherorotatus japonicus japonicus (Theobald) (Diptera: Culicidae), a new invasive mosquito for Georgia and South Carolina .............. 233
ROBBINS, RICHARD G., MICHAEL J. BANGS, and JAMES E. KEIRANS—First report of Ixodes kopsterni Oudemans (Acari: Ixodidae: Ixodidae) from the Kingdom of Cambodia, with a summary of known hosts of this tick in continental southeastern Asia .................. 472
SUN, LU AND W. P. McCAFFERTY—New name for a generic homonym in Caenidae (Ephemeroptera) ................................................................. 936
VANDENBERG, NATALIA J.—Homonymy in the Coccinellidae (Coleoptera), or something fishy about Pseudoscyemus Chapin .................. 483
WHEELER, A. G., JR.—Crophius disconotus (Say) (Hemiptera: Lygaeidae: Oxycarenidae): Southeastern extension of the U. S. range, with rectification of an old Alabama record ........................................ 725
YOUNG, DANIEL K.—Pyrochroa daglariensis: Replacement name for Dendroides cyanipennis Pic 1896, primary junior homonym of Dendroides cyanipennis Latreille 1817 (Coleoptera: Pyrochroidae: Pyrochroidinae) ........................................ 934
ZYLÀ, JOHN D.—First report of the 13-year periodical cicada, Magicicada tredecim (Walsh and Riley) (Hemiptera: Cicadidae) in Maryland ...................... 485
ZYLÀ, JOHN D.—Reports of four year accelerated occurrences of the 2004 emergens of periodical cicadas, Magicicada spp. (Hemiptera: Cicadidae) Brood X in Maryland, Virginia, and the District of Columbia .................. 488

BOOK REVIEWS

EVANS, ARTHUR V.—Encyclopedia of Insects, edited by Vincent H. Resh and Ring T. Cardé ................................................................. 491
HALL, JASON P. W.—The genus Adelphia: Its Systematics, Biology, and Biogeography (Lepidoptera: Nymphalidae: Limenitidini), by Keith R. Willmott ........................................ 728
STEINER, WARREN E., JR.—Water Beetles of South Carolina (Coleoptera: Gyrinidae, Halipitidae, Noteridae, Dytiscidae, Hydrophilidae, Hydraenidae, Scirtidae, Elmidae, Dryopidae, Limnichidae, Heteroceridae, Psephenidae, Ptilodactylidae, and Chelomariidae), by Janet C. Ciegler ......................................................................................................................... 493

OBITUARY


MISCELLANEOUS

Instructions for authors ........................................................................................................... 247, 731
Notice of new publication ........................................................................................................ 245, 500
Regular meetings for 2003–2004 ......................................................................................... 246
Reports of officers .................................................................................................................. 495
Society meetings ..................................................................................................................... 497, 937
Table of contents, volume 106 ............................................................................................. 941
PUBLICATIONS FOR SALE BY THE
ENTOMOLOGICAL SOCIETY OF WASHINGTON

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CONTENTS
(Continued from front cover)

KONDRATIEFF, BORIS C. and ROBERT E. ZUELLIG—A new species of Zealeactus Rickert (Plecoptera: Leuctridae) and confirmation of Hydroperla fugitans (Needham and Claassen) (Plecoptera: Perlodidae) from Texas ................................................................. 840

KUNG, GIAR-ANN and BRIAN V. BROWN—Two new species of Megaselia Rondani (Diptera: Phoridae) from Costa Rica .......................................................... 751

LEWIS, ROBERT E. and RALPH P. ECKERLIN—A new species of Hystrichopsylla Taschenberg, 1880 (Siphonaptera: Hystrichopsyllidae) from Guatemala ....................... 757

LIU, ZHIWEI—A new species of Xestophanes Förster (Hymenoptera: Cynipidae) from Azerbaijan .......................................................... 779

MUEGGE, MARK A.—Description of Evalijapx limpia, n. sp. (Diplura: Japygidae) from the Davis Mountains of western Texas ..................................................... 923


PINTO, JOHN D. and ALBERT K. OWEN—Adrys, a new genus of Trichogrammatidae (Hymenoptera: Chalcidoidea) from the New World tropics ....................................... 905

POINAR, GEORGE, JR. and ALEX E. BROWN—A new subfamily of Cretaceous antlike stone beetles (Coleoptera: Sctydmaenidae: Hapsomelinae) with an extra leg segment ........................................................ 789

STEINER, WARREN E., JR.—New distribution records and recent spread of Hymenorus farri Campbell (Coleoptera: Tenebrionidae: Alleculinae) to Florida and in the Caribbean region ... 739


TENNESSEN, KENNETH J.—Cordulegaster talaria, n. sp. (Odonata: Cordulegastridae) from west central Arkansas .......................................................... 830

WHEELER, A. G., JR. and E. RICHARD HOEBEKE—An introduced knapweed gall fly, Urophora quadrifasciata (Meigen) (Diptera: Tephritidae) in North America: Northeastern and southeastern range extensions .................................................. 784

WOODLEY, NORMAN E.—A remarkable new Solva Walker (Diptera: Xylomyidae) from northern Borneo .......................................................... 900

NOTES

HAJEK, ANN E., ROBERT CURTISS, and JAMES K. LIEBHERR—Characters differentiating male from female Anoplophora glabripennis (Motschulskey) (Coleoptera: Cerambycidae) .......... 928

PEREZ-GELABERT, DANIEL E. and RUTH H. BASTARDO—Symoditellisa bisulcata (Kieffer) (Hymenoptera: Scelionidae) parasitizing Orphulella punctata (DeGeer) (Orthoptera: Acrididae) in the Dominican Republic ........................................................................ 932

SUN, LU and W. P. McCAFFERTY—New name for a generic homonym in Caenidae (Ephemeroptera) ........................................................................................................ 936

YOUNG, DANIEL K.—Pyrochroa daglariensis: Replacement name for Dendroides cyanipennis Pic 1896, primary junior homonym of Dendroides cyanipennis Latreille 1817 (Coleoptera: Pyrochroidae: Pyrochroidae) ................................................................. 934

MISCELLANEOUS

Society Meetings ............................................................................................................. 937

Table of Contents, Volume 106 ...................................................................................... 941