VOL. 105 JANUARY 2003 NO. 1
(ISSN 0013-8797)

PROCEEDINGS
of the
ENTOMOLOGICAL SOCIETY
of WASHINGTON

PUBLISHED
QUARTERLY

CONTENTS

(*Continued on back cover*)

THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

ORGANIZED MARCH 12, 1884

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MEMBERSHIP.—Members shall be persons who have demonstrated interest in the science of entomology. Annual dues for members are $25.00 (U.S. currency).

PROCEEDINGS.—The *Proceedings of the Entomological Society of Washington* (ISSN 0013-8797) are published quarterly beginning in January by The Entomological Society of Washington. POSTMASTER: Send address changes to the Entomological Society of Washington, ℅ Department of Entomology, Smithsonian Institution, Washington, D.C. 20560-0168. Members in good standing receive the Proceedings of the Entomological Society of Washington. Nonmember U.S. subscriptions are $60.00 per year and foreign subscriptions are $70.00 per year, payable (U.S. currency) in advance. Foreign delivery cannot be guaranteed. All remittances should be made payable to *The Entomological Society of Washington*.

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STATEMENT OF OWNERSHIP

Title of Publication: Proceedings of the Entomological Society of Washington.

Frequency of Issue: Quarterly (January, April, July, October).

Location of Office of Publication, Business Office of Publisher and Owner: The Entomological Society of Washington, ℅ Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168.

Editor: David R. Smith, Systematic Entomology Laboratory, ARS, USDA, ℅ Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168.

Books for Review: David R. Smith, Systematic Entomology Laboratory, ARS, USDA, ℅ Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168.

Managing Editor and Known Bondholders or other Security Holders: none.

This issue was mailed 13 January 2003

Periodicals Postage Paid at Washington, D.C. and additional mailing office.

PRINTED BY ALLEN PRESS, INC., LAWRENCE, KANSAS 66044, USA

PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 1–8

A NEW SPECIES OF WATER SCAVENGER BEETLE, *COELOSTOMA* (S. STR.) *TINA* (COLEOPTERA: HYDROPHILIDAE: SPHAERIDIINAE), FROM KENYA, EASTERN AFRICA

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Abstract.—A new species of African water scavenger beetle, ***Coelostoma tina* Spangler and Steiner**, is described. The specimens were collected in an eastern African section of the Rift Valley from lagoons in Lake Magadi, Kenya, and pools adjacent to the lake. The water in these habitats is hypersaline and highly alkaline and shores are salt encrusted. The adults are described and illustrated with line drawings and scanning electron micrographs. Habitat notes and photographs of the biotope are given.

Key Words: aquatic insects, Afrotropical fauna, extreme environments, salt lakes

The new species of water scavenger beetle described in the following account was collected by Scott E. Miller and Tina M. Kuklenski during biodiversity fieldwork in Kenya, eastern Africa. The specimens were collected in the Rift Valley at the site of the Magadi Soda Company in hypersaline and highly alkaline water in lagoons in Lake Magadi and in adjacent pools. The specimens belong to the genus *Coelostoma*, a speciose genus that is widely dispersed in the Eastern Hemisphere tropics. Most recently, Hansen (1999) in his catalog of the Hydrophiloidea of the world listed 92 species and 9 subspecies of *Coelostoma*. Of these taxa approximately 70% are Afrotropical, 25% are Oriental, and the remaining 5% are reported from the Palearctic and Australian regions. Most species inhabit lentic freshwater habitats in weedy margins. Some, and probably most species, can fly and are attracted to ultraviolet, mercury vapor, and incandescent lights. Some species are highly vagile, therefore, widely distributed (fide Hansen 1999) such as *Coelostoma orbiculare* (Fabricius) in the Palearctic Region from Britain to West Siberia, south to Spain and east to Japan. Also, *Coelostoma fabricii* (Montruzier) is reported by Hansen from many countries in the Oriental and Australian Regions as well as the Pacific Islands (Hawaiian Islands).

The genus *Coelostoma* was described by Brullé (1835). Since that time numerous new species were described by a variety of authors, mostly in small contributions and often under other incorrect generic or species names. The genus was first revised by d'Orchymont (1936), 101 years after Brullé originated the genus. Fortunately d'Orchymont, a prolific hydrophilid specialist, described and illustrated the aedeagi of his 15 new species plus 9 species described by earlier authors. In his study he found that it was absolutely necessary to ignore the females and to perform the tedious extractions of the aedeagi, illustrate them, and segregate species on their differences. In a subsequent publication, d'Orchymont (1940) divided the genus into two subgenera, the nominate *Coelostoma* (s. str.) and his new subgenus, *Lachnocoelostoma.*

Later, Mouchamps (1958) followed d'Orchymont's advice and primarily based his descriptions of 25 new species and redescriptions of six previously described species on their distinctive male genitalia. Occasionally, he noted differences in size and density of punctation and microreticulation on dorsal and ventral surfaces of some species. However, both authors essentially used only the distinctive aedeagi to distinguish the different species included in their publications. In Mouchamps's article noted above, he also described two new subgenera, *Hammacoelostoma* and *Holocoelostoma,* and provided a key to the four subgenera presently known.

***Coelostoma* (s. str.) *tina* Spangler and Steiner, new species**

(Figs. 1–10)

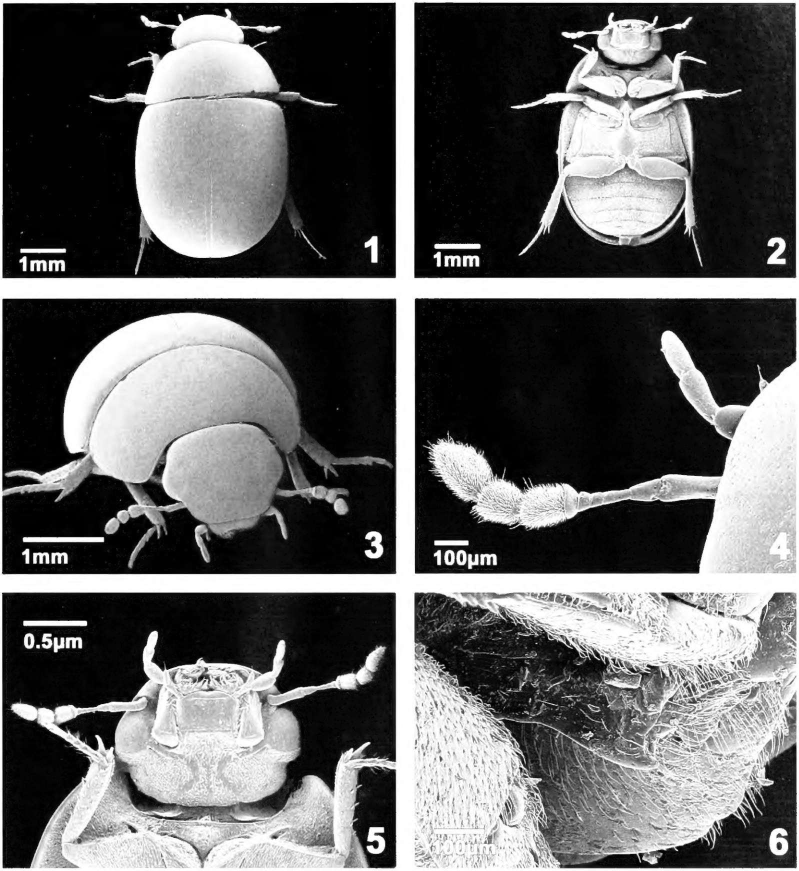
Diagnosis.—Color mostly black, shining, body oval, strongly convex dorsally (Figs. 1–3); length 4.6–5.5 mm. Antenna 9 segmented; base concealed under lateral shelf of head (Figs. 4–5). Mesosternal process sagittate and without a small transverse carina (Figs. 6–7). Tarsal claws simple. Metasternum with posterior process extended between metacoxae and forked apically (Fig. 8). Profemora and mesofemora with dense, stiff, hairlike setae on upper surface and similar but sparser setae on lower surface. First abdominal sternum not carinate longitudinally on midline. Last abdominal sternum rounded, not notched apicomedially. Aedeagus distinctive (Figs. 9–10) for this new species, resembling most closely that of *C. austrine* Mouchamps (1958) but in general more elongate with apices of the parameres less pointed.

Holotype ♂.—Body form and size: Oval, strongly convex dorsally. Length 5.3 mm; width 3.1 mm.

Color: Black and shiny dorsally. Venter black except tarsi dark reddish brown. Basal antennal segments 1–6 glabrous and reddish brown; apical segments 7–9 pubescent and dark reddish brown. Labrum reddish brown across anterior margin and bearing short golden setae. Maxillary and labial palpi reddish yellow. All visible abdominal sterna with reddish brown oval spot adjacent to lateral margins.

Head: Shiny, moderately coarsely and densely punctate, punctures separated by ½ to 3 times puncture diameter; surface between punctures finely microreticulate. A patch of hydrofuge pubescence posterolateral to each eye continues under head over genae except for a glabrous, longitudinal, cariniform ridge on midline between two similarly glabrous, but angular ridges (Fig. 5) bordering each hydrofuge pubescent patch. Labrum finely, densely punctate dorsally and shallowly and broadly emarginate anteriorly. Mentum rimmed, shallowly emarginate apicomedially, shallowly concave on anterior half, moderately coarsely and densely punctate on posterior half. Submentum punctate as on mentum but over entire surface.

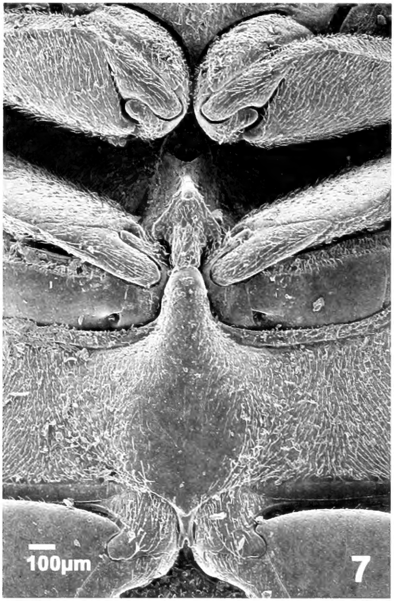
Thorax: Pronotum widest subbasally, lateral margins arcuate; anterolateral and posterolateral angles rounded; punctures on disc moderately coarsely, densely punctate; punctures separated by 1 or 2 times puncture diameter; surface between punctures microreticulate. Prosternum with only a minute denticle apicomedially followed by a low, ovoid medial hump. Mesosternum with broad sagittate medial protuberance with an apical hooklike process (Fig. 6); in ventral view, sides rimmed; a longitudinal, pubescent, medial process extends posteriorly and meets metasternal process between mesocoxae (Fig. 7). Metasternum shiny and ovately raised medially; densely and coarsely punctate laterally and more than on raised discal area; posterior process extended between metacoxae and apex bifurcate (Fig. 8). Metepisterna pubescent. Procoxa sparsely, finely setose. Profemur densely punctate and pubescent on basal four-fifths on all sides except on upper (leading) edge. Mesofemur densely, coarse-

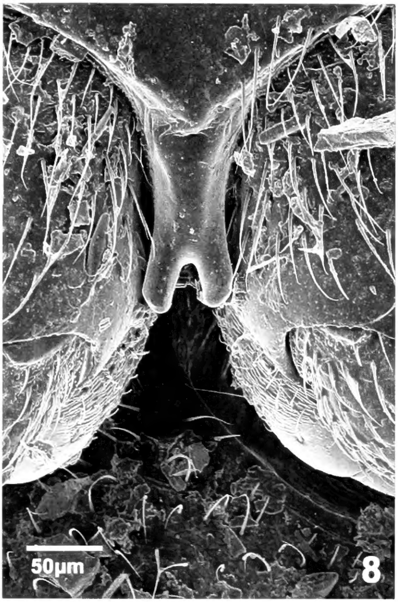


Figs. 1–6. *Coelostoma tina*, male, scanning electron microscope images. 1, Dorsal habitus. 2, Ventral habitus. 3, Oblique frontal view. 4, Left antenna and maxillary palpus, dorsal view. 5, Head, ventral view. 6, Mesosternal process, lateral view.

ly punctate as on profemora. Metafemur similar to mesofemur but with fewer coarse punctures. Elytron with random punctures moderately coarse and dense, punctures separated by 1-2 times diameter of a puncture; side nearly vertical from base to posterior end of metepisterna; with sutural stria extending from apex of scutellum where stria is separated from suture by diameter of an adjacent elytral puncture then deepening and widening to a distance equal to the diameters of 4 adjacent punctures at elytral apex. Scutellum an elongate triangle; coarsely and densely punctate but more finely microreticulate than on pronotum.

Genitalia: Aedeagus (Fig. 9) with me-





Figs. 7–8. *Coelostoma tina*, male, scanning electron microscope images. 7, Coxae and thoracic sterna, showing sagittate mesosternal process. 8, Forked process of metasternum between metacoxae.

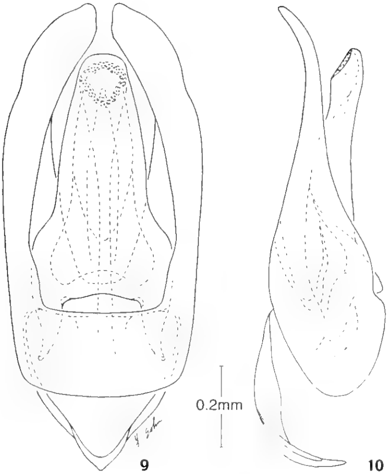
dian lobe wide at base, then tapering to apex; parameres flattened and widest at apex, angled inward, and upturned on apical ⅓ (Fig. 10); gonopore opening ventrally at apex.

Type data.—Holotype (♂): KENYA: Kajiado District, Lake Magadi, NW Lagoon at shortcut road, 1.805°S, 36.051°E, ca. 600 m; Station 3, 31 January 1999, S. E. Miller & T. M. Kuklenski collectors. Allotype and 6 paratypes, same data; 24 paratypes, same data except: NW Lagoon under salt encrusted rocks at edge of lake, 11 June 1997, 1.850°S, 36.217°E; 600 m. The holotype and 3 paratypes will be deposited in the National Museum of Kenya, Nairobi. Paratypes will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC; The Natural History Museum, London; the Central African Museum, Tervuren, Belgium; and the Transvaal Museum, Pretoria, South Africa.

Etymology.—We take pleasure in naming this beetle for Tina Kuklenski Miller, who, according to Scott Miller, urged him to stop at the site and take samples of insects, leading to the discovery of this new species.

HABITAT AND HISTORY

According to investigations by Vincens and Casanova (1987) and Roberts et al. (1993), Lake Magadi lies at 1°50′S, 36°18′E, 600 m above sea level and is a closed lake at the southern end of Gregory Rift Valley in Kenya (Fig. 11). Exploited commercially since 1917 by the Magadi Soda Company, it is described as an active salt lake with thick trona deposits and concentrated alkaline brines. The climate is hot



Figs. 9–10. *Coelostoma tina*, male genitalia, line drawings. 9, Dorsal view. 10, Lateral view.

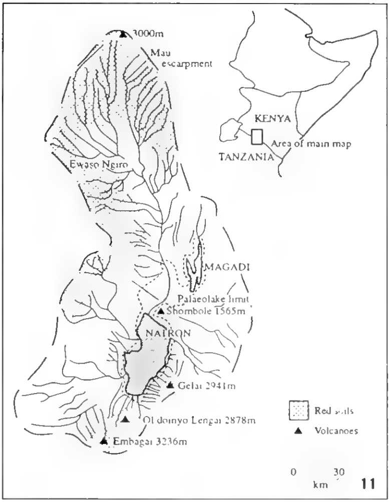


Fig. 11. Map of the features and location of Lake Magadi-Natron basin, Kenya (from Roberts et al. 1993), the type locality of *Coelostoma tina*.

and dry which, along with the prevailing lava and rocks, produces a harsh, semi-arid landscape of grassland and shrubland. Hand axes and other artifacts were discovered in 1942 by M. Leakey, and early hominid fossils were described from the region (Leakey and Leakey 1964), indicating that the area has a long history of human utilization. Baker (1958) reported that the first European to visit the area was a geologist, A. Fischer, in 1883. He was followed by numerous other geologists and a chemist, J. A Stevens (ca. 1930), from the Magadi Soda Company. Stevens provided valuable analyses of alkaline spring waters, lagoon liquors, and various salts that he found in Lake Magadi and adjacent hypersaline and alkaline waters. The lake is fed almost entirely by ground water inflows from modern springs (with their pH ranging from 9–9.5) while the larger Lake Natron, which was formerly connected to Lake Magadi, receives substantial surface water inflows primarily from the Ewaso Ngiro River. Salinities of the various parts and side pools of the lake probably fluctuate with rainfall and evaporation.

Biota and Endemism

The biota of Lake Magadi and its environs has not been thoroughly surveyed; selected taxa have been studied but the insect fauna is virtually unknown. Roberts et al. (1993) refer to two flamingo nurseries in a lagoon in the northwestern section of Lake Magadi (these birds currently provide an important tourist attraction to many East African lakes). Because flamingos usually feed on zooplankton, phytoplankton, crustaceans (amphipods, brine shrimp), insects (ephydrid and chironomid larvae), oligochaetes, etc. (Allen 1956), it seems reasonable that some of these organisms occur in the shallow water in or near the flamingo nurseries of the lake. However, Lesser Flamingos (the species breeding at Lake Magadi) are specialized feeders on diatoms and blue-green algae, and larger food items such as midge larvae and copepods occur

Figs. 12–13. Biotope of the type locality of *Coelostoma tina* at Lake Magadi, Kenya. 12, Lake margin and side pools with emergent rocks. 13, Part of lake basin with shallow pool in foreground, one of the collection sites. Photographs by R. Copeland.

in the less extremely alkaline lakes of the region (Brown 1973). The extreme environment of Magadi and the historical exploitation of the site makes the occurrence of the new species of water scavenger beetle most remarkable.

Scott Miller (in litt.) reported that the lake and pools have many emergent rocks that provide hiding places for invertebrates. In association with *Coelostoma tina,* Miller and Kuklenski collected the following organisms from the northwest lagoon: a probably new species of spider belonging to the genus *Wadicosa*; two whirligig beetles belonging to the genera *Orectogyrus* and *Gyrinus,* and the cosmopolitan earwig, *Labidura riparia* (Pallas).

In addition, the following organisms from the Lake Magadi system have been described or discussed by various authors as follows. The tiger beetle *Lophyra pseudodistans* (Horn) is apparently endemic to the area (Werner 1993). A dwarf cichlid fish, *Tilapia grahami* Boulenger is presently living in more dilute parts of the lake as has been reported by Baker (1958); this species has been recently used as a subject for an experimental study of its adaptations to its highly alkaline environment (Wood et al. 1994). Microbiologists isolated and described a new species of haloalkaliphilic bacterium, *Natronobacterium vacuolata* Mwatha and Grant (1993) from Lake Magadi. The identifications of two diatoms, *Nitzchia lacuum* and *N. pura,* were used by geologists (Roberts et al. 1993) to recognize assemblages of these two species that reflected abrupt changes in lake water chemistry, notably pH and conductivity as lake water changed to more concentrated and alkaline conditions. They concluded that the associated fall in lake level led to the separation of Lake Magadi from Natron into two bodies soon after 10,000 yr BP as inferred from the diatom assemblages and other geochemical indicators. With the aquatic arthropods of the region so wanting for study (in spite of the historical use and interest in the area) it would be most interesting to compare the modern assemblages of species of the two lakes.

ACKNOWLEDGMENTS

We thank Scott and Tina Miller for collecting these beetles for our study and for providing references to the history, geology, geography and biota of lake Magadi and its harsh environs. The sampling was conducted as an activity of the International Centre of Insect Physiology and Ecology (ICIPE), in cooperation with National Museums of Kenya. We thank the Magadi Soda Company for providing ICIPE access to their land and Kenya Wildlife Service for providing export permits. Robert Copeland allowed us to use his photographs of the lake habitat. Jerry Cassis from the Australian Museum identified the earwig. We also thank Young T. Sohn, Biological Illustrator, for the line drawings, Susann Braden and Scott Whittaker for assisting with operation of the scanning electron microscope and preparation of the SEM images and plates, and George Venable, Graphics Illustrator, for formatting the other illustrations and photographs. Comments by Philip D. Perkins and one anonymous reviewer on the manuscript are appreciated.

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PROC. ENTOMOL. SOC. WASH
105(1), 2003, pp. 9–12

A NEW SPECIES OF BLACK FLY (DIPTERA: SIMULIIDAE) FROM NOVA SCOTIA

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Abstract.—The larva and pupa of a new species of black fly from the LaHave River in Nova Scotia, Canada, are described and illustrated. ***Simulium rothfelsi*, n. sp.**, is most closely related to *S. johannseni* but can be distinguished from this species and all others in North America by the configuration of the pupal gill—two swollen dorsal filaments and two slender ventral filaments. This new species is univoltine, passing the winter as eggs and completing its larval and pupal development in a few weeks during May.

Key Words: Simuliidae, *Simulium*, new species, aquatic insects, Nova Scotia

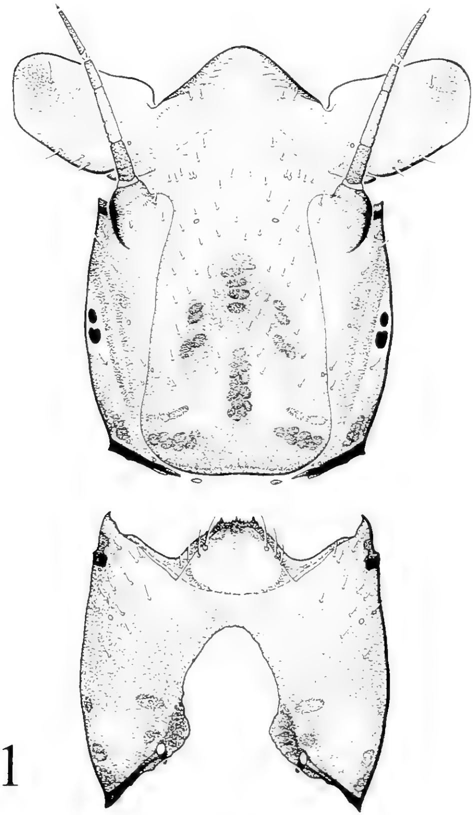
About 190 nominal species of black flies have been recorded from North America north of Mexico (Crosskey and Howard 1997, Crosskey 1999), with about 60 of these known from eastern Canada (Ontario eastward). Areas of eastern Canada that have received the most faunistic attention are Ontario and insular Newfoundland (Davies et al. 1962, McCreadie et al. 1995). The simuliid fauna of the Maritime Provinces remains incompletely studied. The last published account of the fauna, an annotated list of 20 species, appeared more than two decades ago (Lewis and Bennett 1979).

New species of black flies continue to be discovered in North America, although at a declining rate. We describe the larva and pupa of a new species from the LaHave River of Nova Scotia, Canada. The species undoubtedly has a broader range, but its rapid development—a two- to three-week period in May—probably contributed to its absence in previous studies. The adults remain unknown after eight attempts to collect them failed. The unique gill of the pupa, however, should allow adults to be reared and associated in the future.

Material was collected in Carnoy's fixative (1 part glacial acetic acid: 3 parts absolute ethanol) and transferred to 80% ethanol. Descriptive terminology follows primarily that of Peterson (1981). The holotype and some larval paratypes are deposited in the Canadian National Collection, Ottawa. Additional paratypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, and the Clemson University Arthropod Collection, Clemson, SC.

Simulium rothfelsi Adler, Brockhouse, and Currie, new species
(Figs. 1–2)

Larva.—Length 5.4–5.7 mm. Head capsule (Fig. 1) pale brownish yellow, with all



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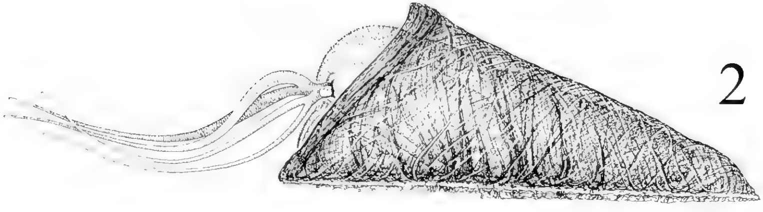

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Figs. 1–2. *Simulium rothfelsi.* 1, Larval head capsule, dorsal view (above), ventral view (below). 2, Pupa and cocoon, left lateral view of holotype.

head spots dark brown, bold, slightly infuscated. Antenna pale brown, extended beyond apex of stalk of labral fan by about ½ length of distal article; medial article with 3 or 4 pale hyaline bands, barely perceptible in some specimens. Hypostoma with median and lateral teeth subequal in size and extended anteriorly to about same level. Postgenal cleft extended about ¾ distance to hypostomal groove, widest at midpoint, tapered and pointed or rounded anteriorly; subesophageal ganglion typically lacking pigmented sheath. Labral fan with 48–55 primary rays. Body brownish or grayish, distinctly banded, with unpigmented intersegmental areas. Abdominal segment IX with prominent, conical ventral tubercles; abdominal setae simple, translucent, sparse. Posterior proleg with 8–10 hooks in about 60 rows. Rectal papillae of 3 compound lobes.

Pupa (Fig. 2).—Length of cocoon, in lateral view, 3.8–4.0 mm. Gill with 4 filaments, about as long as pupa; base short, about as long as wide, giving rise to 2 petiolate pairs of filaments; dorsal and ventral petioles short, subequal in length and width; dorsal pair of filaments markedly swollen; third filament from dorsum slightly swollen; ventralmost filament slender, not swollen; filaments directed anteroventrally, tapered distally, with surface wrinkled and slightly granulate proximally, and marked by transverse furrows distally. Cephalic plate smooth. Thorax dorsally with sparse, irregularly distributed, rounded microtubercles; trichomes simple. Abdomen with spine combs weakly developed on segment V, well developed on segments VI–IX. Cocoon slipper shaped, densely woven.

Types.—Holotype: pupal exuviae + cocoon in ethanol. Canada, Nova Scotia, Lunenburg Co., near New Germany, LaHave River, 44°33′N, 64°43′W, 21 May 1999, C. L. Brockhouse. Paratypes: same data as holotype, 24 May 2000 (1 pupa + cocoon, 1 pupal exuviae without cocoon); 18 May 2001 (13 larvae).

Etymology.—This species is named in honor of Klaus H. Rothfels (1919–1986), the father of simuliid cytotaxonomy. In life, he successfully thwarted attempts to name a species in his honor.

Diagnosis.—Pupae of this new species are distinct from those of all other North American black flies. The four-filamented gill, with the dorsal two filaments markedly inflated and the ventral two slender, is unique. Mature larvae can be distinguished most readily by the configuration of the uncurled gill histoblast; otherwise, they resemble those of *S. johannseni* Hart, the probable sister species of *S. rothfelsi*.

Chromosomes.—The larval polytene chromosomes of *S. rothfelsi* have a haploid number of 3, with standard arm associations and the nucleolar organizer in the base of IS. These features are shared with *S. johannseni* (Golini and Rothfels 1984: 2097). Chromosomal maps of *S. johannseni* have not been published and, therefore, cannot provide further comparative information. The two male larvae that we examined had a minute inversion in the centromere region of chromosome III, suggesting that this region represents the sex-differential segment.

Biology.—The apparent scarcity of this new species is probably due largely to its remarkably narrow window of development. It is univoltine and overwinters as eggs. Larvae probably begin to hatch in early May and begin pupating within three weeks. On 3 May 2001, a large collection of simuliid larvae and pupae from the type locality revealed no specimens of the new species. By 18 May, the first mature larvae were found at the same location. In previous years, no larvae or pupae were found after 24 May. We have not found the adults. Females, like those of *S. johannseni*, probably are chiefly ornithophilic. *Simulium johannseni* is restricted to the central portion of the United States and Canada and has not been found east of Ohio. The two species, therefore, are allopatric.

The LaHave River at the type locality is more than 30 m wide, no more than 2 m deep, with a rocky bottom, small islands, and a forested riparian zone. Larvae were collected from submerged grasses. We have found the following nine species of black flies in the LaHave River, most overlapping to some extent with the development of *S. rothfelsi*: *Prosimulium mixtum* Syme and Davies, *P. fuscum* Syme and Davies, *Stegopterna mutata* (Malloch) (diploid cytospecies), *Simulium euryadminiculum* Davies, *S. quebecense* Twinn, *S. fibrinflatum* Twinn, *S. nyssa* Stone and Snoddy, *S. vandalicum* Dyar and Shannon, and *S. venustum* Say *sensu stricto*.

ACKNOWLEDGMENTS

We thank Ralph Idema for illustrating the larva and pupa, and J. C. Morse, J. K. Moulton, and A. G. Wheeler, Jr. for reviewing the manuscript. This study was supported in part by a grant (no. 972938) from the North Atlantic Treaty Organization to PHA and CLB. This is Technical Contribution No. 4727 from the South Carolina Agriculture and Forestry Research System.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 13–21

NEW SYNONYMS IN THE GENUS *OBRIMA* WALKER (LEPIDOPTERA: NOCTUIDAE), WITH ADDITIONAL DISTRIBUTION RECORDS

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Abstract.—The monotypic genus *Acanthermia* Hampson 1926 is congeneric with *Obrima* Walker 1856 (**new synonym**). Two **new synonymies** of *Obrima didactica* (Dyar) 1914 **(new combination)** are proposed: *Acanthermia dyari* Hampson (1926) and *Obrima cymbae* Pogue (1998). Additional distributional records from Costa Rica are included. Adults of all *Obrima* species are illustrated to show intraspecific variation.

Key Words: *Acanthermia, Obrima didactica, Obrima pyraloides, Obrima rinconada,* distribution, Costa Rica

The genus *Obrima* Walker 1856 was recently revised (Pogue and Janzen 1998), and, at that time, *Obrima cymbae* Pogue was described as new. While visiting INBio (Instituto Nacional de Biodiversidad) in Costa Rica, Vitor Becker arranged a loan of their *Obrima* collection. With this substantial collection from Costa Rica and the holdings at the National Museum of Natural History, Smithsonian Institution (USNM), it was discovered that *O. cymbae* varies considerably in its forewing coloration from cream to light brown to dark reddish brown and the hindwing is equally variable from cream to rufous to brown. Because of this variation, *O. cymbae* and *Acanthermia dyari* Hampson, 1926 were found to be synonyms of *Rhosologia didactica* Dyar, 1914. This paper resolves these taxonomic problems and illustrates the range of variation in wing color. Updated distribution maps of all *Obrima* species are included based on additional material, as well as the localities reported by Pogue and Janzen (1998).

Obrima Walker

Obrima Walker 1856: 134.—Nye 1975: 343.—Poole 1989: 708.—Poole and Gentili 1996: 759.—Pogue and Janzen 1998: 567. Type species: *Obrima pyraloides* Walker 1856, by monotypy.

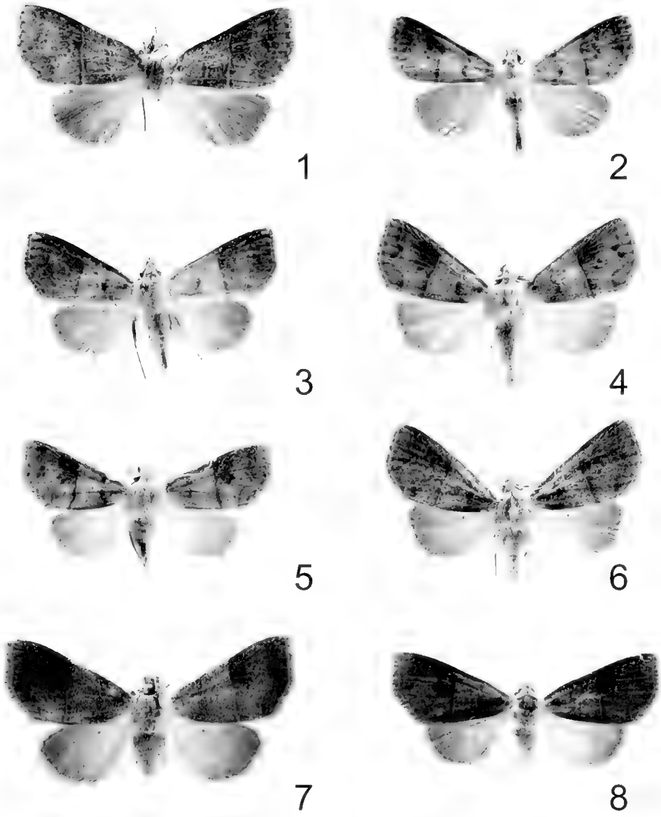
Acanthermia Hampson 1926: 248.—Nye 1975: 17.—Poole 1989: 6. Type species: *Acanthermia dyari* Hampson 1926, by original designation. **New synonymy.**

A diagnosis and description of *Obrima* was given by Pogue and Janzen (1998). Synapomorphies include the conical-shaped unscaled frons and large signum in the female genitalia that has a bifurcate apex and a central groove formed by the lateral margins curving toward the center line. Both of these characters are present in *Acanthermia dyari.*

Obrima didactica (Dyar), new combination

(Figs. 1–8, 23, 26)

Rhosologia didactica Dyar 1914: 386.—Poole 1989: 870.

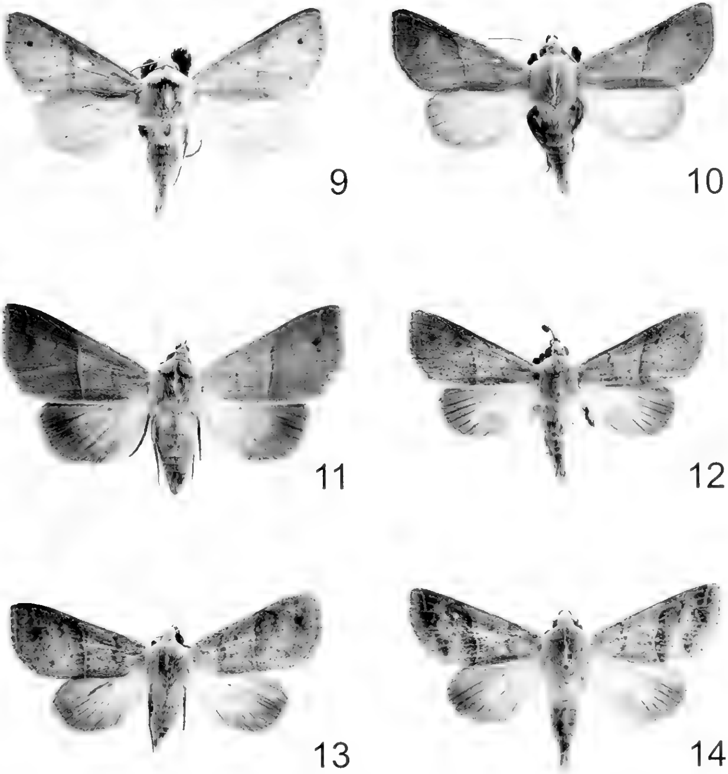


Figs. 1–8. Adults of *Obrima didactica* (Dyar). 1, Holotype ♂, Mexico, Sierra de Guerrero, USNM ENT 142598. 2, ♂, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002532933. 3, ♂, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002532935. 4, ♂, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002584614. 5, ♂, Costa Rica, Guanacaste, Est. Murcielago, 8 km surosete de Cuajiniquil, INBIOCRI 001174296. 6, ♀, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002530533. 7, ♀, Costa Rica, Guanacaste, Est. Murcielago, 8 km surosete de Cuajiniquil, INBIOCRI 001182187. 8, ♀, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002532928.

Acanthermia dyari Hampson 1926: 249. **New synonymy.**

Obrima cymbae Pogue *in* Pogue and Janzen 1998: 574. **New synonymy.**

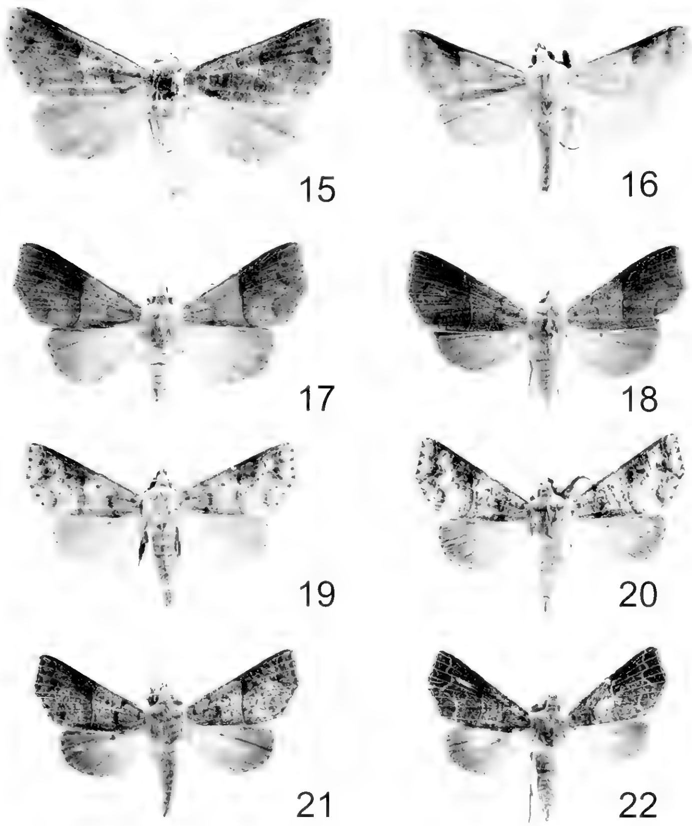
Description.—The description of *O. cymbae* (Pogue and Janzen 1998) can be referred to this species with the following additions: 1) forewing color is variable, from cream to dark reddish brown, with intermediate colors of light brown and pale reddish brown; 2) the lighter colored specimens have more brown markings in the



Figs. 9–14. Adults of *Obrima pyraloides* Walker. 9, ♂, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002587819. 10, ♂, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002587822. 11, ♀, Costa Rica, Cartago, Moravia de Chirripo, INBIOCRI 002587987. 12, ♂, Costa Rica, Guanacaste, P. N. Barra Honda, 3 km NW Nacaome, INBIOCRI 002587869. 13, ♀, Costa Rica, Guanacaste, Est. Murcielago, 8 km surosete de Cuajiniquil, INBIOCRI 001182389. 14, ♂, Costa Rica, Guanacaste, Est. Murcielago, 8 km surosete de Cuajiniquil, INBIOCRI 001182388.

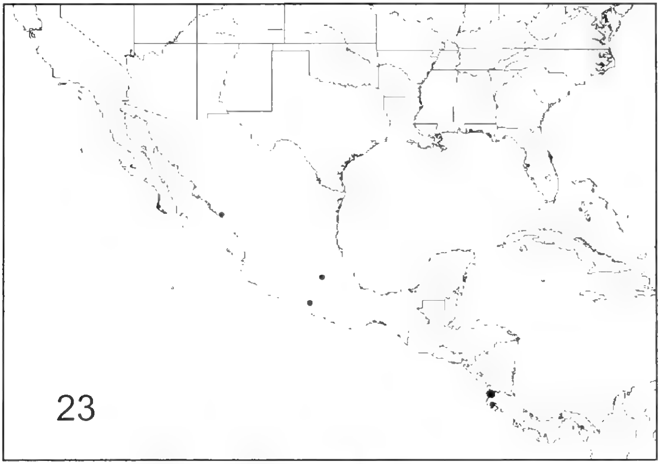
forewings; 3) hindwing color is variable from cream with a tinge of light brown to brown, most of the specimens with dark forewings have a rufous hindwing.

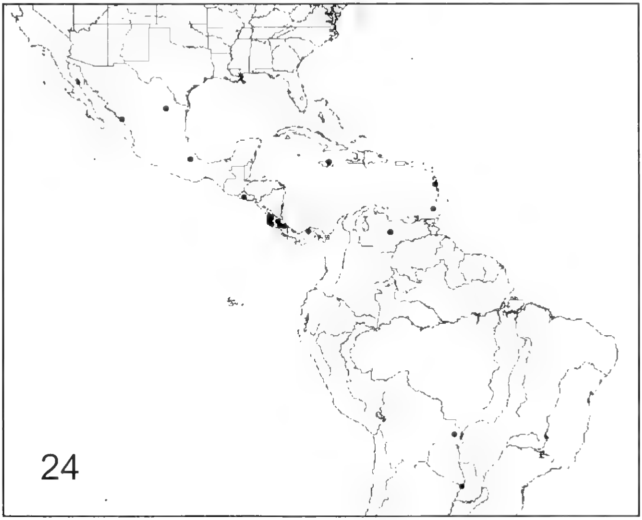
Additional material examined.—89 ♂, 84 ♀. COSTA RICA: GUANACASTE: 2 km al O. De la oficina de Biodiversidad, P. N. Barra Honda, 50 m, Apr. 1996 (1 ♀), M. Reyes; 3 km NO Nacaome, P. N. Barra Honda, 100 m, Apr. 1993 (38 ♂, 34 ♀), M. Reyes; Est. Las Palilas, P. N. Rincon de la Vieja, 800 m, 16–23 Apr. 1993 (1 ♀), 8–27 May 1994 (1 ♂), K. E. Taylor; Est. Los Almendros, P. N. Guanacaste, 300 m, 8–13 June 1994 (1 ♀), E. Lopez; Est. Murcielago, 8 km suroeste de Cuajiniquil, 100 m, 19–24 Apr. 1993 (1 ♂, 4 ♀), 3–14 May 1994 (1 ♂, 1 ♀), 18 May–5 June 1993 (2 ♂, 9 ♀), F. A. Quesada, 3 May 1994 (2 ♂, 2 ♀), 15 May–6 June 1993 (7 ♂, 6 ♀),



Figs. 15–22. Adults of *Obrima rinconada* Schaus. 15, Holotype ♂, Mexico, Vera Cruz, Rinconada, USNM ENT 142599. 16, Holotype ♂, of *O. pimaensis* Barnes and Benjamin, U.S.A., Arizona, Pima Co., Baboquivari Mts., USNM ENT 142600. 17, ♀, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002587849. 18, ♀, Costa Rica, Guanacaste, 3 km NO Nacaome, P. N. Barra Honda, INBIOCRI 001324544. 19, ♂, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002587841. 20, ♂, Costa Rica, Guanacaste, P. N. Santa Rosa, INBIOCRI 002530542. 21, ♂, Costa Rica, Guanacaste, 3 km NO Nacaome, P. N. Barra Honda, INBIOCRI 001324385. 21, ♂, Costa Rica, Guanacaste, P. N. Barra Honda, INBIOCRI 002172152.

6–23 June 1994 (5 ♀), C. Cano; Est. Palo Verde, P. N. Palo Verde, 10 m, May 1991 (1 ♂), May 1992 (1 ♀), U. Chavarria; Est. Santa Rosa, P. N. Santa Rosa, 300 m, 3–12 June 1992 (1 ♂); Estacion Mengo, SW side Volcan Cacao, 1,100 m, 27 May 1987 (1 ♂), D. H. Janzen, W. Hallwachs; Hcda. San Isidro, 6.7 km N Quebrada Grande, 350 m, 3 June 1988 (1 ♀), D. H. Janzen, W. Hallwachs; La Maritza, Hda. Orosi, 550 m, 2–5





Figs. 23–24. Collecting localities of *Obrima*. 23, *O. didactica*. 24, *O. pyraloides*.

June 1986 (1 ♂), W. Hallwachs, D. H. Janzen; P. N. Barra Honda, 100 m, Apr. 1995 (1 ♂), M. Reyes; P. N. Barra Honda, 3 km NW Nacaome, 100 m, 16 May 1988 (3 ♂), Janzen, Hallwachs; P. N. Barra Honda, 900 m Oeste de la oficina de Biodiversidad, 100 m, Apr. 1994 (1 ♂, 2 ♀), M. Reyes; Playa Naranjo, P. N. Santa Rosa, May 1991 (3 ♂, 1 ♀), E. Alcazar; Ref. Nac. Fauna Silvestre Rafael Lucas Rodriguez, Est. Palo Verde,

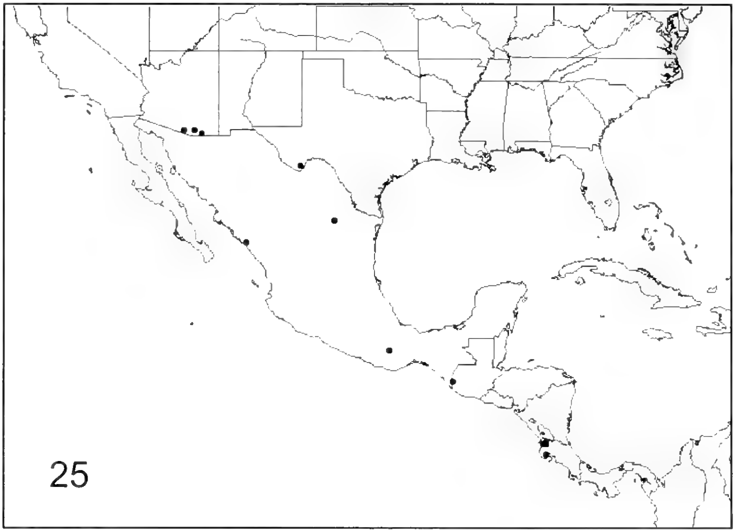
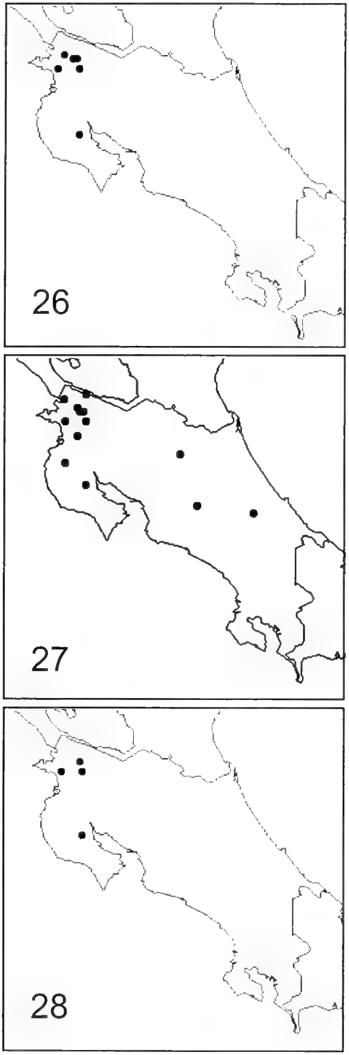


Fig. 25. Collecting localities of *O. rinconada*.

10 m, May 1991 (1 ♂), U. Chavarria; Santa Rosa National Park, 300 m, 13 May 1978 (1 ♀), 15 May 1978 (1 ♂), 15–17 May 1979 (1 ♂, 5 ♀), 18–20 May 1979, (2 ♂, 1 ♀), 24 May 1978 (1 ♂, 1 ♀), 1–3 June 1979 (1 ♂, 1 ♀), D. H. Janzen, Apr. 1983 (3 ♂, 2 ♀), Apr. 1984 (1 ♀), May 1983 (2 ♂, 1 ♀), May 1984 (1 ♂), May 1985 (1 ♂, 1 ♀), D. H. Janzen, W. Hallwachs, 9–11 May 1980 (6 ♂), 12–14 May 1980, D. H. Janzen, W. Hallwachs; Sector Las Pailas, 4.5 km SW del volcan Rincon de la Vieja, 800 m 12 Apr.–4 May 1995 (1 ♀), K. E. Taylor. MEXICO: [State unknown]: Morelos, (1 ♀), Kruger; Sierra de Guerrero, June 1913 (1 ♂), Schaus Coll.; SINALOA: Venadi[ll]o, (1 ♂), Schaus Coll., (2 ♂), B. P. Clark donor.

Distribution (Figs. 23, 26).—In Costa Rica, *O. didactica* is found in lowland dry forest habitat in Guanacaste Province. The type locality is Sierra de Guerrero, Mexico. I have been unable to find a documented latitude and longitude, for this locality and am assuming it is in the state of Guerrero in southwestern Mexico. The two other records from Mexico are difficult to verify. Three specimens were collected in "Venadio," Sinaloa, Mexico. After searching several gazeteers the only locality similar to "Venadio" was Venadillo in Sinaloa. There is no "Venadio" in Mexico. I am assuming that this is the correct locality, and "Venadio" is a misspelling of Venadillo. Venadillo is in the lowland dry west coast of Sinaloa. The second unconfirmed locality is Morelos. There are about 30 localities by this name in Mexico, but only a few are lowland southern Mexico localities. Based on this evidence, the Morelos on the specimen label would most likely be from southern Mexico, excluding the state of Morelos south of Mexico City.

Discussion.—The ♂ holotype of *O. didactica* (Fig. 1) is in the USNM. It has a light brown forewing ground color with a distinct median line borded by brown, an irregular subterminal brown line, and the



Figs. 26–28. Collecting localities of *Obrima* in Costa Rica. 26, *O. didactica*. 27, *O. pyraloides*. 28, *O. rinconada*.

hindwings are medium brown. This is the light brown phenotype. The dark brown to dark red phenotype was described as *A. dyari* and *O. cymbae*. *Obrima didactica* is sympatric with *O. rinconada* Schaus at "Venadio," Sinaloa, Mexico, which is also the type locality of *A. dyari*.

In Costa Rica the larval host plant is *Lonchocarpus orotinus* Pittier (Fabaceae) which is endemic to Guanacaste (Standley 1937). Other species of *Lonchocarpus* occur in southern Mexico, such as *L. atropurpureus* Benth. and *L. mimiflorous* Donn. *Lonchocarpus mimiflorus* is a larval host plant of *O. pyraloides* Walker, 1856. Apparently *O. didactica* is utilizing a different host in Mexico.

Obrima pyraloides Walker
(Figs. 9–14, 24, 27)

Obrima pyraloides Walker 1856: 135.—Nye 1975: 343.—Poole 1989: 708.—Pogue and Janzen 1998: 568.

For a diagnosis and description of *O. pyraloides* see Pogue and Janzen (1998).

The following is additional material examined from Costa Rica and El Salvador.—68 ♂, 49 ♀. COSTA RICA: ALAJUELA: Finca San Gabriel, 16 km ENE Quebrada Grande, 650 m, 5 May 1984 (1 ♂), D. H. Janzen, W. Hallwachs; Sect. San Ramon de Dos Rios, 620 m, 27 Apr.–11 May 1995 (1 ♂), F. A. Quesada. CARTAGO: Moravia de Chirripo, 1,000 m, 10 May 1983 (1 ♀), D. H. Janzen, W. Hallwachs. GUANACASTE: 3 km NO Nacaome, P. N. Barra Honda, 100 m, Mar. 1993 (4 ♂), Apr. 1993 (6 ♂, 1 ♀), 3–30 May 1993 (1 ♂), M. Reyes; 4 km E Casetilla, P. N. Rincon de la Vieja, 750 m, 22 May 1982 (1 ♂), D. H. Janzen, W. Hallwachs; Casa Oeste, Cerro El Hacha, 12 km SE La Cruz, 800 m, Jan. 1988 (1 ♂), A. Chacon; Cerro El Hacha, 12 km SE La Cruz, 300 m, 25 June 1992 (1 ♀); Est. Cacao, Lado SO Vol. Cacao, P. N. Guanacaste, 1,000–1,400 m, June 1990 (2 ♂); Est. Las Pailas, P. N. Rincon de la Vieja, 800 m, 9–27 Feb. 1993 (2 ♂, 2 ♀), 10–27 Mar.

1993 (1 ♂), K. E. Taylor; Est. Los Almendros, P. N. Guanacaste, 300 m, 8–13 June 1994 (1 ♀), E. Lopez; Est. Murcielago, 8 km suroeste de Cuajiniquil, 100 m, 6–24 Jan. 1994 (1 ♂), May 15–June 6 1993 (1 ♂, 4 ♀), C. Cano, May 18–June 5 1993 (4 ♂, 7 ♀), 5–17 July 1994, F. A. Quesada; Est. Palo Verde, P. N. Palo Verde, 10 m, May 1992 (1 ♂, 2 ♀), U. Chavarria; Est. Santa Rosa, 300 m, Feb. 25–Mar. 2 1995 (1 ♂), E. Alfaro; Est. Maritza, W side Volcan Orosi, 600 m, Feb. 26–Mar. 10, 1992 (1 ♂), Feb. 27–Mar. 11, 1992 (1 ♂); Est. Mengo, SW side Volcan Cacao, 1,100 m, July 1987 (1 ♀), July 1987, D. H. Janzen, W. Hallwachs; Est. Santa Rosa, 300 m, Feb. 24–Mar. 7 1995 (1 ♂), A. M. Maroto, Feb. 24–Mar. 8 (1 ♀), R. Villalobos; Juanilama, P. N. Guanacaste, 330 m, 18–28 June 1992 (1 ♀); P. N. Barra Honda, 100 m, Feb. 1992 (1 ♂, 1 ♀), M. Reyes; P. N. Barra Honda, 3 km NW Nacaome, 100 m, 16 May 1988 (1 ♂, 4 ♀), Janzen, Hallwachs; Playa Naranjo, P. N. Santa Rosa, Mar. 1991 (1 ♂), E. Alcazar; R. Gongora, P. N. Guanacaste, 600 m, June 1992 (1 ♀); Ref. Nac. Fauna Silvestre Rafael Lucas Rodriguez, Est. Palo Verde, 10 m, Apr. 1991 (1 ♀), May 1991 (1 ♂, 1 ♀), June 1991 (1 ♂), U. Chavarria; P. N. Santa Rosa, 300 m, Jan. 1985 (1 ♀), Feb. 1983 (6 ♂), 9–17 Mar. 1981 (1 ♂), 10–20 Mar. 1982 (2 ♂), Apr. 1983 (1 ♂), Apr. 1984 (2 ♂), 29–30 Apr. 1980 (2 ♂), May 1983 (4 ♂), May 1984 (1 ♂, 1 ♀), May 1985 (1 ♀), 1 May 1980 (1 ♂), 2–4 May 1980 (3 ♂), 5–6 May 1980 (1 ♀), 9–11 May 1980 (3 ♀), D. H. Janzen, W. Hallwachs, 5–14 Mar. 1979 (1 ♂), 15–17 May 1979 (1 ♀), June 1978 (1 ♂), 5 June 1978 (1 ♂, 5 ♀), 7–9 June 1979 (1 ♀), 21–24 Dec. 1979 (3 ♂), D. H. Janzen; Sect. Palo Verde, 10 m, 4–10 Apr. 1995 (1 ♀), E. Navarro; Sector Las Pailas, 4.5 km SW del volcan Rincon de la Vieja, 800 m, Apr. 12–May 4 1995 (2 ♂, 2 ♀), K. E. Taylor. PUNTARENAS: Est. Queb. Bonita, Res. Biol. Carara, 50 m, May 1992 (1 ♂, 1 ♀), J. C. Saborio. EL SALVADOR: Santa Tecla, 900 m, Apr. 12–May 4 1995 (1 ♀), S. Steinhauser.

Distribution (Figs. 24, 27).—In Costa Rica, this species is widely distributed in Guanacaste from 10 to 1400 m with additional records from Alajuela, Cartago, and Puntarenas Provinces. *Obrima pyraloides* has been collected from northern Mexico, Jamaica, Dominica, and Grenada through Central America to Venezuela, Bolivia, and Paraguay.

Discussion.—The forewing ground color is variable, ranging from cream to light brown to rufous. The basal area of the hindwing can vary from white to ochreous with a broad marginal band that is cream (Fig. 9) or brown (Figs. 11–14) or the veins can be highlighted with rufous scales with only a hint of the band (Fig. 10). The forewing pattern can be reduced to a supapical dark spot and faint median line (Fig. 9) to well developed antemedial, median, and subterminal lines (Fig. 14). The abdomen color exhibits variation similar to the forewing color from cream to light brown to rufous.

Obrima rinconada Schaus
(Figs. 15–22, 25, 28)

Obrima rinconada Schaus 1894: 240.—Poole 1989: 708.—Pogue and Janzen 1998: 571.

Obrima pimaensis Barnes and Benjamin 1925a: 126.—Poole 1989: 708 [jr. syn. of *rinconada*].

Obrima rinconada primaensis Barnes and Benjamin 1925b: 168, [incorrect subsequent spelling of *pimaensis*].

For a diagnosis and description of *O. rinconada* see Pogue and Janzen (1998).

The following is additional material examined from Costa Rica.—23 ♂, 14 ♀. COSTA RICA: GUANACASTE: 3 km NO Nacaome, P. N. Barra Honda, 100 m, Apr. 1993 (2 ♂, 2 ♀), Apr. 1993, M. Reyes; Est. Murcielago, 8 km surosete de Cuajiniquil, 100 m, May 15–June 6, 1993 (1 ♂, 1 ♀), C. Cano, May 18–June 5, 1993 (1 ♂, 1 ♀),

F. A. Quesada; Est. Santa Rosa, P. N. Santa Rosa, 300 m 3–12 June 1992 (1 ♂); P. N. Barra Honda, 100 m, Apr. 1995 (1 ♂), M. Reyes; P. N. Barra Honda, 3 km NW Nacaome, 100 m, 16 May 1988, (1 ♂, 3 ♀), Janzen, Hallwachs; P. N. Santa Rosa, 300 m, May 1983 (8 ♂, 2 ♀), May 1984 (1 ♂, 1 ♀), May 1985 (1 ♂), 18–20 May 1978 (2 ♀), 21–23 May 1979 (1 ♂), 24 May 1978 (1 ♂, 1 ♀), D. H. Janzen, Apr. 1983 (3 ♂), 4–9 June 1981, (1 ♂), D. H. Janzen, W. Hallwachs; Sector Las Pailas, 4.5 km SW del volcan Rincon de la Vieja, 800 m, Apr. 12–May 4 1995 (1 ♀), K. E. Taylor.

Distribution (Figs. 25, 28).—*Obrima rinconada* is restricted to Guanacaste Province in Costa Rica from 100–800 m. This is the only *Obrima* species found in the United States and extends from southern Arizona and Texas to Costa Rica.

Discussion.—The holotype of *O. rinconada* (Fig. 15) is moderately suffused with brown as compared to those that are heavily suffused (Figs. 19–21) or brown (Fig. 22). The holotype of *O. pimaensis* (Fig. 16) is cream with a light brown pattern. Other specimens (Figs. 17–18) show a distinct division of ground color, being lighter proximal to the median line and darker distally. Hindwing color is also variable from cream to brown. The forewing pattern consists of a distinct median line, with a variably distinct subterminal line depending on the degree of brown suffusion.

ACKNOWLEDGMENTS

I thank Henry A. Cochran V. of the Insituto Nacional de Biodiversidad (INBio), Santo Domingo, Costa Rica, for loaning me the Costa Rican specimens. I thank Vitor Becker, Brasilia, Brazil, for pointing out the possibility that *O. cymbae* was a synonym of *O. didactica* and for arranging the loan from INBio. I thank Eric H. Metzler, Columbus, Ohio, and Ronald A. Ochoa and David R. Smith of the Systematic Entomology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Washington, DC, for critically reviewing the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 22–29

NEW SPECIES OF POLYCENTROPODIDAE (TRICHOPTERA) FROM SOUTHEASTERN AND SOUTHERN BRAZIL

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Abstract.—Four **new species** of Polycentropodidae (Trichoptera), ***Cernotina antonina, Cernotina lazzarii, Polycentropus urubici***, and ***Polyplectropus profaupar***, are described and illustrated from the states of Minas Gerais, Paraná, and Santa Catarina, Brazil.

Key Words: Trichoptera, Brazil, new species, Polycentropodidae, inventory

In this paper we describe four new polycentropodid caddisflies in the genera *Cernotina, Polycentropus,* and *Polyplectropus* collected during two inventories of the Trichoptera fauna of southeastern and southern Brazil. The first of these, the PROFAUPAR inventory, was conducted from 1986–1988 and consisted of light and Malaise trap collections of insects from eight localities in the southern Brazilian state of Paraná (Marinoni and Dutra 1993). The Trichoptera material from this inventory was recently sorted and identified by the junior author (Almeida and Marinoni 2000, Marinoni and Almeida 2000). The second, ongoing inventory, funded by the U.S. National Science Foundation's Biotic Surveys and Inventories Program, is focused exclusively on the Trichoptera fauna of the southeastern and southern Brazilian states of Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, and Santa Catarina.

The genera *Cernotina, Polycentropus,* and *Polyplectropus* contain 50, 64, and 42 species, respectively, in the Neotropics (Flint et al. 1999). In Brazil, 24 species of *Cernotina* have been described, all but one of these from the Amazon basin, but only 9 species of *Polyplectropus* and no species of *Polycentropus* have been previously described from the country. However, the latter genus was reported from Brazil by Hamilton (1986) and we have almost two dozen new species of *Polycentropus* from southeastern and southern Brazil in our collections.

Types are deposited in the collections of the Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil (MZUSP), the University of Minnesota Insect Collection, St. Paul, Minnesota (UMSP), the Coleção de Entomologia Pe. Jesus Santiago Moure, Departamento de Zoologia, Universidade Federal do Paraná, Curitiba, Brazil (DZUP, UFPR), and the National Museum of Natural History, Smithsonian Institution, Washington, D.C (NMNH) as indicated below.

Cernotina antonina Holzenthal and Almeida, new species

(Fig. 1)

This new species is a member of the *cygnea* group of Flint (1971), which includes *C. cygnea* Flint 1971, *C. decumbens* Flint 1971, and *C. trispina* Flint 1971. *Cernotina antonina* is similar to *C. decumbens* in the broad truncate lobes of tergum X, but resembles *C. trispina* in the rodlike dorsal

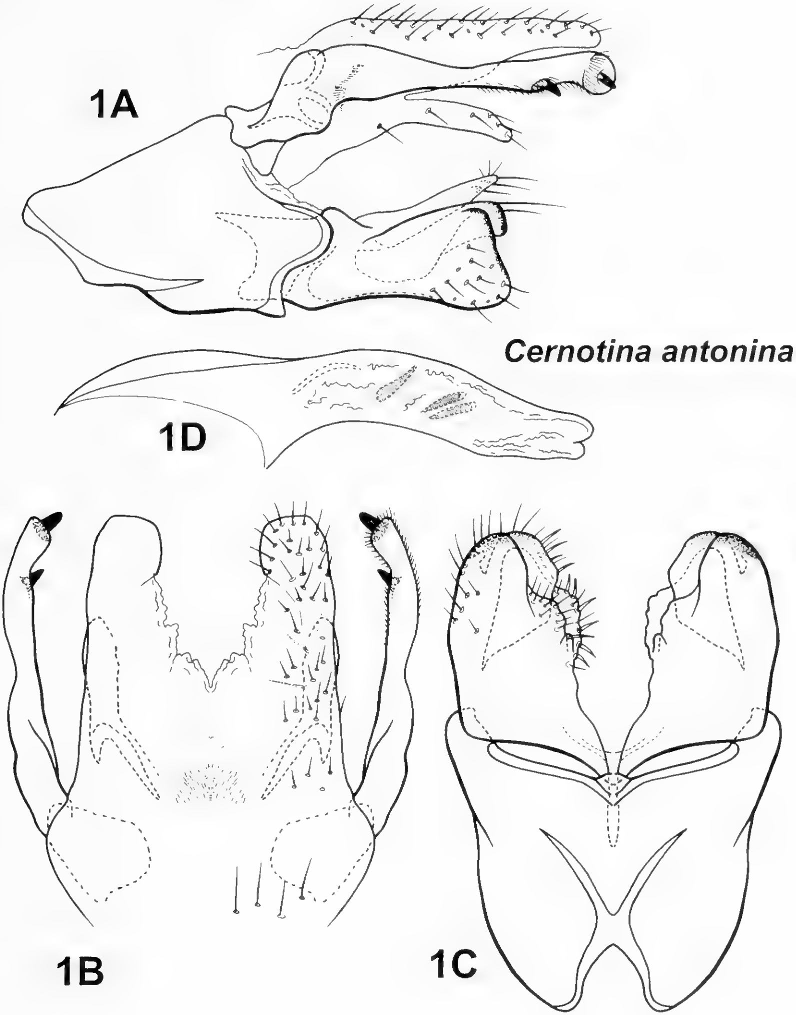

Fig. 1. *Cernotina antonina*, male genitalia. A, Lateral. B, Tergum X and intermediate appendages, dorsal. C, Sternum IX and inferior appendages, ventral. D, Phallus, lateral.

branch of the intermediate appendage which bears a pair of short spinelike setae.

Male.—Length of forewing 4.0 mm. Color in alcohol, pale yellowish brown. Genitalia as in Fig. 1. Sternum IX short, produced anterolaterally; anterior margin, in ventral view, narrowly excavated; tergum IX membranous, not evident. Inferior appendage elongate rectangular, truncate apically; apicoventral and mesal surfaces pigmented, setose; apicomesal lobe wide, truncate, pigmented apically, with 4 short thick apicomesal setae; basodorsal lobe shelflike, with long apicomesal setae and shorter thicker setae mesally. Tergum X membranous basally and mesally, divided mid-dorsally; lateral lobes lightly sclerotized, rounded apically, setose dorsally; base of X internally with pocket of fine setae. Preanal appendage apparently absent. Intermediate appendage bipartite; dorsal branch rodlike, bearing short fine setae and pair of short thick spinelike apical and subapical setae; ventral branch shorter, digitate, setose. Phallus long, slender, tubular, membraneous internally, with internal sclerite and 3 short spines.

Female.—Unknown.

Type material.—Holotype, ♂. BRAZIL: *Paraná:* Antonina, Reserva de Sapitanduva, 25°28′S, 48°50′W, el. 60 m, 27.iii.1987, PROFAUPAR-lâmpada (UFPR). Paratypes. Same data as holotype, 26.iv.1987, 1 ♂ (UFPR); *Minas Gerais:* Rio Santo Antônio, downstream from Morro do Pilar, 19°08.134′S, 43°21.256′W, el. 530 m, 17.x.2000, Paprocki & Ferreira, 1 ♂ (UMSP); *Paraná:* Guarapuava, Estância Água Santa Clara, 25°40′S, 52°01′W, el. 740 m, 1.xii.1986, PROFAUPAR-lâmpada, 1 ♂ (UFPR).

Etymology.—The species is named for the type locality.

Cernotina lazzarii
Holzenthal and Almeida, new species

(Fig. 2)

Cernotina lazzarii appears to be closest to *C. abbreviata* Flint 1971 and *C. perpendicularis* Flint 1971, the three species forming a distinct group within the genus. All share a divided tergum X with its apex bearing a sclerotized process either apically (*C. abbreviata, C. perpendicularis*) or apicoventrally (*C. lazzarii*). The dorsal branch of the preanal appendage of each species is short and bears a pair of spinelike setae, but in the new species this branch is directed posteriorly rather than posteroventrally.

Male.—Length of forewing 3.5–3.7 mm. Body sclerites pale yellowish brown; antenna mostly white, more apical flagellomeres cream colored with light brown setae basally; head and thorax with white setae dorsomesally and light brown setae laterally; legs light brown with darker brown setae; wings light brown with scattered yellowish brown setae and line of white to cream colored setae along anal margin from base to arculus. Genitalia as in Fig. 2. Sternum IX short, produced anterolaterally; anterior margin broadly excavated ventrally; tergum IX membranous, not evident. Inferior appendage elongate rectangular; apex truncate, pigmented, setose apicoventrally; mesal surface with short, broad, setose lobe; apicomesal lobe narrow, acute, pigmented apically, with pair of mesal setae; basodorsal lobe shelflike, with long apicomesal setae and short thick mesal setae. Tergum X lightly sclerotized basally and mesally; in lateral view appearing bulbous and broadly rounded; tergum X divided middorsally, lateral lobes apically acute, slightly mesally directed, subapicoventrally with small sclerotized process. Preanal appendage short, rounded, setose. Intermediate appendage bipartite; dorsal branch short, rodlike, bearing pair of short apical and subapical spinelike setae; ventral branch longer, triangular, with apical and ventral setae. Phallus long, slender, tubular, membranous internally, with internal sclerite and 4 short spines.

Female.—Length of forewing 3.5–4.0 mm. Color and structure similar to male. Genitalia typical for genus.

Type material.—Holotype, ♂. BRAZIL: *Paraná:* Município de Corbélia, Rio Novo headwaters, 24°53.886′S, 53°14.895′W, el.

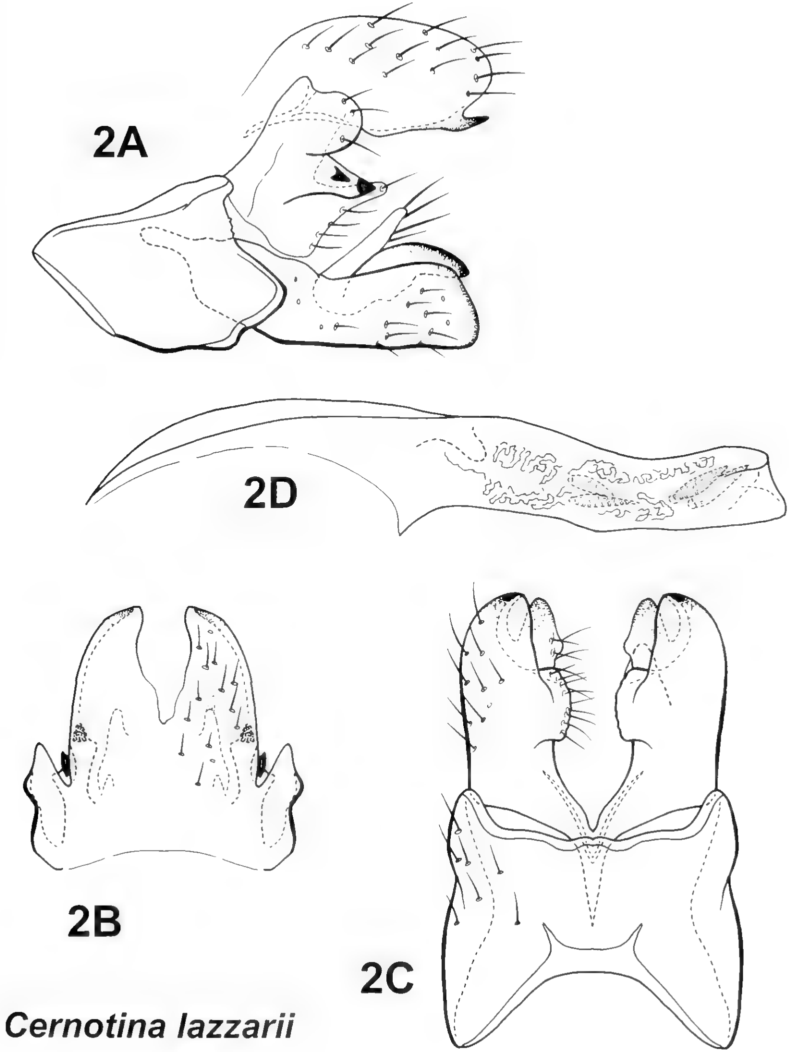

Fig. 2. *Cernotina lazzarii,* male genitalia. A, Lateral. B, Tergum X, preanal and intermediate appendages, dorsal. C, Sternum IX and inferior appendages, ventral. D, Phallus, lateral.

700 m. 4–7.iv.1998, Holzenthal & Huisman (MZUSP). Paratypes. Same data as holotype, 3 ♂, 5 ♀ (UMSP), 1 ♂, 5 ♀ (NMNH), 2 ♂, 5 ♀ (MZUSP); *Paraná:* Fênix, Reserva Estadual ITCF, 23°54′S, 51°58′W, el. 350 m, 20.xi.1987, PROFAUPAR-lâmpada, 1 ♂ (UFPR).

Etymology.—This species is named with gratitude and affection for Dr. Flávio Lázzari, agronomist and plant pathologist, Curitiba, Brazil, on whose farm the new species was collected.

Polycentropus urubici Holzenthal and Almeida, new species

(Fig. 3)

This species appears to be a member of the *jorgenseni* complex of the *gertschi* species group as defined by Hamilton (1986), but the dorsal band in the apical membranes of the phallus in *P. urubici* is not as distinct as illustrated by Hamilton for other members of the complex. *Polycentropus urubici* is not close to any of the described species in the complex, but resembles a few of the undescribed species illustrated by Hamilton (1986).

Male.—Length of forewing 5.5–6.0 mm. Body and wings entirely fuscous, legs dark brown. Genitalia as in Fig. 3. Sternum IX short; anterior margin rounded in lateral view, shallowly emarginate in ventral view; tergum IX membranous. Inferior appendage short, triangular, heavily setose, broad basally, narrowing to acute, slightly upturned apex, with mesoventral toothlike projection; mesal surface setose (in paratypes from Santa Catarina, inferior appendage narrower basally and apex more strongly upturned). Tergum X entirely membranous, broad basally, narrow apically. Intermediate appendage long, rodlike, narrowed apically, extending ventrad to apex of inferior appendage (in paratypes from Santa Catarina, intermediate appendage narrow throughout length). Preanal appendage elongate oval, setose; mesoventral process short, digitate, setose, slightly upturned. Phallobase short; apicoventral processs long, thick, pointed, apex directed ventrad; phallic sclerite and dorsal band lightly sclerotized, indistinct. Subphallic sclerite broad, Y-shaped in caudal view.

Female.—Unknown.

Type material.—Holotype, ♂. BRAZIL: *Paraná:* Telêmaco Borba, Reserva Samuel Klabin, 24°17'S, 50°37'W, el. 750 m, 7.viii.1986, PROFAUPAR-lâmpada (UFPR). Paratypes. Same data as holotype, 23.x.1987, 1 ♂ (UFPR), 17.i.1988, 1 ♂ (UFPR). *Santa Catarina:* Morro da Igreja, Urubici, Cachoeira Véu da Noiva, 28°04.595′S, 49°31.090′W, el. 1,300 m, 5.iii.1998, Holzenthal, Froehlich, Paprocki, 3 ♂ (UMSP), 2 ♂ (MZUSP); Urubici, Cachoeira Avencal, 28°02.839′S, 49°36.997′W, el. 1,260 m, 6.iii.1998, Holzenthal, Froehlich, Paprocki, 1 ♂ (UMSP), 1 ♂ (NMNH).

Etymology.—The species is named for the town in Santa Catarina where paratype specimens were collected.

Polyplectropus profaupar Holzenthal and Almeida, new species

(Fig. 4)

This species is very similar to *Polyplectropus annulicornis* Ulmer, also known from Santa Catarina, Brazil, but differs in the following ways. The dorsolateral process of the preanal appendage, which is thick and spinose in *P. profaupar* is long, slender and without spines in *P. annulicornis*; when viewed ventally, the ventromesal process of the inferior appendage is longer and more digitiform in *P. annulicornis* than in the new species and the apex of the inferior appendage is more rounded in *P. annulicornis.*

Male.—Length of forewing 5.5–6.5 mm. Body sclerites pale yellowish brown; palps pale yellow with scattered brown setae; antenna pale yellow, scape with long white setae, antennal flagellomeres with light brown setae basally; dorsum of head with white setae mesally and light brown setae laterally; pronotum with white and brown setae and mesonotum with white setae; legs yellowish with scattered brown setae; wings light

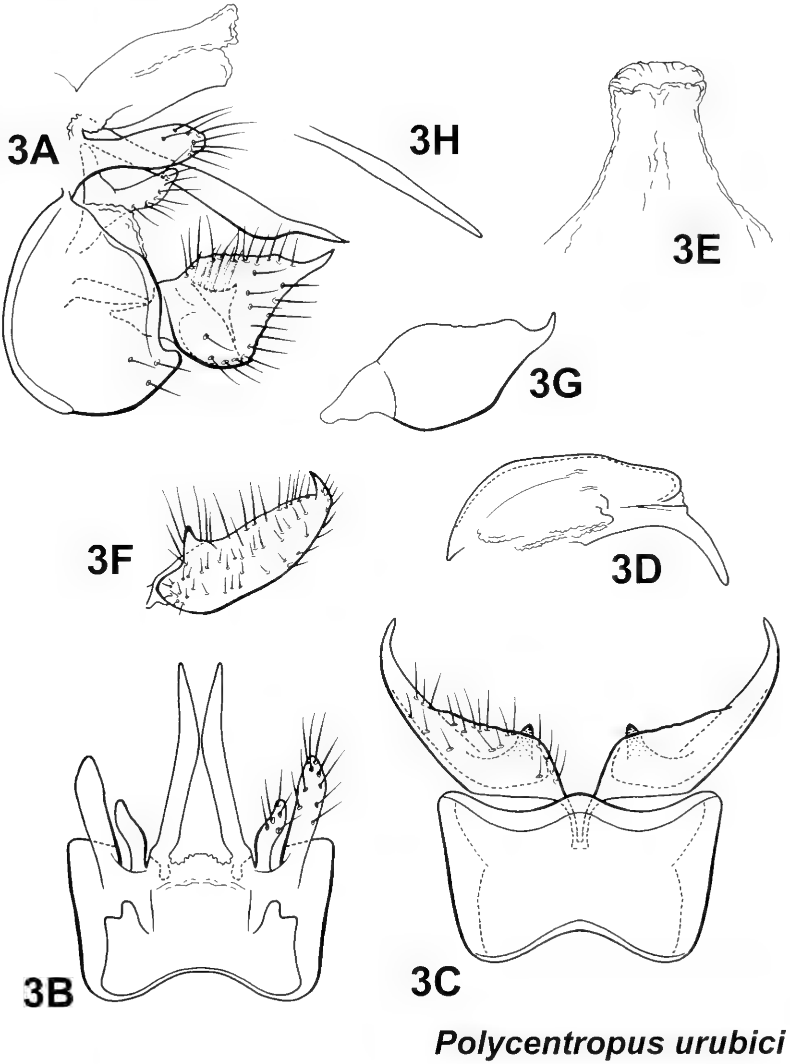

Fig. 3. *Polycentropus urubici*, male genitalia. A, Lateral. B, Segment IX, preanal and intermediate appendages, dorsal. C, Sternum IX and inferior appendages, ventral. D, Phallus, lateral. E, Tergum X, dorsal. F, Inferior appendage, caudal. G, Inferior appendage, paratype from Santa Catarina, lateral. H, Intermediate appendage, paratype from Santa Catarina, lateral.

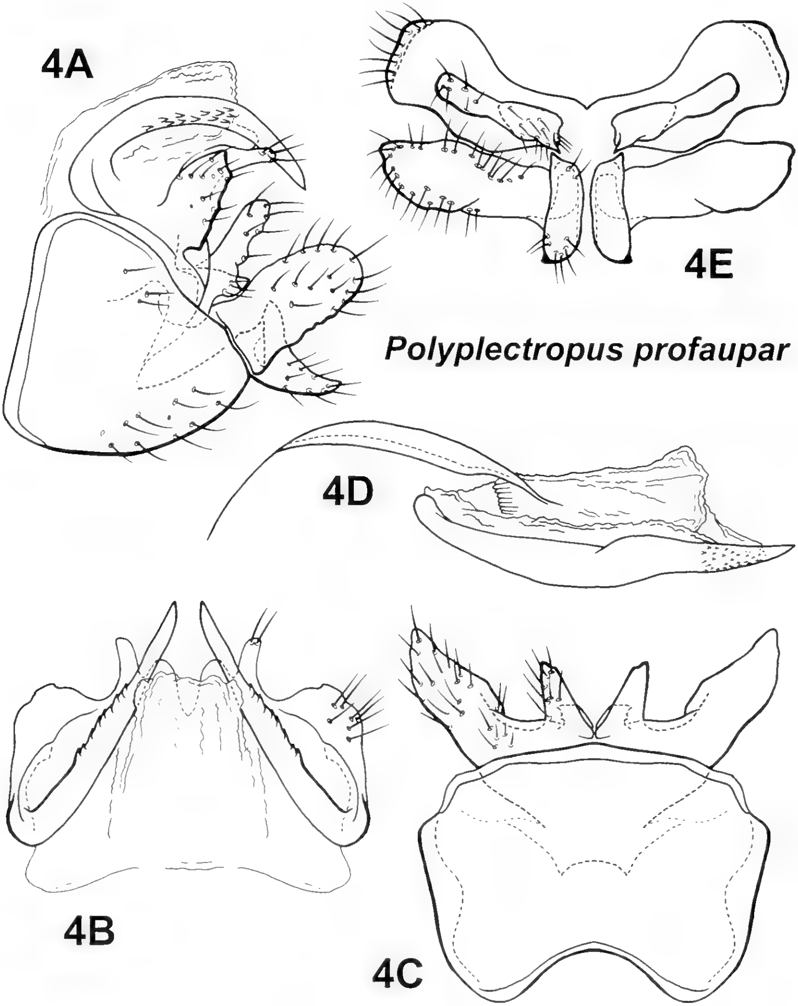

Fig. 4. *Polyplectropus profaupar,* male genitalia. A, Lateral. B, Segment X, preanal and intermediate appendages, dorsal. C, Sternum IX and inferior appendages, ventral. D, Phallus, lateral. E, Inferior appendages and ventral portion of preanal appendages, caudal.

brown, covered with whitish setae and scattered patches of light brown setae, giving a mottled appearance, these patches darker at base of costa and at pterostigma. Genitalia as in Fig. 4. Sternum IX short, triangular; anterior margin straight in lateral view, shallowly emarginate in ventral view; tergum IX membranous. Inferior appendage with lateral lobe setose, elongate oval; ventromesal process triangular, bearing acute projections dorsally and ventrally. Tergum X entirely membranous, short. Intermediate appendage short, digitate, apically setose. Preanal appendage tripartite; dorsolateral process heavily sclerotized, long, thick, recurved, with lateral spines; mesolateral process oval, setose; ventrolateral process spatulate, setose, with digitate mesal process bearing spinelike ventral projection. Phallus with narrow basal portion and membranous apical portion, which bears pair of sclerotized pointed processes ventrally and patch of fine spines subapically; apex of phallus acute; internal phallic sclerites or spines not evident.

Female.—Length of forewing 6.0–8.0 mm. Color and structure similar to male. Genitalia typical for genus.

Type material.—Holotype, ♂. BRAZIL: *Santa Catarina:* Morro da Igreja, Urubici, Cachoeira Véu da Noiva, 28°04.595′S, 49°31.090′W, el. 1,300 m, 5.iii.1998, Holzenthal, Froehlich, Paprocki (MZUSP). Paratypes. Same data as holotype, 2 ♂, 10 ♀ (UMSP), 5 ♀ (MZUSP);). *Paraná:* São José dos Pinhais, Serra do Mar, BR 277, km 54, 24°17′S, 50°37′W, el. 750 m, 21.i.1988, PROFAUPAR-lâmpada, 1 ♂ (UFPR). *Santa Catarina:* Urubici, Cachoeira Avencal, 28°02.839′S, 49°36.997′W, el. 1,260 m, 6.iii.1998, Holzenthal, Froehlich, Paprocki, 1 ♂, 1 ♀ (NMNH).

Etymology.—This species is named after the entomological inventory of Paraná state, Brazil, PROFAUPAR or "Projeto de Levantamento da Fauna Entomológica no Estado do Paraná" (Marinoni and Dutra 1993).

ACKNOWLEDGMENTS

We are very grateful to the Brazilian federal agency CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) for its financial support to the senior author during a visiting professorship at the Universidade Federal do Paraná in 1997–1998 and to the junior author during her graduate program in entomology at UFPR (BEX 0386/01-4). We are also grateful to Dr. Roger J. Blahnik, University of Minnesota, and Dr. Oliver S. Flint, Jr., Smithsonian Institution, for their invaluable assistance in sorting material, verifying identifications, and critically reviewing the manuscript. The senior author is also grateful to Dr. Claudio G. Froehlich and Mr. Henrique Paprocki, Universidade de São Paulo, for assistance with field work. Subsequent systematics research was supported by NSF grant DEB-9971885 to Holzenthal and Blahnik. This paper is contribution number 1342 from the Department of Zoologia, Universidade Federal do Paraná (Curitiba).

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PROC. ENTOMOL. SOC. WASH.
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A REVISION AND PHYLOGENETIC STUDY OF *LIPOCHAETA* COQUILLETT (DIPTERA: EPHYDRIDAE)

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Abstract.—The genus *Lipochaeta* Coquillett is revised and a phylogenetic analysis of the genera of the tribe Lipochaetini is provided. *Lipochaeta* is known thus far only from the New World, where there are now two species. The second species, ***L. ranica*, n. sp.**, (type locality: California), is described herein. The species of *Lipochaeta* occur in saline or alkaline habitats, especially along maritime coasts. The monophyly of *Lipochaeta* is well corroborated and its putative sister group is the Old World genus *Homalometophus* Becker.

Key Words: revision, Diptera, Ephydridae, Lipochaetini, *L. ranica,* New World, phylogeny

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Among 114 genera of shore flies (Diptera: Ephydridae), less than 17% (19 genera) are monotypic (Mathis and Zatwarnicki 1995), and that percentage is decreasing as we better sample the extant fauna and discover additional species. Field work during the last two decades, for example, has revealed hundreds of new species but very few new genera. There is also a decrease in monotypic genera as we clarify and recharacterize higher level taxa to be more inclusive, monophyletic clades, usually comprising more than one species. The genus *Lipochaeta* Coquillett, the subject of this revision, is an example of this evolving pattern in the classification of shore flies.

Coquillett (1896) described *Lipochaeta slossonae* in the late 19th Century, and until now it was the only included species in the genus. Coquillett recognized that this new genus and species were unusual and appropriately suggested that they be placed in a separate and new subfamily, but he did not provide a subfamilial name. Becker (1896: 275) quoted Coquillett's entire paper but substituted "Lipochaetinae" for *Lipochaeta* in the introductory portion, thus making the subfamilial name available. Attribution of Lipochetinae as a family-group name to Becker was followed in all recent catalogs and is continued here. Sabrosky (1999: 179), however, suggested that, "It seems reasonable to correct the obvious lapse and credit Coquillett with the subfamily." Coquillett clearly was the first person to recognize these taxa, from species to subfamily, but the subfamilial name is correctly attributed to Becker and the generic and species names to Coquillett.

The bizarre external appearance of *Lipochaeta,* being highly adapted to psammophilous habitats, initially confused some authors about its familial affiliation. A year after its description, Williston (1897: 8) preferred placement of *Lipochaeta* ". . . among the Ochthiphilinae in the vicinity of *Rhic-*

noessa [Tethinidae]" and added that, "No Ephydrid that I know of lacks bristles, while both of these latter families [Oscinidae and Agromyzidae] have numerous forms without them. The face is too short, the antennae too different in structure to belong with the Ephydridae. Moreover the pollinose body and white wings, while not absent among Ephydridae, are not at all common." Townsend (1898: 168) described a second species in *Lipochaeta* (*L. texensis* from Padre Island, Texas) and commented on the taxonomic placement of the genus. Townsend wrote that while *Lipochaeta* is ". . . clearly allied to the Ephydridae" it ". . . is truly one of singular aspect and anomalous position." Aldrich's (1905) catalog of Nearctic Diptera followed Coquillett and Townsend in listing *Lipochaeta* as a genus in the Ephydridae and also in placing *L. texensis* as a junior synonym of *L. slossonae*. The synonymy of *L. texensis* with *L. slossonae* was apparently based on information in a letter that Williston had written to Aldrich. Although Jones (1906) did not accept *Lipochaeta* as a shore fly in his worldwide catalog of Ephydridae, he offered no alternative placement. Nearly all subsequent authors have followed Coquillett, Townsend, and Becker in recognizing *Lipochaeta* as an ephydrid, usually in the tribe Lipochaetini, subfamily Parydrinae (Sturtevant and Wheeler 1954; Wirth 1965, 1968; Mathis 1977; Cogan 1980). A notable exception was E. T. Cresson, Jr., the doyen of 20th Century shore-fly workers, who was silent on the subject.

Although recognition of *Lipochaeta* as an ephydrid is now virtually universal, its placement in available shore-fly classifications, especially in catalogs, has varied. Cresson's successors (Sturtevant and Wheeler 1954; Wirth 1965, 1968; Mathis 1977; Cogan 1980) accorded tribal status to the genus in the subfamily Parydrinae, apparently considering *Lipochaeta* to be related to the tribes Parydrini and Hyadinini. Giordani Soika (1981), however, was of the opinion that the tribe Lipochaetini is related to *Isgamera* Giordani Soika and *Asmeringa* Becker, two Old-World genera that occur on the seashores of the Mediterranean and East Africa. Giordani Soika further suggested that the occurrence of Lipochaetini in the New World was due to continental drift and that the group has greater antiquity than was previously thought. Mathis (1984a) concurred with Giordani Soika in removing *Lipochaeta* from Parydrinae and in placing it close to *Isgamera* and *Asmeringa* in the subfamily Gymnomyzinae.

The above-cited studies were based on phenetic or overall differences and similarities, and although the placement of *Lipochaeta* did change from Parydrinae to Gymnomyzinae, its position close to *Isgamera* and *Asmeringa* is unsupported. Although the latter two genera appear similar externally, these features represent, for the most part, independent and convergent adaptations to psammophilous environments that are associated with seashores, not synapomorphies that indicate phylogenetic relationships.

Another advance in the phylogenetic position and composition of Lipochaetini was the recognition that the tribe Atissini, as then characterized, was polyphyletic and included genera that are more closely related to *Hecamede* Haliday (tribe Hecamedini, Mathis 1993) and to *Lipochaeta* (tribe Lipochaetini, Zatwarnicki 1992, Mathis 1995a). Zatwarnicki (1992) provided evidence indicating that the tribe Atissini is related to taxa in the subfamily Hydrelliinae, whereas Hecamedini and Lipochaetini are in the subfamily Gymnomyzinae. Zatwarnicki (1992) cited further evidence that Hecamedini and Lipochaetini are sister groups. The principal source of characters (synapomorphies) for these studies derives from structures of the male terminalia. The latter studies, especially Zatwarnicki (1992), indicate that the tribe Lipochaetini is closely related to the tribe Hecamedini and includes the following four genera (date and author(s) who first placed the genus in Lipochaetini are noted in parenthesis): *Glenanthe* (Mathis and Zatwarnicki 1990b), *Paraglenanthe* Wirth (Zatwarnicki 1992), *Lipochaeta* (Becker 1896), and *Homalometopus* Becker (Mathis 1984b). Recent revisionary and phylogenetic studies of genera of the tribe Lipochaetini include *Homalometopus* (Mathis 1984b, Munari 1988) and *Glenanthe* (Mathis 1992).

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; Mathis and Zatwarnicki 1990a, b). The terminology for structures of the male terminalia is provided directly on Figs. 17–18. 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 height divided by the eye height. Costal vein ratio is the straight line distance between the apices of R_{2+3} and R_{4+5} divided by the distance between the apices of R_1 and R_{2+3}. M vein ratio is the straight line distance along vein M between crossveins (dm-cu and r-m) divided by the distance apicad of dm-cu.

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 generic level.

Although many specimens for this study are in the National Museum of Natural History, Smithsonian Institution, Washington, DC (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.
BMNH	The Natural History Museum (formerly the British Museum (Natural History)), London, England, United Kingdom.
CNC	Canadian National Collection, Ottawa, Canada.

SYSTEMATICS

Tribe Lipochaetini Becker

Lipochaetini Becker 1896: 275 [as Lipochaetinae]. Type genus: *Lipochaeta* Coquillett 1896.—Zatwarnicki 1992: 89, 118–119 [listing of included genera, phylogenetic placement].—Mathis and Zatwarnicki 1995: 160–163 [world catalog].—Mathis 1995a: 2–4 [description, key to genera].

Diagnosis (synapomorphies indicated by an asterisk (*)).—*Head:* Frontal vitta (or ocellar triangle) setulose*; ocellar seta either greatly reduced or absent (sometimes with a pair of intrafrontal setae slightly larger than other setulae, this pair inserted in front of anterior ocellus)*; pseudopostocellar seta reduced or lacking*; fronto-orbital setae 3 (reduced secondarily in *Lipochaeta*), anterior 2 setae proclinate, posterior seta reclinate. Pedicel lacking prominent, spinelike seta; arista with cuticular hair dorsally and ventrally, appearing macropubescent or brushlike, without dorsal rays*. Eye bearing numerous interfacetal microsetulae (apparently arising from each interfacet). Genal seta reduced or lacking.

Thorax: Dorsocentral setae weakly developed, only posteriormost pair conspicuous; acrostichal setulae in 2–4 rows, frequently with a prescutellar pair better developed; postsutural supra-alar seta lacking; frequently postpronotal and presutural supra-alar seta reduced or lacking; posterior notopleural seta inserted above level of anterior seta, sometimes only slightly so (as in *Homalometopus* and *Lipochaeta*). Wing with vein R_{2+3} long, extended nearly to level of apex of vein R_{4+5}. Legs lacking conspicuous setae; femora and tibiae usually gray to pale brown; tarsi yellow.

Abdomen: 5th tergite of male longer than 4th. Male terminalia as follows: epandrium attenuate, either emarginate posteriorly or incomplete dorsally; surstylus well developed, usually elongate, frequently as long or longer than epandrium; aedeagus elongate, slender, tubular, apex with recurved flap oriented posterodorsally, apical flap in groove at rest, base of aedeagus bifurcate, sometimes with arms elongate*; ejaculatory apodeme present, compressed laterally*; aedeagal apodeme L-shaped, sometimes with extended ventromedial process; gonites (pre- and postgonites) lacking, possibly fused with hypandrium*; hypandrium well sclerotized, usually V- or U-shaped; 5th sternite deeply V- or U-shaped into which the surstyli and aedeagus lie at rest.

Natural history.—This tribe is unusually tolerant of alkaline or saline aquatic environments, and species of most genera occur on seashores or are associated with inland aquatic habitats that are saline or alkaline.

Discussion.—Although the tribe Lipochaetini and each of the included genera are readily characterized, often with substantial evidence that they are monophyletic, the relationships among the genera are not well understood. In the key that follows, for example, we have included numerous characters, nearly all autapomorphies, that facilitate identification of the genera but contribute virtually nothing to resolution of their phylogenetic relationships. A further complicating factor is the debatable status or polarity of the few characters that may indicate relationships. For example, a gaping oral cavity and a wide clypeus are character states that are common to *Lipochaeta* and *Homalometopus,* whereas a narrow oral opening and clypeus occur in *Glenanthe* and *Paraglenanthe.* The problem is that both the narrow and wide conditions occur in the outgroup, Hecamedini, as well as commonly elsewhere in the Ephydridae, thus confusing issues about which character state is apomorphic within the Lipochaetini.

The tribe Lipochaetini, which is one of six tribes now placed in the subfamily Gymnomyzinae (Mathis and Zatwarnicki 1995), appears to be most closely related to the tribe Hecamedini (Zatwarnicki 1992). Lipochaetini's sister-group relationship with Hecamedini is corroborated by two synapomorphies that we have identified (including Zatwarnicki's [1992] characters 59–60): 1) pre- and postgonites apparently fused or greatly reduced; 2) posterior notopleural seta inserted much farther dorsad from notopleural suture than anterior seta.

Lipochaetini are distinguished from Hecamedini and other tribes of the subfamily Gymnomyzinae and the tribe's monophyly is confirmed by the following characters (synapomorphies are noted by an asterisk (*)): 1) body densely invested with microtomentum, generally dull colored; *2) ocellar seta lacking or weakly developed; *3) pseudopostocellar seta lacking; *4) arista microsetulose, lacking dorsal rays; *5) frontal vitta bearing many setulae; 6) posterior margin of gena broadly rounded onto occiput; 7) scutellum with 2 pairs of marginal setae; 8) foreleg normal, forefemur slender, foretibia not having a large spur apically; 9) abdominal tergites 2–4 subequal in width, microtomentose, but more or less smooth; *10) aedeagus with apical flap or appendix that is folded back dorsally; and *11) gonite reduced.

With the phylogenetic background of the tribe Lipochaetini within the subfamily Gymnomyzinae established and the monophyly of Lipochaetini documented, we now

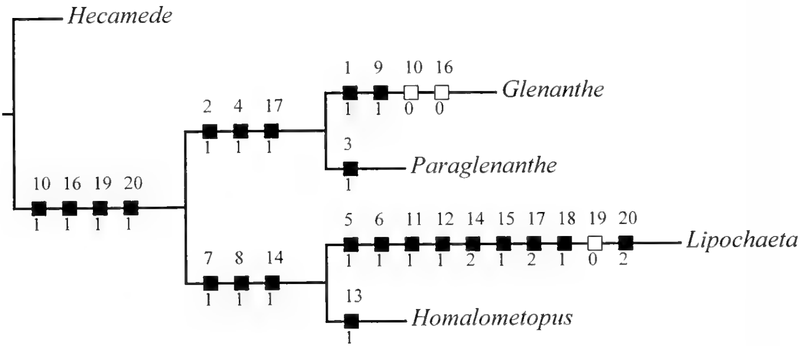


Fig. 1. Cladogram depicting hypothetical cladistic relationships among genera of Lipochaetini (length 17 steps, consistency index 0.82; retention index 0.62).

proceed with the cladistic analysis and resultant relationships among the included genera, but with a few explanatory remarks first. In the presentation on genus-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, a 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. All multistate characters (7, 14, 17, and 20) were treated as nonadditive (−), and characters 1, 3, 5, 6, 9, 11, 12, 15, and 18, which are autapomorphies for various genera or tribes, were made inactive ⟨]⟩ for the analysis so that they do not alter 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 *Hecamede*, which is the nominate genus for the tribe Hecamedini, was the outgroup in our phylogenetic analysis.

Table 1. Matrix of characters and taxa used in the cladistic analysis of Lipochaetini (numbers for characters correspond with those used in the text).

Taxa	Characters		
	000000000 123456789	1111111 0123456	1112 7890
Hecamede	000000000	0000000	0000
Glenanthe	110100001	0000000	1011
Lipochaeta	000011110	1110211	2102
Homalometopus	000000110	1001101	0011
Paraglenanthe	011100000	1000001	1011

CHARACTERS USED IN THE PHYLOGENETIC ANALYSIS
(RUNNING COUNT IN PARENTHESIS.)

Head

1(1). Shape of eye: (0) round or oval; (1) pyriform (an autapomorphy for *Glenanthe*).

2(2). Shape of clypeus: (0) wide, band-like; (1) narrow (a synapomorphy for *Glenanthe* and *Paraglenanthe*).

3(3). Shape or ventral facial margin: (0) flat; (1) emarginate (an autapomorphy for *Paraglenanthe*).

4(4). Oral opening: (0) wide, gaping; (1) narrow (a synapomorphy for *Glenanthe* and *Paraglenanthe*).

5(5). Height of face: (0) normal, usually higher than wide; (1) short (an autapomorphy for *Lipochaeta*).

6(6). Size of antenna: (0) normal; (1) reduced, especially the arista (an autapomorphy for *Lipochaeta*).

7(7). Distance between antennal bases: (0) narrow, distance between antennal bases less than antennal width; (1) wide, antennal bases separated by width greater than antennal width (an autapomorphy for *Homalometopus*); (2) very wide, antennal bases separated by 3× antennal width (an autapomorphy for *Lipochaeta*).

8(9). Shape of mesofrons: (0) narrow, V-shaped, with wide parafrons and fronto-orbits (*Glenanthe* and *Paraglenanthe*); (1) wide, broadly U-shaped, parafrons and fronto-orbits comparatively smaller (a synapomorphy for *Homalometopus* and *Lipochaeta*).

9(9). Height of gena: (0) high, 0.33 to more than 0.5× eye height; (1) short, less than ⅛ eye height (an autapomorphy for *Glenanthe*).

Thorax

1(10). Katepisternal seta: (0) present, conspicuous, well developed; (1) greatly reduced (a synapomorphy for *Homalometopus, Lipochaeta,* and *Paraglenanthe*).

2(11). Postpronotal seta: (0) present; (1) reduced (an autapomorphy for *Lipochaeta*).

3(12). Presutural supra-alar seta: (0) present; (1) absent (an autapomorphy for *Lipochaeta*).

4(13). Position of posterior notopleural seta: (0) inserted above level of anterior seta; (1) inserted at about same level as anterior seta or only slightly elevated (a synapomorphy for *Homalometopus* and *Lipochaeta*).

5(14). Setae along posterior margin of anepisternum: (0) 2 setae and some smaller setulae; (1) 1 seta (an autapomorphy for *Homalometomus*); (2) no large setae, only setulae (an autoapomorphy for *Lipochaeta*).

6(15). Wing near apex of subcostal vein and vein R_1: (0) normal, membranous; (1) sclerotized and thickened, yellow (an autapomorphy for *Lipochaeta*).

7(16). Wing membrane coloration: (0) hyaline, transparent; (1) white, translucent (a synapomorphy for *Glenanthe, Paraglenanthe,* and *Lipochaeta*).

Abdomen

1(17). Epandrium: (0) entire dorsally; (1) attenuate with a posterodorsal notch (an autapomorphy for *Glenanthe* and *Paraglenanthe*); (2) incomplete dorsally with a gap between two lateral portions (an autapomorphy for *Lipochaeta*).

2(18). Cerci: (0) separate, unfused with medial margin of epandrium; (1) fused laterally with median margin of epandrium (an autapomorphy for *Lipochaeta*).

3(19). Length of surstylus: (0) about same length as epandrial length; (1) much longer than epandrial length, usually by more than twice (a synapomorphy for *Homalometopus, Glenanthe,* and *Paraglenanthe*).

4(20). Base of aedeagus: (0) truncate or nearly so; (1) bifurcate (a synapomorphy for *Homalometopus* and *Paraglenanthe*); (2) arms of basal bifurcation more elongate and curled beneath (an autapomorphy for *Lipochaeta*).

ANALYSIS AND RESULTS

Using the implicit enumeration (ie*) option of Hennig86, which is an exhaustive

Table 2. Analysis of characters based on the cladogram (Fig. 1). Con. Index = Consistency Index; Ret. Index = Retention Index.

	Characters									
	1	2	3	4	5	6	7	8	9	10
Steps	1	1	1	1	1	1	1	1	1	2
Con. Index	100	100	100	100	100	100	100	100	100	50
Ret. Index	100	100	100	100	100	100	100	100	100	0
	Characters									
	11	12	13	14	15	16	17	18	19	20
Steps	1	1	1	2	1	2	2	1	2	2
Con. Index	100	100	100	100	100	50	100	100	50	100
Ret. Index	100	100	100	100	100	0	100	100	0	100

search, a single most parsimonious tree was generated from the analysis of the 20 characters. The cladogram has a length of 17 steps and consistency and retention indices of 0.82 and 0.62 respectively. The matrix was then subjected iteratively to successive weighing (xs w, ie*, cc) to determine a character's contribution or weight and to find cladograms supported by the most consistent characters (Carpenter 1988, Dietrich and McKamey 1995). The analysis of the characters for this cladogram is given in Table 2 and the weights of the various characters is given in Table 3. Given these character weights, the analysis of the resultant cladogram resulted in consistency and retention indices of 1.00 and 1.00 respectively.

As indicated on the cladogram (Fig. 1), the tribe Lipochaetini is divided into two basal sublineages. The first basal sublineage comprises half of the genera (number of species in parenthesis): *Lipochaeta* (2) and *Homalometopus* (7), with 9 species. The monophyly of this sublineage is corroborated by characters 7, 8, and 14. From a biogeographic standpoint, this sister-group relationship suggests that the cladogenetic event(s) that resulted in the divergence of *Lipochaeta* and *Homalometopus* occurred some time ago. *Homalometopus* is only found in the Old World where it now has relatively high diversity, i.e., seven species representing several speciation events, especially in the area of the Mediterranean Sea. *Lipochaeta* occurs only in the New World where speciation has been slower, resulting in only two described species and the possibility of a third in Chile.

The second basal sublineage includes the other two genera of Lipochaetini, *Glenanthe* (15) and *Paraglenanthe* (3), with 18 species. The monophyly of this sublineage is corroborated by characters 2, 4, and 17. *Glenanthe* occurs in both the New and Old Worlds, but there is apparently greater species diversity in the New World, assuming the present number of described species is

Table 3. Weights (varying between 1–10) and status (additive = +, nonadditive = −, active = [, inactive =]) of characters after successive weighting.

	Characters									
	1	2	3	4	5	6	7	8	9	10
Weight, status	10+]	10+[	10+]	10+[	10+]	10+]	10−[	10+[	10+]	0+[
	Characters									
	11	12	13	14	15	16	17	18	19	20
Weight, status	10+]	10+]	10+[	10−[	10+]	0+[	10−[	10+]	0+[	10−[

a good indicator. *Paraglenanthe*, on the other hand, has a more limited distribution, occurring only in the New World where it is primarily circumcaribbean.

KEY TO GENERA OF LIPOCHAETINI BECKER

1. Eye pyriform, distinctly narrowed ventrally; gena short, less than one-fourth eye height; katepisternal seta present along posterior margin, moderately well developed . . *Glenanthe* Haliday
[15 species, worldwide; Mathis 1995a]

– Eye generally oval or round, not distinctly narrowed ventrally; gena high, one-third or more of eye height; katepisternal seta reduced 2

2. Antenna reduced, inserted in well-separated cavity, arista atrophied, budlike; face short, height subequal to length of reduced antenna; clypeus bandlike; oral opening gaping; body setae and setulae pale; costa distinctly thickened at merger of vein R_1 . . . . . *Lipochaeta* Coquillett
[2 species, New World; mostly costal marine on sand but also inland where saline conditions exist]

– Antenna normally developed, not in deep cavity, arista as long as flagellomere 1; face well developed, height much more than length of antenna; clypeus variable; oral opening narrow or gaping; setae and setulae largely black; costa only slightly thickened at merger of vein R_1 . . 3

3. Mesofrons large, occupying most of frons, platelike, subrectangular, uniformly and evenly setulose; ventral facial margin flat; clypeus wide, bandlike; oral opening large, gaping . . . . *Homalometopus* Becker
[7 species, Eastern Hemisphere (Mediterranean); Mathis 1984b, Munari 1988]

– Frons lacking differentiated mesofrons, at most with frontal or ocellar triangle or vitta that is weakly differentiated from remainder of frons; ventral facial margin emarginate; clypeus narrow, exposed through ventral facial emargination; oral opening small . . *Paraglenanthe* Wirth
[3 species, New World (Caribbean); Wirth 1956]

Genus *Lipochaeta* Coquillett

Lipochaeta Coquillett 1896: 220. Type species: *Lipochaeta slossonae* Coquillett 1896, original designation.—Becker 1896: 274–275 [quote of original description].—Williston 1897: 7 [placement near *Rhicnoessa*, family Agromyzidae, subfamily "Ochthiphilinae"]; 1908: 306 [generic key].—Townsend 1898: 168 [notes on generic placement].—Aldrich 1905: 631 [Nearctic catalog].—Jones 1906: 169 [note, diagnosis].—Curran 1934: 346–347 [figs. of head, generic key].—Sturtevant and Wheeler 1954: 215–216 [listed as a genus in Napeae].—Wirth 1965: 750 [Nearctic catalog]; 1968: 22 [Neotropical catalog].—Mathis and Zatwarnicki 1995: 163 [world catalog].

Diagnosis.—*Lipochaeta* is distinguished from other genera of Lipochaetini by the following combination of characters: Body setae and setulae generally inconspicuous, pale. Antennae widely separate and arista rudimentary. Frons projected and large; sub-cranial cavity large, gaping. Body length 2.0–4.0 mm, generally grayish, dorsum of head and thorax sometimes brownish, and almost entirely microtomentose.

Description.—*Head:* Wider than high in anterior view, grayish; entirely microtomentose, sparsely setulose; mesofrons wide, broadly U-shaped, uniformly setulose, differentiated from remainder of frons by darker gray to brownish gray; parafrons a comparatively small triangular anterior area; fronto-orbits comparatively narrow. Head without conspicuous setae. Ocellar setae absent; pseudopostocellar setae absent, fronto-orbital setae absent (reduced secondarily); ocelli arranged to form equilateral triangle. Antenna reduced, in well-separated (gap between antennal bases about 3× antennal width), deep cavities, oriented laterally; pedicel with fine, pale setulae on ventral and dorsal sides, but lacking dorsoapical seta, arista rudimentary and budlike. Eye generally irregularly round with distinct, angular margin posterodorsally near vertex; interfacetal microsetulae present, numerous, conspicuous. Face short, height subequal to length of reduced antenna, narrowly triangular in profile, tapered to acute angle posteroventrally; clypeus bandlike, wide. Gena bearing fine, pale setulae. Subcranial cavity large and gaping.

Thorax: Entirely grayish to brownish, microtomentose, pleural area generally paler than dorsal coloration; mesonotum bearing numerous, fine, pale setulae, setulae most conspicuous on posterior portion of scutellum, particularly in females; postpronotal seta reduced; posterior notopleural seta at only slightly elevated position relative to anterior seta; anepisternum bearing numerous setulae; katepisternal seta variable. Wing with costal vein extended to vein M; costa distinctly thickened at merger of vein R_1; dorsal setulae along costal vein ended just beyond vein R_{2+3}; wing white, translucent, wing venation and halter yellow. Midfemur bearing comblike row of 6–7 white, longer setae anteriorly at apical ⅓–½; tarsi yellowish; midtarsus with basitarsomere longer than remaining four; each tarsomere with dark, ventroapical setae; midtarsus bearing twice as many black setae as others, these paired at apices of tarsomeres, basitarsomere bearing 4–5 pairs, apical tarsomere variable; pulvillus present.

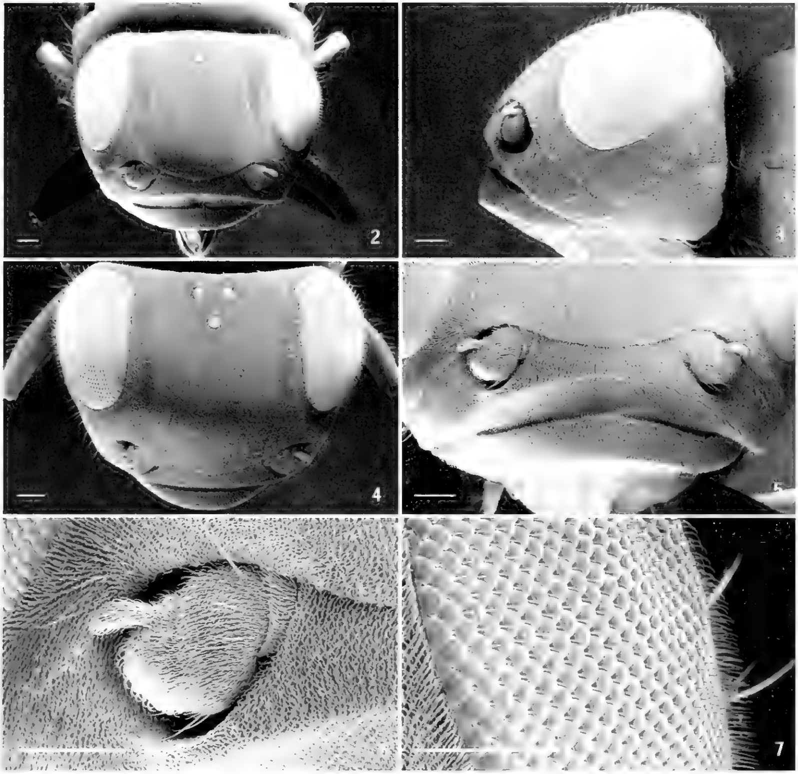
Abdomen: Male: tergites 2–4 about equal in length; length of 5th tergite slightly more than combined length of 3rd and 4th tergites; 5th tergite triangular in dorsal view; sternites 2–4 linear, much narrower than long, weakly sclerotized; 5th sternite deeply U-shaped and better sclerotized along inner margin of U. Male Terminalia: epandrium greatly reduced, in lateral view about as long as cerci, fused dorsolaterally with cerci, incomplete dorsally, with a gap between lateral portions; surstylus digitiform, moderately to conspicuously elongate, mostly parallel-sided, usually shallowly curved in lateral view, generally evenly setulose, setulae longer apically; gonites either indistinguishably fused with hypandrium or lacking; ejaculatory apodeme evident as a simple, slightly angulate, long, narrow process; aedeagus very long, narrow, tubular, length twice or slightly longer than surstylus, apex with membranous flap folded back on itself, length of flap about ¼–⅓ length of aedeagus, basal portion of aedeagus angled ventrally and forked with aedeagal apodeme between arms of basal fork; hypandrium well sclerotized, more or less Y-shaped in ventral view, with forked portion basal, lateral phalanges from basal arms of fork. Female Terminalia: Segments 6–7 telescoped out to form tube; 8th segment apparently lacking; hypoproct Y-shaped.

Remarks.—The poorly developed epandrium and an aedeagus with a terminal membranous flap are similar to *Glenanthe* and *Homalometopus* Becker. The female terminalia is also similar to that of *Homalometopus.*

Until now, *Lipochaeta* has been monotypic, with *L. slossonae* as the only included species. The second species, *L. ranica,* is very similar and obviously closely related. Differences between these two species are seemingly slight but are consistent and significant (see key and descriptions of species below). In addition to describing a second species, which is found primarily on the west coast of California and Mexico, we also report the possibility of a third species from Chile. The potential third species is represented by two female specimens from Atacama. One of the females has an elongate scutellum and bears a fringe of long, white setulae along the margin. An elongate scutellum also occurs in *L. slossonae* and *L. ranica,* and to a degree, the scutellar fringe of setulae is also apparent within the variation of these two species. Thus we are unsure about the status of the Chilean specimens, i.e., is the variation in the scutellar features intra- or interspecific. Additional specimens, especially males, are needed to assess better these possibilities.

KEY TO SPECIES OF *LIPOCHAETA*

1. Tarsi often entirely yellow; surstylus elongate (distinctly longer than height of epandrium), tapered apically to narrowly rounded apex (east coast of North America from Massachusetts south to Florida and Texas, islands of the Caribbean, Belize [Stann Creek], Mexico [Chiapas], and Panama [Playa Santa Clara] . . . . *L. slossonae* Coquillett
– Apical tarsomere always slightly to distinctly darkened; surstylus shorter (subequal to height of epandrium), parallel sided to bluntly rounded apex (west coast of North America from



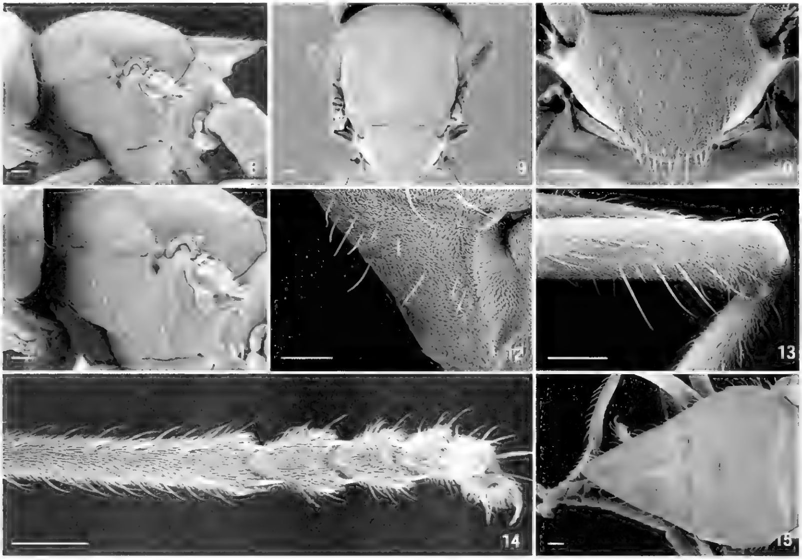
Figs. 2–7. Scanning electron micrographs of *Lipochaeta slossonae*. 2, Head, anterodorsal view. 3, Same, lateral view. 4, Frons, anterodorsal view. 5, Face, anterior view. 6, Right antenna, anterior view. 7, Left compound eye and interfacetal setae, anterior view. Scale bars equals 100 μm.

San Francisco south to the Mexican states of Baja California Sur and Nayarit, and to the Galápagos Islands) . . . . *L. ranica*, new species

Lipochaeta slossonae Coquillett
(Figs. 2–19)

Lipochaeta slossonae Coquillett 1896: 220.—Becker 1896: 275 [description].—Aldrich 1905: 631 [Nearctic catalog (partim)].—Jones 1906: 169 [note, diagnosis].—Johnson 1913: 86 [list, Florida].—Sturtevant and Wheeler 1954: 216 [list, Florida, Maryland, New Jersey, Texas, comments on habitat and behavior].—Wirth 1956: 18 [list, Bahamas]; 1965: 751 [Nearctic catalog (partim)]; 1968: 22 [Neotropical catalog (partim)].—Foote 1995: 422 [sandy beach habitat].—Mathis and Zatwarnicki 1995: 163 [world catalog (partim)].—Mathis 1997: 28–29 [review, Belize].

Lipochaeta texensis Townsend 1898: 168.—Aldrich 1905: 631 [synonymy].—



Figs. 8–15. Scanning electron micrographs of *Lipochaeta slossonae*. 8, Thorax, lateral view. 9, Same, dorsal view. 10, Scutellum, dorsal view. 11, Pleural area, lateral view. 12, Anepisternum, dorsoblique view. 13, Left midfemur, anterior view. 14, Left midtarsus, ventral view. 15, Abdomen, dorsal view. Scale bar equals 100 μm.

Sturtevant and Wheeler 1954: 216 [synonymy]. Diagnosis.—Moderately small to moderately large shore flies, body length 2.0–4.0 mm.

Description.—*Head* (Figs. 2–7): In profile as long as high. Mesofrons slightly differentiated by darker brown or gray microtomentum. Setae and setulae generally inconspicuous; genal setulae shorter than anepisternal setulae.

Thorax (Figs. 8–16): Mesonotum varying from slightly darker brown to gray. Anepisternal setae moderately long; katepisternal seta reduced. Wing as in Fig. 16. Tarsi usually yellow, apical tarsomere slightly darkened in some specimens.

Abdomen (Figs. 17–18): Surstylus elongate (distinctly longer than height of epandrium), tapered apically to narrowly rounded apex.

Type material.—Described from two ♂. The lectotype ♂ of *Lipochaeta slossonae* Coquillett, here designated to preserve stability and make more universal the use of this name, is labeled "CH[arlotte]. H[ar]B[o]R, FL[orid]A [folded]/Mrs-Slosson Collector/Type No 4300 U.S.N.M. [red; "4300" handwritten]/Lipochaeta slossonae Coq. [handwritten; black sub-border." The lectotype is double mounted (glued to a paper triangle along with a second specimen, also a male, that lacks its head), is in good condition, and is deposited in the USNM (4300). Coquillett (1896) wrote that the two syntypes were specifically from Punta Gorda, which is a city on the eastern shore of Charlotte Harbor bay. The second male is a paralectotype.

The syntype(s) of *Lipochaeta texensis* is from USA. Texas: Cameron County, Padre Island; ST (sex ?), BMNH. We were unable to locate this specimen, which apparently was in the BMNH. Its whereabouts is unknown.

Other specimens examined.—ANGUILLA. Long Pond Bay (18°13′N, 63°01′W), 29 Mar 1992, W. E. Steiner, J. M. Swearingen (37 ♂, 41 ♀; USNM); Prickly Pear, (18°16′10″N, 63°10′30″W), 30 Mar 1992, W. E. Steiner, J. M. Swearingen (7 ♂, 11 ♀; USNM); Sandy Ground (18°12′20″N, 63°05′30″W), 24–30 Mar 1992, W. E. Steiner, J. M. Swearingen (2 ♀; USNM).

BAHAMAS. *Great Inaqua Island:* Matthew Town, 31 Jan 1953, E. B. Hayden, G. B. Rabb (1 ♀; AMNH). *Turks and Caicos Islands:* Grand Turk Island, 19 Feb 1953, E. B. Hayden (3 ♂, 2 ♀; AMNH); South Caicos Island, 11 Feb 1953, E. B. Hayden (1 ♂, 3 ♀; AMNH).

BELIZE. *Stann Creek:* Carrie Bow Cay, 31 May 1985, W. N. Mathis (2 ♂, 4 ♀; USNM).

CUBA. *Sancti Spiritus:* La Boca (4 km S; 21°45.9′N, 80°01.5′W), 12 Dec 1994, W. N. Mathis (8 ♂, 3 ♀; USNM); Playa Ancón (21°44.1′N, 79°59.9′W), 12 Dec 1994, W. N. Mathis (2 ♂, 3 ♀; USNM).

CURAÇÃO. Coral Specht (3 km E Willemstad), 8–15 Feb 1987, W. E. Steiner, J. M. Swearingen (1 ♀; USNM).

DOMINICAN REPUBLIC. *Azua:* Puerto Viejo (18°20.9′N, 70°50.4′W), 14 May 1995, W. N. Mathis (2 ♂, 2 ♀; USNM). *Barahona:* Barahona (18°12′N, 71°5.3′W), 20 May 1998, D. and W. N. Mathis (4 ♂, 1 ♀; USNM). *La Romana:* Isla Saona, Mano Juan (18°08.1′N, 68°44.5′W), 13 May 1995, W. N. Mathis (11 ♂, 2 ♀; USNM). *Monte Cristi:* Monte Cristi (beach; 19°51.5′N, 71°39.5′W), 18 May 1995, W. N. Mathis (6 ♂; USNM).

GRAND CAYMAN. Double Head (19°23.4′N, 81°22.3′W), 27 Apr 1994, D. and W. N. Mathis (8 ♂, 4 ♀; USNM).

GUYANA. Mahaica (6°42.8′N, 57°55.6′W), 14 Apr-20 Aug 1994, 1997, W. N. Mathis (1 ♂, 1 ♀; USNM).

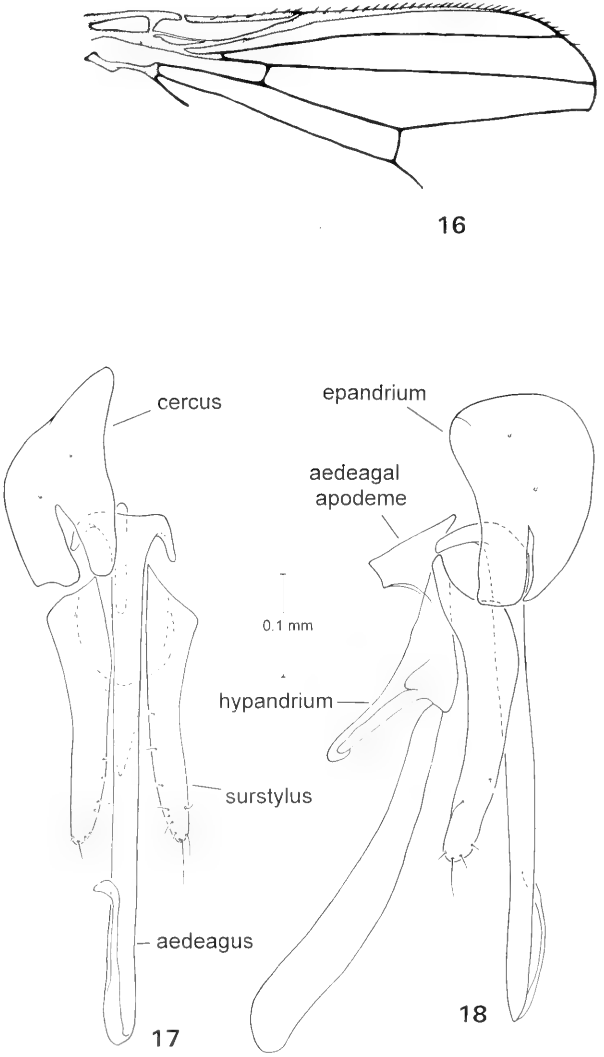
JAMAICA. *Clarendon:* Barnswell Beach (17°45′N, 77°08.5′W), 13 May 1996, D. and W. N. Mathis, H. Williams (1 ♂; USNM); Farquhars Beach (17°50.9′N, 77°22.8′W), 9 May 1996, D. and W. N. Mathis, H. Williams (5 ♂, 5 ♀; USNM); Jackson Bay (17°44.7′N, 77°12.6′W), 13 May 1996, D. and W. N. Mathis, H. Williams (6 ♂, 3 ♀; USNM). *St. Elizabeth:* Great Pedro Pond (17°52.5′N, 77°45.2′W), 19 Apr 2000, W. N. Mathis (4 ♂, 4 ♀; USNM); Salt Pond, Parottee Beach (17°58.1′N, 77°50.2′W), 19 Apr 2000, W. N. Mathis (2 ♀; USNM).

MEXICO. *Chiapas:* Puerto Arista (2 km E), 18 May 1985, A. Freidberg, W. N. Mathis (10 ♂, 31 ♀; USNM).

PANAMA. *Cocle:* Playa Santa Clara, 2 Jul 1967, W. W. Wirth (1 ♂, 1 ♀; USNM).

PUERTO RICO. Bahía Salinas (beach; 17°57.5′N, 67°12′W), 20 Sep 1995, D. and W. N. Mathis (4 ♂, 7 ♀; USNM). Punta Jacinto (near Guanica; 17°57′N, 66°52.6′W), 20 Sep 1995, D. and W. N. Mathis (1 ♂; USNM).

UNITED STATES. *Florida. Charlotte:* Charlotte Harbor (2 ♂; USNM); Punta Gorda, 27 Jan 1932, A. L. Melander (1 ♂; ANSP). *Duval:* Little Talbot Island State Park, 28 May 1953, M. R. Wheeler (2 ♂, 2 ♀; USNM). *Lee:* Bonita Beach, 17 Apr 1970, W. W. Wirth (10 ♂, 19 ♀; USNM); Sanibel Island, Lighthouse Park, 17 Apr 1989, D. and W. N. Mathis (4 ♂; USNM). *Manatee:* Anna Maria, 19 May 1953, M. R. Wheeler (2 ♂, 1 ♀; USNM). *Monroe:* Everglades National Park (on white sand beach), 3 Apr 1958, H. V. Weems, Jr. (1 ♂; USNM); Key West, 5 Feb 1938, A. L. Melander (6 ♂, 4 ♀; ANSP); Matecumbe, 2 Feb 1938, A. L. Melander (2 ♂; ANSP). *Pinellas:* St. Petersburg, 29 Jan-30 Mar 1932, E. T. Cresson, Jr., A. L. Melander (4 ♂, 13 ♀; ANSP). *Georgia. Liberty:* St. Catherines Island, 21 Apr–30 Oct 1977, 1978, A. Hook, R. W. Matthews, J. Krispyn (1 ♂, 1 ♀; USNM). *Chatham:* Chatham (at light), 1 Oct 1953, H. F. Schoof (1 ♂; USNM). *Maryland. Calvert:* Chesapeake Beach, 20 Aug–20 Sep 1914, J. M. Aldrich, N. Banks, G. H. Greene (28 ♂, 15 ♀; ANSP, USNM). *Massachusetts. Barnstable:*



Figs. 16–18. Wing and structures of the male terminalia of *Lipochaeta slossonae* (ejaculatory apodeme not illustrated; Florida. Lee: Bonita Beach). 16, Wing, dorsal view. 17, Cerci (left side only), epandrium (left side only), surstylus, aedeagus, aedeagal apodeme, and hypandrium, lateral view. 18, Same (hypandrium lacking), posterior view. Scale bar equals 0.2 mm.

Sagamore Beach, 14 Jul 1932 (1 ♀; USNM). *Mississippi. Harrison:* Ship Island (north side; 30°12.6′N, 88°58′W), 27 Jun 1962, D. L. Deonier (1 ♀; USNM). *Jackson:* Horn Island (taken in inter-tidal zone on sand surface; 30°15′N, 88°42′W), 13 Jun 1962, D. L. Deonier (1 ♀; USNM). *New Jersey. Cape May:* Cape May, 6 Jun 1971 (1 ♂; ANSP); Wildwood, 18 Jul–18 Sep 1908, 1920, E. T. Cresson, Jr. (25 ♂, 29 ♀; ANSP). *New York. Weschester:* Oak Island, 31 Jul 1913 (3 ♂, 1 ♀; ANSP). *North Carolina. Onslow:* Ashe Island (emergence trap), 7 Oct 1976, T. D. Edwards (2 ♂; USNM). *Oklahoma. Alfalfa:* Cherokee Salt Plains, 18 Jun 1930, R. D. Bird (3 ♂; USNM); Great Salt Plains (salt marsh), 22 May 1969, W. W. Wirth (6 ♂, 3 ♀; USNM). *South Carolina. Beaufort:* Hilton Head Island (UV light trap), 29 May 1980, P. H. Adler (2 ♂; USNM). *Texas. Brazoria:* Freeport, 9 Mar 1951 (1 ♂; USNM). *Calhoun:* Indianola, 28 Apr–5 Jun 1951, 1953 (4 ♂, 1 ♀; USNM). *Cameron:* Port Isabel, 23 Mar–11 Dec 1910, 1951 (1 ♂, 6 ♀; ANSP, USNM). *Galveston:* Galveston, May–26 Dec 1900, 1917, 1951, J. M. Aldrich, F. H. Snow, M. R. Wheeler (21 ♂, 19 ♀; ANSP, USNM). *Kleberg:* Riviera, 23 Mar 1951 (8 ♂, 4 ♀; USNM). *Nueces:* Corpus Christi, 18 Mar 1908, Jones and Pratt (1 ♂, 3 ♀; USNM). *San Patricio:* Sinton, 23 Mar 1951 (2 ♀; USNM).

Distribution (Fig. 19).—Nearctic: USA (FL, GA, MA, MS, NC, NJ, NY, OK, SC, TX). Neotropical: Bahamas, Belize, Curaçao, Guyana, Mexico (CHI), Panama, West Indies (Anguilla, Cuba, Dominican Republic, Grand Cayman, Jamaica, Puerto Rico).

Natural history.—This species occurs on the bare surface of wet, sandy, maritime beaches, especially in embayments and areas where the beach is somewhat protected from the direct and abrading actions of waves. Although saline habitats are primarily coastal maritime, this species also occurs inland, such as in Oklahoma, where beaches associated with saline environments, usually as saline playas, are also found.

Remarks.—Although we were unable to locate and study the syntypes of the junior synonym, *L. texensis,* we are reasonably confident that the specimens are conspecific with the senior synonym and that the synonymy Aldrich (1905) proposed is correct. All specimens we have examined from Texas, including specimens from coastal sites near Padre Island, the type locality of *L. texensis,* are conspecific. If the syntype is found, the question of conspecificity should be confirmed and a lectotype designated.

Lipochaeta ranica Mathis and Trautwein, new species

(Figs. 20–31)

Lipochaeta slossonae of authors, not Coquillett [misidentification].—Townsend 1898: 168 [abundance on seashore in southern California].—Aldrich 1905: 631 [Nearctic catalog (partim), note on abundance in southern California].—Cole 1912a: 838 [note]; 1912b: 161–162 [list, habitus fig.]; 1923: 478 [list, Loreto, Isla Partida]; 1969: 392, 404 [generic key, discussion].—Wirth and Stone 1956: 465, 470 [generic key, list, California].—Wirth 1965: 751 [Nearctic catalog (partim)]; 1968: 22 [Neotropical catalog (partim)].—Cheng and Lewin 1974: 167–168 [behavior, feeding habits].—Mathis 1995b: 4 [Galápagos Islands].—Zatwarnicki 1992: 112 [figs. of male terminalia].—Mathis and Zatwarnicki 1995: 163 [world catalog (partim)].

Diagnosis.—Moderately small to medium-sized shore flies, body length 2.10–3.80 mm.

Description.—*Head* (Figs. 20–23): In profile appearing projected, longer than high. Mesofrons differentiated as dark brown or dark gray. Setae and setulae generally more conspicuous than *L. slossonae*; length of genal setulae equivalent to length of anepisternal setulae, giving a more setulose appearance.

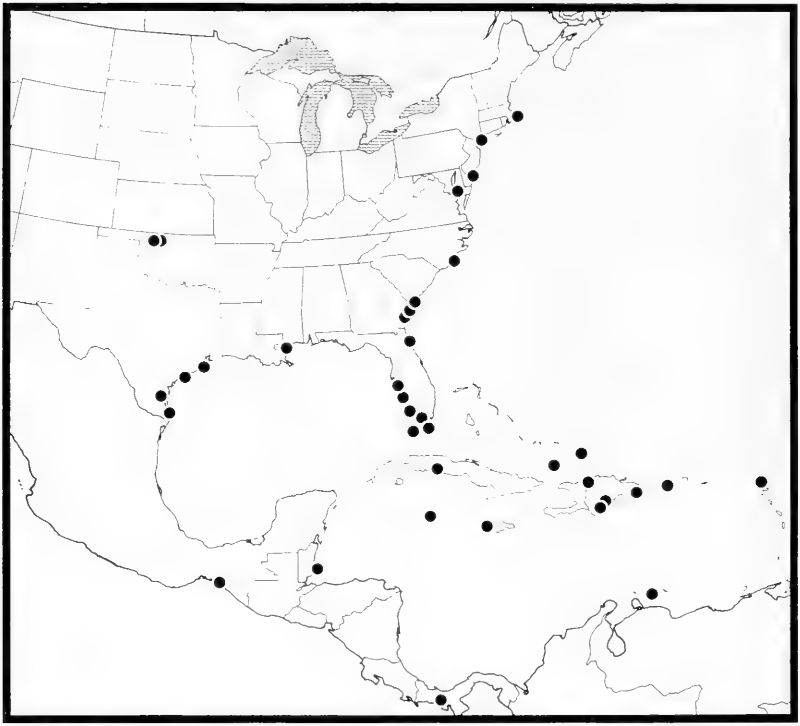


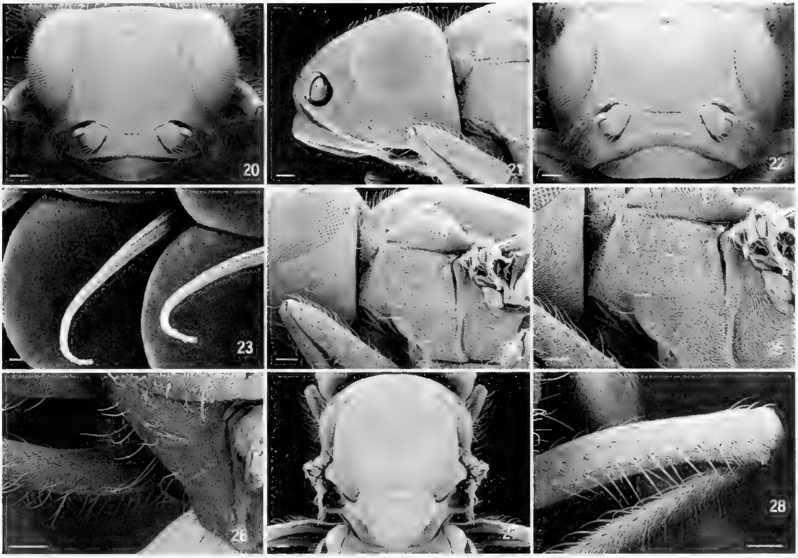
Fig. 19. Distribution map for *Lipochaeta slossonae*.

Thorax (Figs. 24–28): Mesonotum varying from dark brown to dark gray. Anepisternal setae long, setae appearing brushlike; katepisternal seta reduced but other setulae usually evident. Legs, particularly tibiae, bearing long setae, appearing brushlike; apical tarsomere partially to completely darkened.

Abdomen (Figs. 29–30): Surstylus shorter (subequal to height of epandrium), parallel sided to bluntly rounded apex.

Type material.—The holotype ♂ is labeled "CoronaDelMar 29/6/42 [29 Jun 1942] CAL[IFORNIA] AlMelander/AlMelander Collection 1961 [right ⅓ with green stippling]/HOLOTYPE ♂ Lipochaeta ranica W. N. Mathis & Trautwein USNM [red; species name, gender symbol, and "& Trautwein" handwritten]." The holotype is double mounted (minuten in a rectangular card), is in excellent condition, and is deposited in the USNM. Eighty-one paratypes (37 ♂, 44 ♀; USNM) bear the same locality data as the holotype.

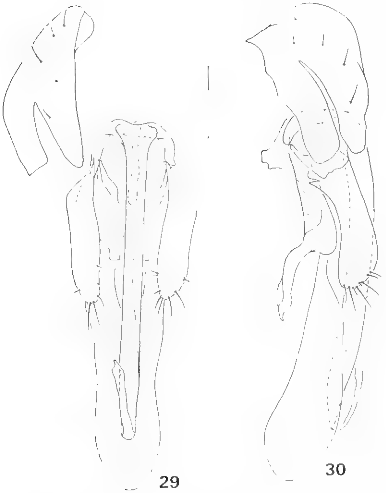
Other specimens examined.—ECUADOR. *Galápagos Islands: Isabela:* Puerto Villamil (littoral, sweeping sand beach), 7 Mar 1989, B. J. Sinclair (5 ♂, 1 ♀; CNC). *Santa Cruz:* Charles Darwin Research Station (littoral, intertidal rocks, beach at high tide line), 17–27 Jan 1989, B. J. Sinclair (10 ♂, 11 ♀; CNC, USNM).



Figs. 20–28. Scanning electron micrographs of *Lipochaeta ranica*. 20, Head, anterodorsal view. 21, Same, lateral view. 22, Same, anterior view. 23, Interfacetal setae, lateroblique view. 24, Left pleural area, lateral view. 25, Left anepisternum, lateral view. 26, Notopleuron and anepisternum, dorsoblique view. 27, Thorax, dorsal view. 28, Left midfemur, anterior view. Scale bar equals 100 µm

MEXICO. *Baja California Norte:* San Felipe, 19 Feb 1954, P. H. Arnaud, Jr. (15 ♂, 7 ♀; USNM); San Felipe (3 mi N), 25 Mar 1964, M. E. Irwin (2 ♂, 2 ♀; USNM); Ensenada, 24 Jun 1950, A. L. Melander (20 ♂, 16 ♀; USNM); San Quintin, 7 May–25 Sept 1925, 1950, H. H. Keifer, R. L. Langston (3 ♂; USNM); Bellandra Bay: Isla Carmen, Gulf of California, 28 Mar 1953, P. H. Arnaud, Jr. (6 ♂, 6 ♀; USNM); Loreto (Baja), 29 Mar–19 May 1921, 1953, P. H. Arnaud, Jr., E. P. Van Duzee (2 ♂, 12 ♀; USNM). *Nayarit:* Agua Verde Bay, 23 Mar 1953, P. H. Arnaud, Jr. (6 ♂, 1 ♀; USNM); San Blas, 2 Apr 1964, E. I. Schlinger (1 ♂; USNM). *Sonora:* Puerto Peñasco, 28 Apr 1948 (1 ♀; USNM).

UNITED STATES. *California. Los Angeles:* Huntington Beach, 7 Oct 1929, L. D. Anderson (1 ♂; USNM); Laguna Beach, 27 Aug 1943, F. R. Cole, A. L. Melander (2 ♂; USNM); Long Beach, 4 Aug–21 Oct 1911, 1935, R. W. Doane, A. L. Melander (17 ♂, 17 ♀; USNM); San Pedro, 8 Jul 1950, T. D. A. Cockerell (2 ♂; ANSP, USNM); Seal Beach, 26 Jul 1942, A. L. Melander (1 ♂; USNM). *Santa Barbara:* Carpinteria, 12–17 Jun 1955, A. L. Melander (6 ♂, 1 ♀; USNM); Santa Barbara, 6 Jul 1917, J. M. Aldrich (1 ♂, 2 ♀; USNM). *San Benito:* Castroville, 19 May 1950, A. H. Sturtevant (11 ♂, 8 ♀; USNM). *San Diego:* La Jolla, 22 Jun–16 Aug 1935, 1950, M. T. James, A. L. Melander (2 ♂; ANSP, USNM); San Diego, 5 Apr–3 Aug 1915, 1917, 1932, J. M. Aldrich, M. Van Duzee (11 ♂, 12 ♀; ANSP, USNM). *San Francisco:* San Francisco Bay (salt marshes), 11 Oct 1906, R. W. Doane (3 ♂, 1 ♀; ANSP). *San Luis Obispo:* Morro Bay, 30 Aug 1945,



Figs. 29–30. Structures of the male terminalia of *Lipochaeta ranica* (ejaculatory apodeme not illustrated; Mexico. Baja California Norte: San Fellipe). 29, Cerci (left side only), epandrium (left side only), surstylus, aedeagus, aedeagal apodeme, and hypandrium, lateral view. 30, Same, posterior view. Scale bar equals 0.2 mm.

A. L. Melander (1 ♂, 1 ♀; USNM). *San Mateo:* San Mateo, 19 May 1950, A. H. Sturtevant (7 ♂, 2 ♀; USNM).

Distribution (Fig. 31).—Nearctic: USA (CA). Neotropical: Ecuador (Galápagos Islands), Mexico (BCN).

Etymology.—The species epithet, *ranica,* is of Latin derivation and refers to the froglike face of this species. Townsend (1898: 169), in referring to the head of *Lipochaeta,* described it as "frog-mouthed" or "frog-faced," and we concur (Fig. 22).

Remarks.—All specimens from California and Baja California Norte (Mexico) that we have examined were previously misidentified as *L. slossonae* and represent this new species (see species synonymy).

Cheng and Lewin (1974) reported on the peculiar "fluidisation" of the substrate as part of the feeding behavior of this species (as *L. slossonae*). From observations in both the field and laboratory, they discovered that this species fluidizes the wet sand on the beach through a shaking motion that apparently loosens the interstitial microflora, which is then imbibed as a kind of soup.

Variation is evident between some populations of this species. Externally, the specimens from the Galápagos Islands are very similar to *L. slossonae,* especially in the length and number of setae and setulae and to a lesser degree in coloration. Structures of the male terminalia indicate that these specimens are *L. ranica,* however.

ACKNOWLEDGMENTS

We gratefully acknowledge the assistance and cooperation of many organizations and individuals who contributed to the field work and production of this paper. To David A. Grimaldi (AMNH), Jon K. Gelhaus and Donald F. Azuma (ANSP), Nigel Wyatt (BMNH), J. Richard Vockeroth (CNC), and their institutions, who loaned specimens, we express our sincere thanks.

The illustrations were carefully inked by Young T. Sohn. Hollis B. Williams provided technical support. Susann Braden and Scott Whittaker assisted with the preparation of the scanning electron micrographs. For reviewing a draft of this paper, we thank Amnon Freidberg, Stephen D. Gaimari, and Tadeusz Zatwarnicki. We are also grateful to David Challinor, former Assistant Secretary for Research, and to Anna K. Bernensmeyer and David L. Pawson, former Associate Directors for Science, National Museum of Natural History, Smithsonian Institution, for financial support to conduct research at The Natural History Museum (BMNH), London, England, through grants from the Research Opportunity Fund. In 1995, 1996, and 1998, field work on the West Indies was funded in large measure by grants from the Biodiversity Program (Biotic Surveys and Inventories, BSI), National Museum of Natural History, Smithsonian Institution (Lynne R.

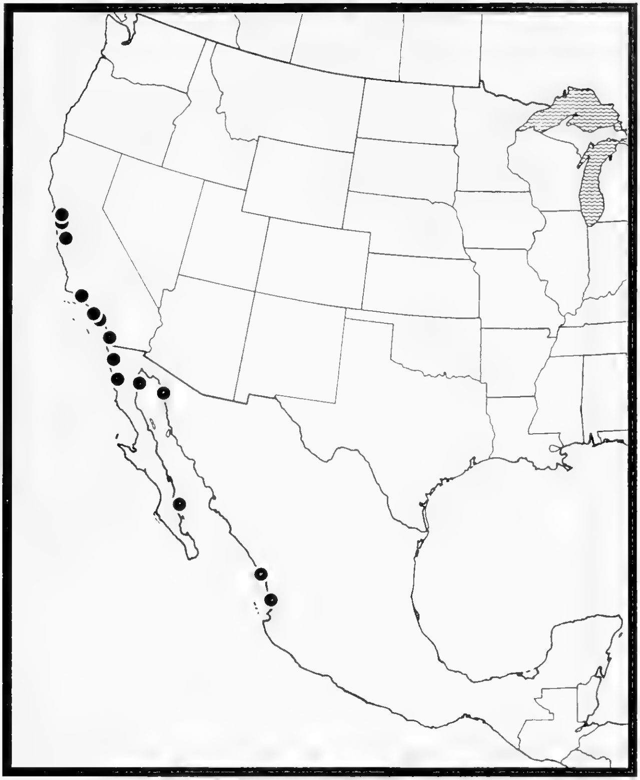


Fig. 31. Distribution map for *Lipochaeta ranica.*

Parenti, former chair, George R. Zug, chair). Field work on the West Indies was greatly expedited through the able and pleasant assistance of N. Dianne Mathis, Hollis B. Williams, Kelvin Guerrero, Daniel E. Pérez-Gelabert, and Oliver S. Flint, Jr. Field work in Guyana was supported by the Smithsonian Institution's Biological Diversity of the Guianas Program (publication number 65; Vicki A. Funk, Director; Carol L. Kelloff, Coordinator).

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PROC. ENTOMOL. SOC. WASH.
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BRUMOIDES SEPTENTRIONIS DAVISI (LENG) (COLEOPTERA: COCCINELLIDAE): DISTRIBUTION, HOST-PLANT ASSOCIATIONS, AND HABITATS OF A SELDOM-COLLECTED LADY BEETLE

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Abstract.—The chilocorine coccinellid *Brumoides septentrionis davisi* (Leng) is an infrequently collected lady beetle whose broad distribution in eastern North America has been mapped; few specific localities, however, have been published. Despite a known association with pines, the *Pinus* species on which it is found have not been recorded. Historical locality data are provided based on specimens in five museum collections, and new records from recent field work are presented. This coccinellid's plant and habitat associations are discussed. Its populations apparently have declined in the Northeast in recent years. Certain scale insects probably serve as prey.

Key Words: *Brumoides septentrionis davisi*, coccinellids, insect distribution, pine barrens

The most frequently encountered of all predacious beetles (Clausen 1940), coccinellids are associated with biological control more than any other group of predators (Obrycki and Kring 1998). Coccidophagous lady beetles have proved more effective as classical biological control agents than those that are aphidophages (Dixon 2000). The establishment, either from biocontrol introductions or accidentally from commerce, of several Old World coccinellids that are generalist aphid predators has led to more stringent regulations for their importation and has prompted interest in native lady beetles whose densities have declined as those of adventive coccinellids have increased (e.g., Schaefer et al. 1987, Wheeler and Hoebeke 1995, Colunga-Garcia and Gage 1998, Cottrell and Yeargan 1998, Obrycki et al. 1998, Evans 2000).

I provide distributional records of the Nearctic *Brumoides septentrionis davisi* (Leng) and notes on its plant associations and habitats to call attention to this infrequently collected lady beetle. I also suggest possible prey associations and a recent decline in its numbers. The availability of this background information might prove useful if studies on the bionomics of this coccinellid are initiated.

Brumoides septentrionis davisi (Leng)

The chilocorine *Brumoides septentrionis davisi* (*sensu* Gordon 1985) is the eastern North American subspecies of *B. septentrionis* (Weise), whose other subspecies are found farther west in Canada (McNamara 1991) and the United States (Gordon 1985). Leng (1908) described the eastern subspecies as *Exochomus* (*Brumus*) *septentrionis* var. *davisi* from Alabama, District of Columbia, "Lake Superior," Massachusetts, Michigan, New Jersey, Pennsylvania, and Virginia; except for Lakehurst, N.J., specific localities were not mentioned. The subgenera of *Exochomus* that Leng (1908) recognized—*Arawana, Brumus,* and *Exochomus*—were later considered valid genera (see Gordon 1985).

Chapin (1965) proposed the new genus *Brumoides,* with the Old World *Coccinella suturalis* Fabricius designated as type, and included both *B. davisi* (Leng) and *B. septentrionis* as valid species. I am retaining the generic name *Brumoides* for *septentrionis davisi,* although Kovář (1995) restricted this genus to the Old World; he did not, however, propose a new generic name to accommodate the New World species.

Brumoides septentrionis davisi is broadly oval, convex, 3.5 to 4.5 mm long, with the upper surface glabrous. The head and pronotum are black and the elytra yellowish brown to red and coarsely punctured. Each elytron typically has two large black discal spots with the sutural area broadly black; the black areas often are confluent. Gordon (1985) illustrated the adult habitus and male and female genitalia.

DISTRIBUTION

Historical (Table 1).—State and provincial records that have been added since Leng's (1908) original description are New York (Leonard 1928), Minnesota and Wisconsin ("Lake Superior" was cited by Leng 1908) (Wingo 1952), South Carolina (Kirk 1970), and Ontario and Quebec (McNamara 1991). In his key to species of *Brumoides,* Gordon (1985) gave the general range of *B. septentrionis davisi* as "eastern United States, New York and New Jersey west to Wisconsin," but under its distribution he stated that the subspecies ranges from "southeastern Canada to Virginia, west to Minnesota." Gordon (1985) did not include Alabama, listed by Leng (1908), in the known distribution. The distribution given by Belicek (1976) for *B. septentrionis* included Illinois and Indiana, and his map appears also to include Tennessee; he did not recognize subspecies, but his records for these three states might apply to *B. septentrionis davisi.* Neither Belicek (1976) nor Gordon (1985) listed locality data for the specimens they examined. Downie and Arnett's (1996) inclusion of Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, Ohio, Pennsylvania, Rhode Island, Vermont, and Virginia in the known distribution apparently is based on their interpretation of the stippled area on Gordon's (1985) map.

New records.—*Brumoides septentrionis davisi* was collected mainly during studies on mirids (Wheeler 1991; A.G.W., unpublished data) and other hemipterans found in northeastern pitch pine-scrub oak barrens (Wheeler 1996, 1999a, b; Wheeler and Wilson 1996). Voucher specimens have been deposited in the Clemson University Arthropod Collection; Pennsylvania Department of Agriculture Collection, Harrisburg (PADA); and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

CONNECTICUT: Hartford Co., Shaker Pines, Enfield, 28 Sept. 1991; Windham Co., Windham Airport, 1 Sept. 1991. MASSACHUSETTS: Barnstable Co., North Falmouth, 29 May 1988; Franklin Co., Montague Sand Plain, 15 June 1991. NEW HAMPSHIRE: Merrimack Co., Concord barrens, 14 Sept. 1991. NEW YORK: Suffolk Co., Yaphank, 29 May 1982; Ulster Co., Sam's Point Dwarf Pine Ridge Preserve NE of Cragsmoor, 1 & 14 June and 29 Sept. 1991. NORTH CAROLINA: Rockingham Co., Rt. 220, 5.6 km S of Virginia state line, 3.3. km NNW of Stoneville, 9 Apr. 1979; Guilford Co., Rt. 68, 6.4 km S of Rt. 421, 5 km SE of Sandy Ridge, 10 April 1983. PENNSYLVANIA: Chester Co., Goat Hill Serpentine Barrens, SW of Nottingham, 8 July 1990; Lancaster Co., New Texas Serpentine Barrens, 7 July 1988; Luzerne Co., Milnesville, 17 Sept. 2001; Schuylkill Co., jct. Rt. 81 & Rt. 61, S of Frackville, 20 June & 6 Oct. 1991. SOUTH CAROLINA: Oconee Co., Rt. 76, 10.5 km NW of Westminster, 11 Nov. 2001. VIRGINIA: Botetourt Co., Eagle Rock, 8 May 1999; Rt. 81 Rest Area, 2.4 km N of jct. Rt. 640, SE of Fincastle, 26 May & 29 July 1978, 23 May 1981, 9 June 1982, 4 Mar. & 8 Apr. 1983; Henry Co., Rt. 220, 4.4 km SW of Ridgeway, 14 Mar. 1982. WEST VIRGINIA: Mercer Co., Rt. 77, 0.6 km N of Bluestone River SE of Camp Creek, 8 May 1999.

Plant Associations and Habitats

Brumoides septentrionis davisi is a conifer inhabitant found almost exclusively on pines. Leng (1908) noted its occurrence on pines [likely pitch pine, *Pinus rigida* Mill.] at Lakehurst, N.J. Few specimens from the localities listed in Table 1 bear host-plant data, but those from Berlin, Framingham, and Sherborn, Mass., are labeled as found on pitch pine. At least historically, pitch pine was present at nearly all the northeastern localities from which this coccinellid is known (e.g., Bromley 1935, Cryan 1985, Motzkin et al. 1999). The specimen from near Gordon, Wisc., was taken on jack pine (*P. banksiana* Lamb.).

The adults that I collected from the New England states, New York, and Pennsylvania were from pitch pine except for a specimen from eastern red-cedar (*Juniperus virginiana* L.) in Lancaster County, Pennsylvania. Specimens from North Carolina, South Carolina, and Virginia were from Virginia pine (*P. virginiana* Mill.); the West Virginia record is based on an adult from table mountain pine (*P. pungens* Lamb.).

In the Northeast, *B. septentrionis davisi* was found in pitch pine-scrub oak barrens and similar communities. It was collected in the dwarf pine plains (ridges) near Lake Maratanza in Ulster County, New York; the Montague Sand Plain in Franklin County, Massachusetts; a pitch pine community in Schuylkill County, Pennsylvania; and remnant pine barrens such as Concord, N.H.; Shaker Pines near Enfield, Conn.; and Yaphank (Long Island), N.Y. It also was found on pitch pine in serpentine barrens in Chester and Lancaster counties, Pennsylvania. In Luzerne County, Pennsylvania, it was found on pitch pine in a ruderal site, a coal spoilbank. Collections from table mountain pine and Virginia pine in North Carolina, South Carolina, Virginia, and West Virginia also did not involve specialized communities but were from disturbed sites, such as roadsides, in the Piedmont and in the Valley and Ridge ecoregions.

Possible Prey Associations

Predation on scale insects is well known among chilocorine coccinellids (e.g., Balduf 1935, Majerus 1994, Hodek and Honěk 1996, Dixon 2000). Within *Brumoides*, the Old World *B. suturalis* preys mainly on armored scales (Diaspididae), mealybugs (Pseudococcidae), and soft scales (Coccidae) (e.g., Gautam 1990, Williams and Greathead 1990, Carnegie 1997, Ponsonby and Copland 1997), with aphids and other insects serving as alternative prey (e.g., Gautam 1990). In addition, Gordon (1985) stated that members of this genus (species unspecified) feed on cochineal or dactylopiid scales (Dactylopiidae) and mealybugs. For *B. septentrionis*, Belicek (1976) reported that the balsam woolly adelgid, *Adelges piceae* Ratzeburg, serves as prey, apparently referring to predation by one of the western subspecies of this lady beetle. No prey records for the easternmost subspecies, *B. septentrionis davisi*, are available, although Leng (1908) noted its occurrence at Lakehurst, N.J., on aphid-infested pines.

No definite prey records were obtained during my field work. Aphids of several genera (mainly *Cinara*) were observed at all sites where the coccinellid was found and might serve at least as alternative prey. All 10 adults of *B. septentrionis davisi* that were observed in Luzerne County, Pennsylvania, in September 2001 were on a single pitch pine growing on a coal spoilbank with 8–10 other pitch pines; the coccinellid was beaten only from branches infested with a pine needle scale, *Chionaspis heterophyllae* Cooley. In Franklin County, Massachusetts, and Schuylkill County, Pennsylvania, this lady beetle also was found on pitch pines that harbored a margarodid scale, *Matsucoccus gallicolus* Morrison. The frequent co-occurrence (ca. 5 additional sites) of the coccinellid with a more or less specialized predator of *Matsucoccus* scales (e.g., Lussier 1965), the anthocorid *Elatophilus inimicus* (Drake and Harris), suggests that *M. gallicolus* also was present at other collection sites for the coccinellid.

DISCUSSION

Brumoides septentrionis davisi is about as large as many of our familiar and well-studied coccinelline lady beetles. Moreover, its coloration—black and yellowish brown to red—is only slightly more subdued than that of our readily recognized reddish, black-spotted coccinellids. Its restriction to pines, a consistent association with specialized communities such as pitch pine-scrub oak barrens, and an apparent absence (northeastern states) on pines in Christmas tree plantations and landscape plantings might partly explain the infrequency of its collection and lack of attention given to its bionomics.

Brumoides septentrionis davisi was collected from New Hampshire to South Carolina at elevations from near sea level on Long Island, New York (17 m), to about 685 m in Ulster County, New York. Adults were found in all months from March to November (range: 4 Mar.–11 Nov.), suggesting that this coccinellid is multivoltine like most other Chilocorini (e.g., Iperti 1999).

In the Northeast, this lady beetle has been collected in several well-known pine barrens, including the New Jersey Pine Barrens and those on Cape Cod, Massachusetts, and Long Island, New York. Despite intensive collecting on pitch pines, it was not observed in New York's Albany Pine Bush or in pine barrens such as Fryeburg, Shapleigh, and Waterboro in Maine and Ossipee in New Hampshire.

In addition to the need for more field work in those northeastern pine barrens in which *B. septentrionis davisi* has yet to be found, the southern extent of its distribution requires greater resolution. Specifically, the Alabama record, listed by Leng (1908) in describing this coccinellid but not mentioned by Gordon (1985), requires verification. It was not found in the survey of the Alabama Coccinellidae by Grimes (1965). Attempts to collect it in Alabama (and Georgia) might focus on pines in upland areas, including the Appalachian Plateau.

The taxonomic status of *B. septentrionis davisi* might also be reevaluated. Gordon (1985) indicated that he was not satisfied with his arrangement of species and subspecies of *Brumoides.* Following Leng's (1908) description of *B. septentrionis* var. *davisi,* Casey (1908) reduced this variety to a synonym of *Brumus septentrionis* Weise. According to Leng (1911), Casey, in reconsidering the status of *davisi,* thought it represented a new species that "should be called *Brumus davisi* Leng." Most subsequent authors also listed *davisi* as a valid species, including Leonard (1928) (as *Exochomus davisi*), Stehr (1930) (as *E. [Brumus] davisi*), Wingo (1952) (as *Brumus davisi*), Chapin (1965) (as *Brumoides davisi*), and Kirk (1970) (as *Brumoides davisi*). Following Gordon's (1985) monographic treatment of North American Coccinellidae, however, subsequent authors (e.g., McNamara 1991, Downie and Arnett 1996) have continued to list *davisi* as a subspecies of *B. septentrionis.*

Another gap in our knowledge of North American *Brumoides* is the lack of larval descriptions. The larval key to genera (and selected species) of Nearctic coccinellids (Rees et al. 1994) excluded this genus because larvae were unavailable for study.

The determination of this chilocorine's trophic habits also is needed. My suggestion that the diaspidid *Chionaspis heterophyllae* serves as acceptable prey is based only on the beating of 10 adults of the lady beetle from scale-infested branches of a pitch pine. The suggestion that *B. septentrionis davisi* might prey on the margarodid scale *Matsucoccus gallicolus* is offered because of the co-occurrence of these species

Table 1. Locality data for *Brumoides septentrionis davisi* from five museum collections and previously published localities (minimum of county level).

Locality	Year of Collection	Museum[a] or Reference
	United States	
District of Columbia		
Washington (Rock Creek)	1901	USNM
Maryland		
Glen Echo	1992	USNM
Massachusetts		
Berkley	1936	MCZ
Berlin	1937	MCZ
Dover	1900	MCZ
Fall River	NA[b]	MCZ
Framingham	1944	MCZ
Marion	1902–1904	MCZ, USNM
Sherborn	1934	MCZ
Springfield	NA	MCZ
Tyngsboro	1893, 1908	MCZ
Michigan		
Whitefish Point	NA	USNM
Minnesota		
Duluth	1918	Stehr 1930
Hubbard County	1929	Stehr 1930
New Hampshire		
Durham	1899	UNH
New Jersey		
Browns Mill	1911	USNM
Clementon	1906	USNM
Jamesburg	NA	Smith 1910
Lakehurst	1903–1943	Leng 1908, Smith 1910; CUIC, USNM
Manchester	NA	USNM
Milltown	NA	Smith 1910
New York		
Keeseville	1952	CNC
Lake Ronkonkoma	1922	CUIC
Melville	1924	CUIC
Mt. Whiteface	1922	USNM
Riverhead	1950, 1953	CUIC
Rockaway Beach	NA	USNM
Southold	1941, 1942	CUIC
Wyandanch	1911	Davis 1911, Leonard 1928; USNM
Yaphank	NA	Davis 1911, Leonard 1928
Pennsylvania		
Hazleton	NA	MCZ
Rhode Island		
Lonsdale	1920	MCZ
Watch Hill	1909	MCZ
South Carolina		
Long Creek	NA	Kirk 1970

Table 1. Continued.

Locality	Year of Collection	Museum[a] or Reference
Virginia		
Mt. Vernon	1911, 1960	CNC, USNM
Wisconsin		
Gordon (4 mi. east)	1952	USNM
	Canada	
Ontario		
Constance Bay	1892	CNC
Sudbury	1932, 1935	CNC

[a] CNC: Canadian National Collection, Ottawa, Ont.; CUIC: Cornell University Insect Collection, Ithaca, N.Y.; MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, Mass.; UNH: University of New Hampshire, Durham; USNM: National Museum of Natural History, Smithsonian Institution, Washington, D.C.
[b] NA = Not Available.

and the known coccidophagous habits of other chilocorine coccinellids. Trophic relationships of a coccinellid species should not be assumed merely from its syntopy with potential prey species, and experimental studies on *B. septentrionis davisi* are needed to identify both its essential and accepted or alternative prey (*sensu* Hodek and Honěk 1996).

Leng (1908) commented on the abundance of the coccinellid at Lakehurst in the New Jersey Pine Barrens. About 75–80% of the specimens in the USNM are from this locale (R.D. Gordon, pers. comm.). I have not found this coccinellid in the New Jersey Pine Barrens during my studies of mirids (Wheeler 1991; A.G.W., unpublished data) and other insects (Wheeler 1996; 1999a, b; Wheeler and Wilson 1996). In the absence of baseline data on population trends of this lady beetle, any evidence pointing to a recent decline in its densities is tenuous. My impression, though, is that it has become increasingly difficult to find in northeastern pine barrens. Since the early 1990s, my attempts to recollect this species have been unsuccessful at several northeastern sites where 10 or more adults had been observed one or more times in 1991. Recent collecting was most intensive at Sam's Point Dwarf Pine Ridge in New York (13 Aug. 2000, 5 Sept. 2001), but also included efforts to recollect *B. septentrionis davisi* in the pitch pine community near Frackville, Pa. (4, 6 Sept. 2001) and the Montague Sand Plain in Massachusetts (15 Aug. 1993, 6 Sept. 2001). In contrast, adults of another conifer-associated lady beetle, the coccinelline *Mulsantina picta* (Randall), were found at these and other sites during the 1990s and in 2000–2001.

The numbers of coccinellid species, especially those in crop fields, can fluctuate widely at a particular site from year to year (e.g., Foott 1974, Elliott and Kieckhefer 1990, Kieckhefer and Elliott 1990). If populations of *B. septentrionis davisi* actually have declined recently in pine barrens, hypotheses to account for its reduced densities might include competition from and intraguild predation by Old World coccinellids that have become established in North America (e.g., Evans 1991, 2000; Elliott et al. 1996; Obrycki et al. 1998). The most abundant and widespread of these adventive species are *Coccinella septempunctata* L. and *Harmonia axyridis* (Pallas). The former coccinelline spread rapidly during the 1980s (e.g., Hoebeke and Wheeler 1980, Schaefer et al. 1987, Staines et al. 1990, Gordon and Vandenberg 1991), whereas the latter species began to assume dominance in some natural and managed systems in the 1990s (e.g., Tedders and Schaefer 1994, Brown and Miller 1998, Colunga-Garcia and Gage 1998, Hesler et al. 2001). Although the establishment of *H. axyridis* in the eastern United States might be the result of an accidental introduction (Day et al. 1994), this predator was intentionally released numerous times between 1916 and 1985, mainly to control arboreal homopteran pests, including margarodid scales (e.g., Gordon 1985, McClure 1987). Adults and larvae of *H. axyridis* were found in the majority of the stands of pitch pine and Virginia pine that I surveyed in the late 1990s and in 2000–2001. Adults of two other adventive coccinellids—*Hippodamia variegata* (Goeze) and *Propylea quatuordecimpunctata* (L.)—were observed less often on pines (A.G.W., unpublished data).

In apple orchards of eastern West Virginia, the Old World *H. axyridis* has become the dominant coccinelline, displacing another Old World species, *C. septempunctata* (Brown and Miller 1998). It is, however, the potential adverse effects of nonindigenous coccinellids on lady beetles (and other insects) native to North America that is a cause of concern (e.g., Ehler 1990, Evans 1991, Horn 1991, Elliott et al. 1993, Wheeler and Hoebeke 1995). A detrimental effect on native coccinellids such as *Adalia bipunctata* (L.), *Coccinella novemnotata* Herbst, *C. transversoguttata richardsoni* Brown, *Cycloneda munda* (Say), and *Hippodamia convergens* Guérin-Méneville already has been suggested (Wheeler and Hoebeke 1995, Elliott et al. 1996, Wheeler and Stoops 1996, Brown and Miller 1998, Colunga-Garcia and Gage 1998). Coccinellids that have more specialized habitat requirements than those associated with agroecosystems might be especially vulnerable to competitive displacement by adventive coccinellids, their numbers perhaps declining more rapidly than those of agriculturally important lady beetles (Elliott et al. 1996). Any long-term monitoring of our native coccinellid fauna, therefore, might include not only species associated with agroecosystems but also those such as *B. septentrionis davisi* that are found in specialized natural communities.

ACKNOWLEDGMENTS

For providing label data from specimens of the coccinellid I am grateful to Edward Becker (CNC), Richard Hoebeke (CUIC), David Furth (MCZ), Donald Chandler (UNH), and Robert Gordon and Natalia Vandenberg (USNM). Natalia Vandenberg additionally called my attention to and provided a copy of the paper by Kovář. My appreciation also is extended to Randall Schuh (American Museum of Natural History, New York) for checking for possible specimens in the AMNH, Cecil Smith (University of Georgia, Athens) for checking for material in the UGA collection, Paul Huth (Mohonk Preserve, New Paltz, N.Y.) for facilitating my access to Sam's Point Dwarf Pine Ridge Preserve, James Stimmel (PADA) for identifying the scale insects, and Peter Adler (Clemson University) for comments that improved the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 59–65

PROBOSCIDOTYLUS NIGROSQUAMIS (MALDONADO) (HETEROPTERA: MIRIDAE: ORTHOTYLINAE): NEW COMBINATION AND FIRST RECORD FOR THE UNITED STATES

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Abstract.—*Parthenicus nigrosquamis* Maldonado, described and previously known only from Puerto Rico, is reported for the first time in the United States from Key West, Florida. Based on head morphology, vestiture, and male genital structures, this species is removed from *Parthenicus* Reuter and transferred to the monotypic genus *Proboscidotylus* Henry (**n. comb.**), previously known only from Mexico. The type species of *Proboscidotylus*, *P. carvalhoi* Henry, and *P. nigrosquamis* are redescribed and their relationships are discussed. Scanning electron micrographs of selected structures, dorsal and lateral photographs, and illustrations of male genitalia for both species are provided to help facilitate recognition.

Key Words: Insecta, Heteroptera, Miridae, Orthotylinae, new combination, descriptions, distribution

While studying material housed in the Florida State Collection of Arthropods in Gainesville, I discovered four specimens of *Parthenicus nigrosquamis* Maldonado from Key West, Florida, that represent a new record for the United States. Maldonado (1969), in describing *P. nigrosquamis* from Puerto Rico based on seven specimens, indicated that this species might not be congeneric with other species of *Parthenicus*, but refrained from erecting a new genus. My study of external characters and male genitalia indicates that *P. nigrosquamis* is congeneric with *Proboscidotylus carvalhoi* Henry described from Veracruz, Mexico (Henry 1995).

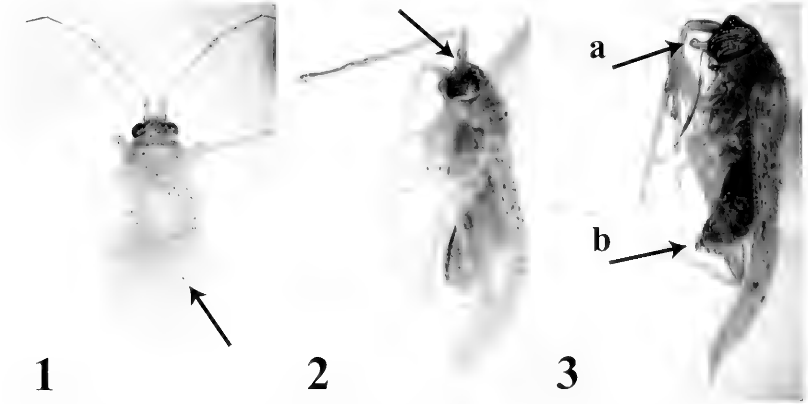
In this paper, I transfer *Parthenicus nigrosquamis* to the genus *Proboscidotylus*, redescribe *P. carvalhoi* and *P. nigrosquamis*, and provide for both species scanning electron micrographs of selected structures, dorsal and lateral photographs, and illustrations of male genitalia. Also given are an identification key, a discussion of relationships, and new records of *P. nigrosquamis* from Puerto Rico and the United States.

Acronyms for collections cited in this paper are as follows: FSCA (Florida State Collection of Arthropods, Florida Department of Agriculture, Gainesville); UNAM (Instituto de Biologia, Universidad Nacional Autónoma de México, Mexico, DF); USNM ([United States] National Museum of Natural History, Smithsonian Institution, Washington, DC).

Proboscidotylus Henry

Proboscidotylus Henry 1995: 340. Type species: *Proboscidotylus carvalhoi* Henry 1995. Original designation.

Diagnosis.—Members of this genus may be separated from all other Orthotylinae by



Figs. 1–3. *Proboscidotylus carvalhoi.* 1, Dorsal aspect, ♀; arrow indicating cuneal patch. 2, Lateral aspect, ♀; arrow indicating swollen frons. 3, Lateral aspect, ♂; arrow a indicating extended tylus; arrow b indicating setigerous tubercle on genital capsule.

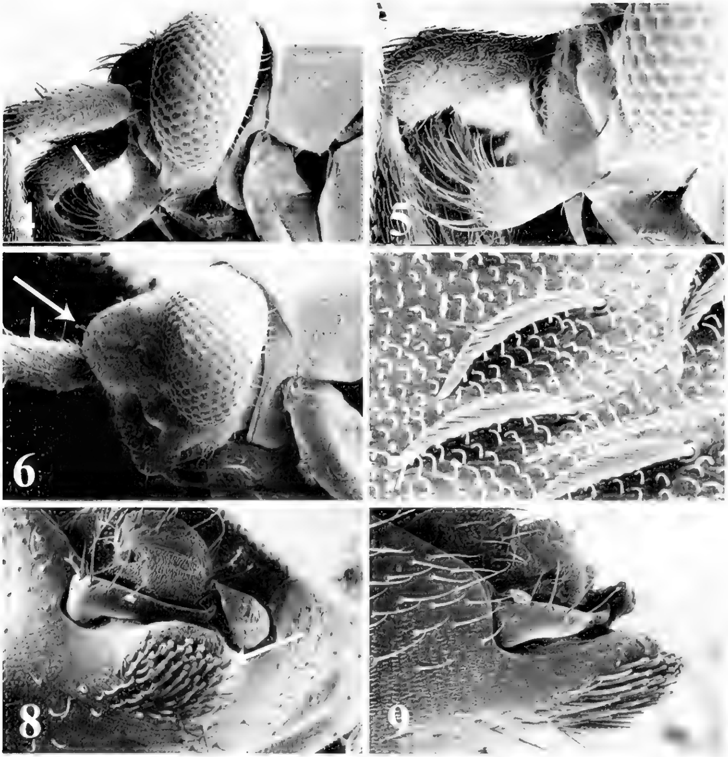
the strongly swollen frons extending well in front of the eyes in both sexes (Figs. 4, 6, 12), particularly in females; prominent tylus, sometimes extended into an elongate tubercle (Figs. 3–5); relatively stout antennal segment I; uniformly cylindrical antennal segment II, sometimes slightly more thickened basally in males; erect simple setae on the dorsum, intermixed with black scalelike setae on the pronotum and hemelytra, with a small, more dense, patch of black scalelike setae on each paracuneus (Figs. 1, 10); and a cluster of stout, apically swollen, bristlelike and, possibly, glandular setae on the ventral surface of the genital capsule (Figs. 8–9, 15–17). Male genitalia: Vesica simple, secondary gonopore typical with indistinct horseshoe-shaped opening, bearing one slender or clavate spiculum (Figs. 19, 22); left paramere L-shaped (Figs. 18, 21); right paramere simple, elongate to elongate oval (Figs. 20, 23).

Discussion.—The relationship of *Proboscidotylus* to other orthotylines is not fully known. Henry (1995) indicated that it belonged in the nominate tribe Orthotylini, somewhere near the *Zanchius* group as defined by Schuh (1974), and noted that only a few other orthotyline genera bear black, scalelike, dorsal setae, including *Brooksetta* Kelton, *Ilnacora* Reuter, *Ilnacorella* Knight, *Macrotyloides* Van Duzee, and *Parthenicus* Reuter. Synapomorphies distinguishing *Proboscidotylus* from these and other orthotylines possessing black, scalelike, dorsal setae are the strongly swollen frons, the uniformly cylindrical second, and the cluster setae on the ventral surface of the male genital capsule.

KEY TO THE SPECIES OF *PROBOSCIDOTYLUS*

1. Length of male 2.68–2.84 mm, female 2.64–3.04 mm; tylus of male extended into an elongate, apically setigerous tubercle (Figs. 3–5); antennal segment II of male and female much longer than the basal width of the pronotum, at least by the dorsal width of an eye; Mexico (Veracruz) . . . . *carvalhoi* Henry

Length of male 2.35–2.55 mm, female 2.40–2.65 mm; tylus of male not extended into an elongate tubercle (Figs. 11–12); antennal segment II of male and female only slightly longer than the basal width of the pronotum, much less than by the dorsal width of an eye; Puerto Rico and United States (Florida) . . . . *nigrosquamis* (Maldonado)



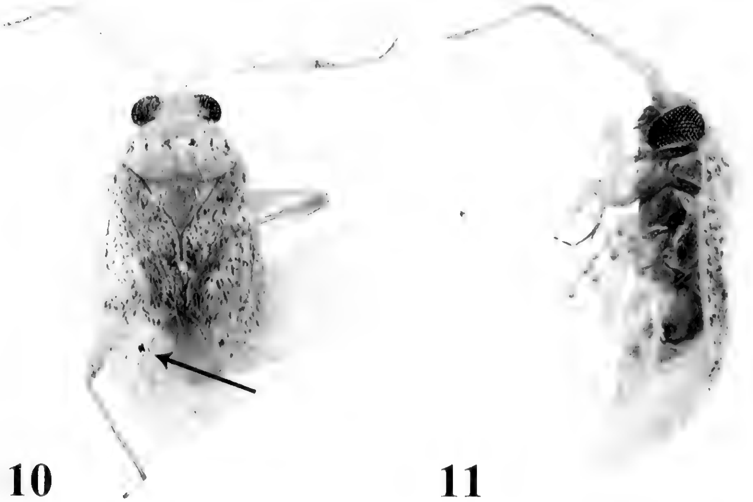
Figs. 4–9. Scanning electron micrographs of *Proboscidotylus carvalhoi* (after Henry 1995). 4, Head, lateral aspect of ♂ (150×); arrow indicating extended tylus. 5, Extended tubercle on tylus of ♂ (260×). 6, Head, lateral aspect of ♀ (151×); arrow indicating swollen frons. 7, Scalelike setae on hemelytra (1,610×). 8, Genital capsule, caudal aspect (426×); arrow indicating setal cluster. 9, Genitala capsule, lateral aspect (447×); arrow indicating setal cluster.

Proboscidotylus carvalhoi Henry
(Figs. 1–9, 18–20)

Proboscidotylus carvalhoi Henry 1995: 344 (n. sp.).

Diagnosis.—Separated from *P. nigrosquamis* by the larger size, more strongly swollen frons, elongate tubercle on the tylus found only in the male, and the proportionately longer second antennal segment.

Description (modified after Henry 1995).—Male (n = 4): Length 2.68–2.84 mm, width 1.20–1.26 mm (widest area across hemelytra). Overall coloration pale brownish yellow. Dorsum clothed with scattered erect, simple setae, intermixed with slender, black, scalelike setae (Fig. 7) on hemelytron and similar scattered scalelike setae on posterior half of pronotum (more dense transverse patches as in *P. nigrosquamis* possibly rubbed away); each paracuneus with a small, dense patch of



Figs. 10–11. *Proboscidotylus nigrosquamis* (♂). 10, Dorsal aspect; arrow indicating cuneal patch. 11, Lateral aspect.

black scalelike setae. *Head:* Width 0.64–0.66 mm, vertex 0.24–0.28 mm; frons strongly swollen (Fig. 4); tylus extended into an elongate, apically setigerous tubercle (Figs. 4–5), length 0.10 mm. *Rostrum:* Length 0.74–0.78 mm, extending nearly to bases of metacoxae. *Antenna:* Segment I, length 0.28–0.30 mm; II, 1.20–1.24 mm; III, 0.56–0.64 mm; IV, 0.34–0.40 mm. *Pronotum:* Length 0.28–0.30 mm, basal width 0.84–0.86 mm. *Genitalia:* Genital capsule (Figs. 8–9); left paramere (Fig. 18); slender vesical spiculum (Fig. 19); right paramere (Fig. 20).

Female (n = 8): Length 2.64–3.04 mm, width 1.24–1.28 mm. *Head:* Width 0.60–0.62 mm, vertex 0.28–0.30 mm. *Rostrum:* Length 0.80–0.86 mm. *Antenna:* Segment I, length 0.30–0.32 mm; II, 1.12–1.20 mm; III, 0.74–0.78 mm; IV, 0.40–0.46 mm. *Pronotum:* 0.28–0.32 mm, basal width 0.84–0.88 mm.

Similar to male in overall coloration and pubescence, but differs by the broader form (Figs. 1–2), more strongly swollen frons (Fig. 6), and tylus lacking an elongate tubercle.

Host.—Unknown.

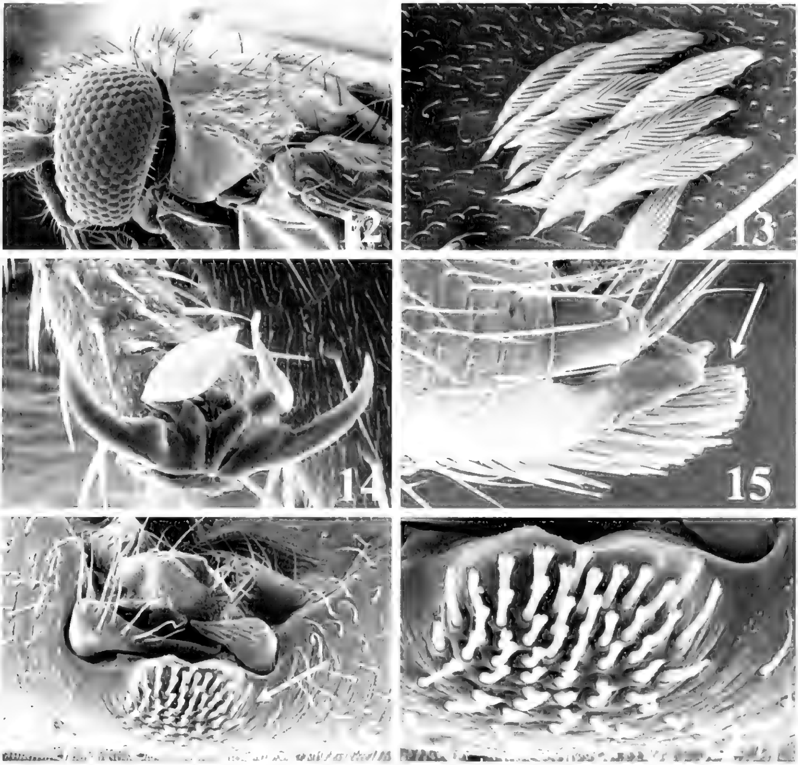
Distribution.—Known only from Veracruz, Mexico.

Specimens examined.—MEXICO: holotype ♂ and 4 ♂, 8 ♀ paratypes, Veracruz, UNAM Los Tuxlas Estac. Biol., N. Catemaco, 16–19 Sept. 1989, E. Barrera, T. J. Henry, & I. M. Kerzhner, taken at light (1 ♂, 3 ♀ UNAM; holotype, 3 ♂, 5 ♀ USNM).

Proboscidotylus nigrosquamis (Maldonado), **new combination**
(Figs. 10–17, 21–23)

Parthenicus nigrosquamis Maldonado 1969: 66 (n. sp.); Schuh 1995: 179 (cat.).

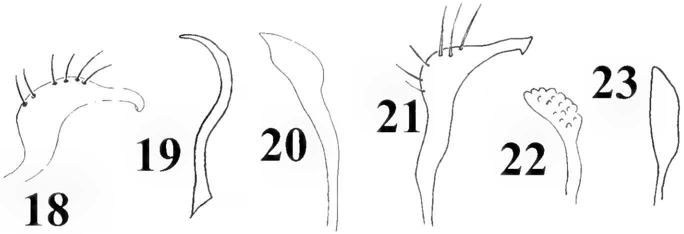
Diagnosis.—Separated from *P. carvalhoi* by the smaller size, less strongly swollen



Figs. 12–17. Scanning electron micrographs of *Probosidotylus nigrosquamis* (♂). 12, Head, lateral aspect (151×). 13, Patch of scalelike setae on cuneus (1,710×). 14, Claw (1,300×). 15, Genital capsule, lateral aspect (895×); arrow indicating setal cluster. 16, Genital capsule, caudal aspect (530×); arrow indicating setal cluster. 17, Highly magnified bristlelike setae on genital capsule (1,270×).

frons, absence of a tubercle on the tylus of the male, and the proportionately shorter antennal II that is only slightly longer than the width of the pronotum by a length much less than the dorsal width of an eye.

Description.—Male (n = 5): Overall coloration uniformly green to yellowish green. Dorsum clothed with scattered erect, simple setae, intermixed with slender, black, scalelike setae (Figs. 10, 13) on hemelytron and posterior half of pronotum; black scalelike setae on pronotum thicker and clustered into 5 or 6 more dense, transverse patches; each paracuneus with a dense patch of black scalelike setae. Length 2.35–2.55 mm, width 1.01–1.09 mm (widest area across hemelytra). *Head:* Width 0.57–0.59 mm, vertex 0.20–0.21 mm; frons swollen, tylus prominent (Fig. 12), but not extended into a long tubercle and without apical cluster of long setae. *Rostrum:* Length 0.74–0.78 mm, extending nearly to bases of metacoxae (extends past metacoxae to base of abdomen in curled or more teneral speci-



Figs. 18–23. Male genitalia of *Proboscidotylus* spp. 18–20, *P. carvalhoi* (after Henry 1995): 18, Left paramere. 19, Vesical spiculum. 20, Right paramere. 21–23, *P. nigrosquamis*: 21, Left paramere. 22, Vesical spiculum. 23, Right paramere.

mens). *Antenna:* Segment I, length 0.20–0.21 mm; II, 0.94–0.96 mm; III, 0.35–0.38 mm; IV, 0.22–0.29 mm. *Pronotum:* Length 0.27–0.29 mm, basal width 0.91–0.82 mm. *Legs:* Slender, concolorous with body; tibial spines pale, indistinct; claws slender, parempodia fleshy, typically convergent apically (Fig. 14). *Genitalia:* Genital capsule (Figs. 15–17); left paramere (Fig. 21); apically clavate vesical spiculum scalloped along dorsal edge (Fig. 22); right paramere (Fig. 23).

Female (n = 5): Length 2.40–2.65 mm, width 1.12–1.14 mm. *Head:* Width 0.52–0.57 mm, vertex 0.26–0.26 mm; frons more strongly swollen than in male. *Rostrum:* Length 0.78–0.79 mm, extending nearly to metacoxae (extending past metacoxae nearly to base of ovipositor in curled or more teneral specimens). *Antenna:* Segment I, length 0.21–0.22 mm; II, 0.85–0.86 mm; III, 0.36–0.40 mm; IV, 0.22–0.26 mm. *Pronotum:* Length 0.23–0.25 mm, basal width 0.79–0.81 mm.

Similar to male in color and pubescence, but differs by the more strongly swollen frons and slightly broader hemelytra.

Host.—Unknown.

Distribution.—Previously known only from Puerto Rico. Now newly recorded from the United States (Florida).

Discussion.—Although this species lacks the extended tylus that is characteristic of *P. carvalhoi* males, it shares all other characters that define the genus, including the swollen frons in both sexes, the stout antennal segment I, the uniformly cylindrical antennal segment II, the black scalelike setae on the dorsum (including the cuneal patch), and the male genital capsule with a field of stout setae on the ventral surface.

Specimens examined.—PUERTO RICO: Holotype ♂, allotype ♀ (and 3 badly damaged paratypes), Mayaguez, Julio 1961, J. Maldonado C. (USNM); 2 ♂, 1 ♀, El Verde, June 1967, J. Maldonado C. (USNM); 2 ♂, Caribbean N. F., El Verde Field Sta., 8–14 May 1985, at UV light, 300 m el., C.U.I.C. 1985 Exp. E. R. Hoebeke, J. K. Liebherr, & S. W. Nichols (USNM; additional material in Cornell University collection); 3 ♂, 5 ♀, El Verde Field Station, 12 June 1990, A. G. Wheeler, Jr., taken at UV light (USNM). UNITED STATES: 3 ♂, 1 ♀, Florida, Monroe Co., Flemming Key [man-made key off north edge of Key West], 23 January 1979, 19 & 21–25 December 1979, 27 January 1980, John A. Acree & H. V. Weems, Jr., insect flight trap (FSCA, 1 ♂ USNM).

ACKNOWLEDGMENTS

I thank Julieta Brambila and Susan Halbert (FSCA) for lending specimens representing the first U.S. record of *P. nigrosquamis,* and A. G. Wheeler, Jr. (Clemson University, Clemson, SC) for the series of this species he collected in Puerto Rico. I also extend thanks to Michele Touchet (Systematic Entomology Laboratory [SEL], ARS, USDA, ℅ USNM) for the adult digital photographs, and to the late Richard C. Froeschner (USNM), David R. Smith (SEL), and E. E. Grissell (SEL) for reviewing the manuscript and offering suggestions for its improvement.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 66–69

PEORIA INSULARIS, A NEW SPECIES OF PEORIINI (LEPIDOPTERA: PYRALIDAE: PHYCITINAE) FROM MISSISSIPPI AND LOUISIANA

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Abstract.—**Peoria insularis** is described from four male specimens as a new species of pyralid moth from Mississippi and Louisiana. It is distinguished as the only North American species of *Peoria* with both a transverse posterior forewing band and prominent white markings on the forewing veins. Photographs of the adult moth and genitalia are included. Range extensions are given for two *Peoria* species. *Peoria floridella* Shaffer, previously known only from the east coast of Florida is recorded from coastal dunes of North Carolina and Alabama, and *P. punctata* Shaffer, described from a single locality in Texas is now recorded from additional localities there and from Louisiana.

Key Words: *Peoria floridella, Peoria punctata*

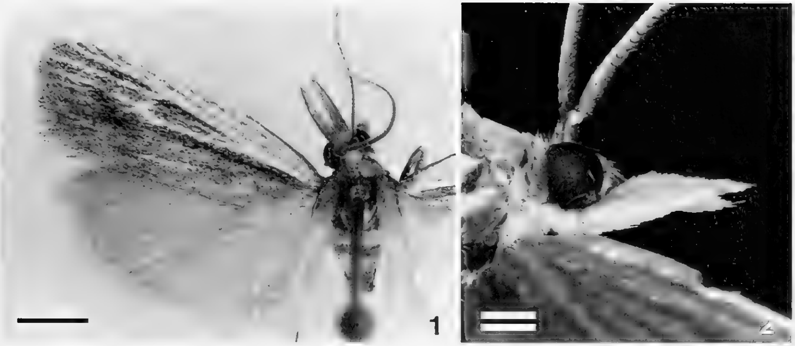
A perusal of an excellent series of specimens of Peoriini from the Mississippi Entomological Museum, Mississippi State University, turned up four specimens of a new species of *Peoria* as well as some noteworthy range extensions for *P. floridella* Shaffer 1968 and *P. punctata* Shaffer 1976.

MATERIALS AND METHODS

Four genitalia slides and one right forewing slide (the right hind wing was missing from the specimen) were prepared from the four specimens. All were mounted in Euparal. Moths and slides were examined using a Wild M5 stereo microscope; slides were also examined at high power with a Nikon L-Ke microscope. Genitalia photographs were taken with an Olympus Vanox AHBT3 microscope. Color names follow the ISCC-NBS Color-Name Charts (Kelly 1965) except for small structures where only general designations could be given. Moths and color samples were viewed together using the Wild microscope and a fluorescent ring light. The holotype is deposited in the National Museum of Natural History, Smithsonian Institution, and the three paratypes are in the collection of the Mississippi Entomological Museum.

Peoria insularis Shaffer, new species
(Figs. 1–5)

Diagnosis.—Among North American species of *Peoria* the presence of a transverse posterior forewing band is possessed only by *P. insularis, P. longipalpella* (Ragonot), and *P. punctata. P. longipalpella* is devoid of the white markings on the forewing veins exhibited by *P. insularis* and in varying degree by several other *Peoria* species. These white vein markings are rather indistinct in *P. punctata,* a species which is unique within *Peoria* in that its uncus arms are of very unequal length, the dorsal arm only about one third as long as the ventral one (see Shaffer, 1976, Fig. 10). The dark central island on the forewing cell (Fig. 1)



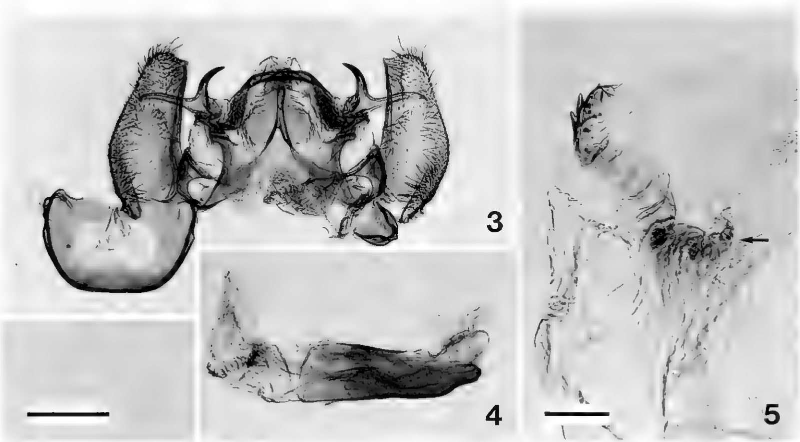
Figs. 1–2. *Peoria insularis*, holotype. 1, Adult showing left wings. 2, Head, right side. Scale bar = 2 mm (1), 1 mm (2).

is unique to *P. insularis*, though it may be difficult to discern in worn specimens.

The genitalia provide no unique apomorphies or combination of characters distinguishing this species. Indeed, most *Peoria* genitalia are rather uniform with the long, slender, digitate medial process of the gnathos being shared with eight other species and the single well developed cornutus with nine other species.

Description.—Male: *Head:* Frons conical, brown dorsally, lighter laterally. Labial palpus (Fig. 2) porrect, 4× as long as eye diameter; basal segment white, second brown on dorsal half, light brown at base and on ventral half, third brown. Maxillary palpus cylindrical, not quite extending to tip of frons. Antenna shaft subserrate, scaling light brown. Ocellus normal, black with clear center. *Forewing* (Fig. 1): Length 8.5–10.0 mm ($\bar{x}$ = 9.25; n = 4). R_2 well stalked with R_{3+5}, from just before upper outer angle; M_1 from the angle; M_{2+3} stalked about half its length, from lower outer angle of cell, well separate from CuA_1. Costa dark brown basally along wing margin, elsewhere white; subcosta and radius broadly white, with narrow bands of yellowish pink between costa and subcosta and between subcosta and radius. Cell broadly outlined with white (on anterior margin, posterior margin, and closing vein) leaving island of brownish gray in center of cell. Subcosta and radial and medial veins beyond cell more narrowly marked by white. Cubital veins beyond cell indistinctly marked with white. Ground rather uniformly brownish gray posterior to cell and CuA_1. 1A+2A indistinctly marked with white. *Hind wing:* M_{2+3} fused, stalked with CuA_1 about half length of latter, from lower outer angle of cell; CuA_2 from very near the angle. *Genitalia* (Figs. 3–5): Medial process of uncus a well sclerotized somewhat narrow band of uniform width, laterally bearing numerous, minute, irregular, rounded protuberances; lateral arms of equal or nearly equal length. Gnathos with long, narrow, digitate median process; lateral arms broad, quite flat. Juxta scoop-like, devoid of setae. Vinculum broadly rounded, somewhat flattened along anterior margin. Valve with costa terminating in small tooth. Aedeagus somewhat irregular; vesica with a small patch of minute triangular teeth; 2 cornuti (Fig. 5), one cornutus distinct, rounded and bearing 3 or 4 somewhat slender teeth, well sclerotized only on side bearing teeth, second cornutus (Fig. 5, arrow) indistinct, variably developed, lacking teeth.

Holotype.—♂: Mississippi, Franklin Co.,



Figs. 3–5. *Peoria insularis*, male genitalia, holotype. 3, Genitalia, aedeagus removed. 4, Aedeagus. 5, Vesica, enlarged and rotated 90° clockwise. Scale bar = 0.5 mm (3, 4), 0.1 mm (5).

Porter Creek, T5N, R4E, Sec. 8 NW, 29 June 1992, T. Schiefer & R. Fontenot; ♂ genitalia on slide 2720 J. C. Shaffer. With the permission of Richard Brown, the holotype is deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Paratypes.—♂, Mississippi, Grenada Co., T22N, R3E, Sec. 31 NW, 7–13 Aug. 1991, R. L. Brown, ♂ genitalia on slide 2732, wing and antenna on slide 2756, J. C. Shaffer; ♂, Louisiana, Bossier Parish, Barksdale A.F.B., 32°30′42″N, 93°32′42″W, 26 June 1996, D. M. Pollock, Blacklight in shortleaf pine forest, ♂ genitalia on slide 2731 J. C. Shaffer; ♂, Barksdale A.F.B., 32°31′13″N, 93°35′46″W, 24 August 1996, D. M. Pollock, Blacklight in calcareous prairie, ♂ genitalia on slide 2730 J. C. Shaffer. All deposited in the Mississippi Entomological Museum, Mississippi State University.

Etymology.—The specific epithet is derived from the Latin *insula* (island) in reference to the isolated dark patch in the forewing cell.

Discussion.—Table 1 (Shaffer 1968, p. 12) compares 12 sets of characters for known North American species of *Peoria*. For *P. insularis* the symbols o, x, x, o, x, x, x, p, x, ss, a, 1 may be added to columns 1 through 12 respectively for that table, updated copies of which are available from the author. *Peoria insularis* brings the total of described North American species of *Peoria* to 16, 13 of which were covered in Shaffer (1968). *Peoria punctata* Shaffer (1976), and *P. padreella* A. Blanchard (1980) were described more recently. In addition, there are 4 known Neotropical *Peoria* species, bringing the grand total of *Peoria* to 20. The genus is limited to the Western Hemisphere.

RANGE EXTENSIONS FOR *PEORIA FLORIDELLA* AND *PEORIA PUNCTATA*

In the Mississippi State material there are ten specimens of *P. floridella*, a species previously known only from the east coast of Florida, ranging from Summer Haven (St. Johns Co.) south to Vero Beach (Indian River Co.). These ten specimens consist of two males from Ft. Macon State Park in North Carolina (Carteret Co.) and eight specimens (2 ♂, 6 ♀) from Bon Secour National Wildlife Refuge (Baldwin Co.) Alabama. The North Carolina locality is on a barrier island (Bogue Bank), the Alabama locality on a coastal peninsula. J.B. Sullivan (personal communication) reports the species as common in the coastal dunes of North Carolina, but apparently absent from similar inland habitats.

Three male specimens of *P. punctata* from the same collection are of interest because the species was previously known from only two specimens, the male holotype from Conroe, Texas (Montgomery Co., collected 13 May 1970), and a second male collected by the author at the Welder Wildlife Refuge near Sinton, Texas (San Patricio Co., 22 May 1977; record not previously published). Of the three Mississippi State specimens, two are also from Texas (13.5 miles east of Seguin, Guadalupe Co.; both 8 May 1993), and the other from Louisiana (6 miles east southeast of Buhler, Calcasieu Par.; 14 June 1993).

ACKNOWLEDGMENTS

I thank Richard Brown of the Mississippi Entomological Museum for calling this material to my attention, arranging the loan, and reviewing a draft of the manuscript. Specimens were collected with grants and contracts to Richard Brown and Terence Schiefer from the National Science Foundation (BSR-9024810), the Mississippi Natural Heritage Program, and The Nature Conservancy, Louisiana Field Office. I am grateful to J. B. Sullivan for providing additional information of *P. floridella*.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 70–72

A NEW *DACTYLOLABIS* OSTEN SACKEN (DIPTERA: TIPULIDAE) FROM NORTH CAROLINA

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Abstract.—The male of ***Dactylolabis* (*D.*) *sohiyi*, new species**, from North Carolina is described and illustrated. It is compared with *D. pemetica* Alexander, the only other American species of *Dactylolabis* with a greatly enlarged stigmal area on the wing.

Key Words: Tipulidae, Limoniinae, *Dactylolabis,* alar stigma

While collecting Tipulidae in western North Carolina in the spring of 1999, one of us (DAR) found an unusually large *Dactylolabis* Osten Sacken with distinctive wings. A search for this remarkable fly in the spring of 2001 yielded no further specimens. We therefore describe it here in the hope that other entomologists in the region will learn more about the species. The description is based on one male, pinned after original preservation in alcohol.

Dactylolabis (*Dactylolabis*) *sohiyi* Byers and Rossman, new species

(Figs. 1–3)

Description.—*Head:* Dorsum gray, pruinose, with short, pale setae; posterior vertex and occiput brown with slight pruinosity; longer, black setae above and behind eyes. Rostrum brown, palps darker brown. Antenna dark brown, with 14 flagellomeres.

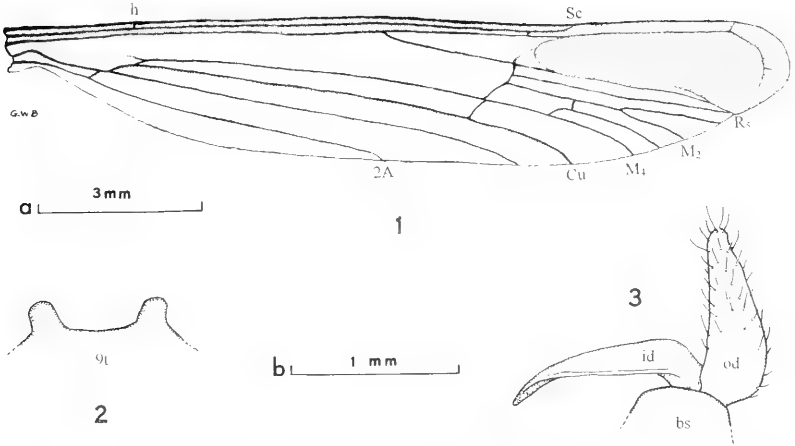
Thorax: Mesonotum dark reddish brown, with weakly defined, broad median stripe of slightly darker brown and diffuse, shorter stripe at each side; posterior scutum and scutellum darker, nearly dull black. Pleural areas and coxae light grayish tan. Halter light tan. Femora yellowish brown near base but mostly brown; tibiae brown; tarsi dark blackish brown.

Wings (Fig. 1): Pale yellowish brown; costal margin slightly undulate; stigma unusually large, light brown, extending from C to R_4 and R_5 and from just beyond fork of Rs to apex of wing; veins C, Sc and R dark brown, membrane along Cu and 2A somewhat lighter brown. Anterior arculus absent but vestige of it present as basal spur off M at level of humeral crossvein.

Abdomen: Most terga grayish brown with narrow, paler posterior borders; sterna light gray. Segments 8 and 9 light brown. Two bluntly rounded projections from posterior edge of tergum 9 (Fig. 2), creating broadly U-shaped median indentation. Outer dististyles (Fig. 3) tapering from base to tip, with numerous setae; inner dististyles smooth, slightly twisted apically, without setae, directed mesad with apices crossing (in preserved specimen).

Measurements: Body length (in fluid) 8.8 mm. Wing length 13.9 mm. Antenna about 2.9 mm. Femora (legs 1–3): 7.6, 7.6 and 8.8 mm. Tibiae: 7.8, 6.9 and 7.3 mm. Tarsi: 6.2, 6.4 and 5.4 mm.

Holotype.—Male collected from rock



Figs. 1–3. *Dactylolabis sohiyi*, male. 1, Wing, showing enlarged stigmal area (coarser shading). 2, Ninth abdominal tergum, dorsal aspect. 3, Apex of left basistyle and dististyles, dorsolateral aspect; bs—basistyle, id—inner dististyle, od—outer dististyle. Scales: a—Fig. 1, b—Figs. 2–3.

wall in Hickory Nut Gorge at Chimney Rock Park, elevation approximately 2,100 feet, Rutherford Co., North Carolina, on 19 April 1999, by D. Rossman. The specimen has had one wing and the terminal abdominal segments dissected off but glued (water-soluble glue) to the cardboard point bearing the rest of the fly. The fore and middle legs are intact; the hind legs are somewhat damaged but also glued to the point. Deposited in the Snow Entomological Division, Natural History Museum, University of Kansas, Lawrence. When captured, the fly was "scuttling up a sheer, dry rock face." At the time *D. sohiyi* was collected, *D. montana* (Osten Sacken) was also present and fairly common, although in more shaded situations at a slightly lower elevation.

Etymology.—The specific epithet, *sohiyi*, comes from the Cherokee and means "place of the hickory nut," a reference to Hickory Nut Gorge, of which the Chimney Rock area forms the southern wall. The name was chosen to honor the indigenous people of the region, for whom the Gorge was important in one of their myths (Rossman 1988).

Discussion.—Of the 19 Nearctic species of *Dactylolabis* named and described previously, 13 are western, one is boreal-arctic, and five occur in eastern North America. In only one of these five, *D. pemetica* Alexander, does the male have the stigmal area of the wings greatly enlarged. The known range of *D. pemetica* extends from Maine southward to North Carolina, where it may overlap the range of *D. sohiyi*. Accordingly, males of these two species may be usefully compared. Most noticeable are differences in the wings: those of *D. sohiyi* are about 46% longer than the greatest recorded length for *D. pemetica* and about 4.8 mm. longer than the body; and the enlarged stigma in the former appears smooth (with very fine hairs barely visible at high magnification) and distinctly darker than the rest of the wing, as contrasted with "hairy" and "faintly darkened" in *D. pemetica*. Sexual dimorphism in the wings is tentatively presumed to occur in *D. sohiyi* as in *D. pemetica* (Alexander 1936: 288, fig. 1). The mesonotum in *D. pemetica* is almost uniformly dark brown, while in *D. sohiyi* it has dark brown stripes on a background of paler reddish brown.

Published illustrations of the ninth abdominal tergum and dististyles (Osten Sacken 1869, Snodgrass 1904) of the male of North American *Dactylolabis* are not very useful for comparison with those of *D. sohiyi.* A species similar to *D. sohiyi* in these structures is the European *D.(D.) transversa* (Savchenko 1989: 70, fig. 1), which has more typical wings. All these illustrations do, however, indicate a setiferous outer dististyle and smooth inner dististyle; and Osten Sacken's figure of *D. cubitalis* (O.S.) shows a ninth tergum quite different from that of *D. sohiyi.* Alexander (1936) for some reason did not mention male genital structures in describing *D. pemetica.*

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 73–79

INVERTEBRATE BIODIVERSITY (ANTS, BEES, AND OTHERS) ASSOCIATED WITH STEM DOMATIA OF THE INDIAN MYRMECOPHYTE *HUMBOLDTIA BRUNONIS* WALLICH (MAGNOLIOPHYTA: FABACEAE)

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Abstract.—The legume tree genus *Humboldtia* Vahl contains three mutualistic, myrmecophytic species. These trees develop inflated, hollow internodes which differentiate a single, self-opening entrance hole for each domicile unit. At leaf flush, hundreds of new, accessible, empty domatia are available to any organism capable of entering and defending the hollow space. In terms of abundance, ants are the primary occupant of the hollow internodes of *H. brunonis* Wallich of India, followed by a bee, *Braunsapis* sp., and several minor inhabitants including an arboreal annelid. *Humboldtia laurifolia* Vahl in Sri Lanka is the closest relative of *H. brunonis,* and we compare and discuss the internode inhabitants of these two geographically separated, but morphologically very similar tree species.

Key Words: *Humboldtia brunonis, Humboldtia laurifolia,* ants, *Braunsapis,* mutualism, India, Sri Lanka

Numerous plants have entered into mutualistic relationships with ants. The plant evolves either, or both, a solid or liquid food supply, and a domicile in the form of leaf pouches, inflated leaf petioles, or a hollow stem, while the ants provide a modicum of anti-herbivore defense. The simplest arrangement is where a plant possesses extrafloral nectaries which are visited by an assortment of ants, wasps, and other invertebrates to obtain nectar from these secretory tissues (Kopter 1991, Rickson and Rickson 1998). In these "open" systems there is usually no dominant ant species and the visiting species assemblage can change over time. Those plants possessing a predictable domatia, or a food source requiring some innate ability to access, often have a particular ant species dominating the plant, although this too can change through time, perhaps through simple competition (Maschwitz et al. 1991), or seemingly at a particular age stature of the plant (McKey 1991). Often those ants which are restricted to a particular plant species tend to be very aggressive toward intruders, and the plants, conversely, can have lower innate chemical defenses (Rehr et al. 1973). The actual success of the protection seems to vary widely from system to system, but where measured, a positive benefit to the plant usually arises from the relationship.

Little information is available on the total complement of organisms living within a plant's domatia, across a series of populations, because the ants dominating the biomass of associated organisms are usually collected and reported as the animal partners involved (Huxley 1978).

In a number of relationships, the ant, often a founding queen, chews a hole into a preformed, hollow domicile. In these situations, there is always an ant present within the chamber, the queen and/or her brood, should another organism seek to occupy the same space. Another group of plants also develops preformed domatia, but the plant provides a self-opening entrance hole to each of the chambers. If there is already an ant colony present on the plant, workers can move eggs or brood into newly available chambers as they become available. Ants are always dominant in these situations. However, in the case of a new leaf flush where each leaf is associated with an adjacent stem domatium having an open entrance hole, there may be a superabundance of open potential nest sites available to any organism capable of accessing the hole first, without any predisposed ability to find a specific location or method of chewing into the plant tissue. In such cases, other organisms may also evolve a predisposition to regularly take up residency in the hollow domatia and either compete with ants for dominance, or coexist.

Humboldtia, with four species in southern India and one species in Sri Lanka, has three species which develop extrafloral nectaries on the leaf blades, leaf stipules, and flower buds, and domatia in the form of inflated, hollow stem internodes (Krombein et al. 1999). Each internodal domatium has a single, consistently placed, self-opening entrance hole. Potential occupants of the hollow internodes do not need any special location or chewing instincts, or special mouth parts, to gain access to the open cavity.

The node between each hollow internode along a branch is solid. This creates a linear series of independent units, each with a preformed access opening. A shoot, which has an average of eight to ten new leaf/internodes associated with each stem flush, produces a similar number of individual, potential nest sites with each leaf flush. An annual production of 20–30 new shoots produces a corresponding 200–300 new potential nest sites, each year, available to any organism capable of accessing the entrance hole and defending the hollow internode space. The ant-associated *Humboldtia* species are gregarious with as many as 100+ individuals growing in close proximity, and so the yearly leaf/domatia production produces a very large number of potential nesting sites within a small area.

Humboldtia laurifolia Vahl, endemic to the southwestern lowland wet zone of Sri Lanka, has been thoroughly sampled and its internode-inhabiting associates enumerated (Krombein et al. 1999). The inhabitants include: 14 species of ants, four wasps, one bee, two dipterans, three coleopterans, a pseudoscorpion, and an annelid. Included in this list are seven undescribed species and a number of first and second order predators and parasites on the various inhabitants. Finally, the cryptic nature of the *Humboldtia* associates can be appreciated by noting that the Smithsonian Institution carried out a Fauna of Ceylon project over 12 years and yet the inhabitants of this common tree largely escaped detection and collection.

Humboldtia brunonis Wallich, is a small, gregarious, understory tree found along the eastern edge of the Western Ghats in southern India from about 13°70′N, 75°00′E to 11°30′N, 76°30′E (Ramesh et al. 1997). This species, along with *H. decurrens* Beddome ex Oliver found in the southwestern part of the Western Ghats, possesses the same extrafloral nectary placement and domicile traits as described for *H. laurifolia* (Krombein et al. 1999).

MATERIALS AND METHODS

Several hundred hollow internodes from random trees of *H. brunonis* growing in the Makut Reserve Forest, Coorg District, Karnataka State, India (12°10′N, 75°50′E) were first collected by KG in 1994, with author KVK making a second collection effort within this population of trees in 1997. The Makut population is a little south of the center of the North-South distribution of the species (Ramesh et al. 1997). The internodes were split open, distribution of the included organisms noted, and samples preserved in 70% alcohol. Only those organisms actually collected from within the hollow internodes, as opposed to specimens found foraging on the tree, were included in this summary.

RESULTS

We present below, in general order of abundance, the invertebrates collected from *Humboldtia brunonis* hollow internodes.

HYMENOPTERA

Formicidae

Krombein collected 100 hollow internodes of which 27 contained ants, while another 38 were empty, 13 contained a common bee *Braunsapis* sp. (see below), and the remaining internodes possessed an assortment of organisms. Eleven ant species were found nesting within the hollow stem internodes. There was no single dominant ant taxon although *Crematogaster* spp. were present in approximately 50% of the ant-occupied internodes, and the three species within that genus contributed approximately equally to that 50%. A surprising finding was the lack of weaver ants, *Oecophylla smaragdina* (F.) associating with *H. brunonis* at Makut. This species is a common visitor to many plant species with extrafloral nectaries, and is found nesting on both *H. laurifolia* in Sri Lanka and *H. vahliana* Wight in south India. Two undescribed species of ants were collected.

The following species were nesting within hollow internodes of *Humboldtia brunonis*. The species are arranged according to Bolton (1995).

Dolichoderinae

- *Tapinoma indicum* Forel
- *Technomyrmex albipes* (F. Smith)
- *Technomyrmex*, prob. n. sp.

Formicinae

- *Camponotus compressus* F.
- *Polyrhachis illaudata* Walker
- *Polyrhachis*, n. sp.

Myrmicinae

- *Crematogaster nilgirica* Emery
- *Crematogaster* prob. *travancorensis* Forel
- *Crematogaster* sp. 1
- *Monomorium* sp.
- *Tetramorium pacificum* Mayr

Anthophoridae

Braunsapis sp., an undescribed bee, was found in 13 internodes out of 100 collected by KVK, and was also common in the KG collections. Both sexes and all stages of development were present. Given that the species has not been collected before, despite being a common associate of the tree, we assume that it does not venture far from the internodes. There was no evidence of the food used by this bee. This species is the same associated with *H. laurifolia* in Sri Lanka, however in Sri Lanka, *Braunsapis* sp. was only found in four internodes out of over 1300 sampled, while two wasps, *Krombeinictus nordenae* Leclercq, and *Crossocerus mukalanae* Leclercq were common. Neither of the wasps however, was collected from *H. brunonis* in India.

Bethylidae

A solitary, small, pale, bethylid pupa was removed from a single internode. These small wasps are parasitoids of Coleoptera and Lepidoptera, but no other organisms were noted in the internode.

COLEOPTERA

Cleridae

Numerous clerid larvae were collected from three internodes. In one, a single late stage predaceous larva was in an internode containing *Braunsapis* eggs. Another larva of the same species was found in an internode with a queen and worker *Crematogaster*, and approximately 30, 2mm long clerid larvae were taken from another internode which lacked other organisms. Clerid larvae were also found associated with *Braunsapis* brood internodes in *H. laurifolia* from Sri Lanka.

Staphylinidae

A staphylinid larva was found in an internode without any evidence of prey, while a second larva was present in an internode which had a silken cap across the cavity above the larva.

Diptera

A dipterous pupa, with black legs, was attached to, and below, a flat closure disk. The cavity had mucus coating the walls. Three puparia of another diptera were removed from internodes, and 20 immature diptera were collected from a KG bulk sample.

Collembola

Collembola were found just within the entrance hole of three unoccupied internodes.

Orthoptera

Two Blattodae oothecae were found within an internode, and several adult cockroaches were found on trees.

OLIGOCHAETA

Megascolecidae

Pale, approximately 2.5 cm long annelids were found in a number of internodes. These appeared similar to the undescribed, immature *Perionyx* sp. collected from *H. laurifolia,* but were adults in *H. brunonis.* This arboreal annelid is interesting in that the posterior one-third is curved and acts as a suction devise while the organism moves leech-like over a surface (Krombein et al. 1999).

ARANEIDA

Salticidae

A small salticid, with some webbing, was removed from one internode.

Chilopoda

A single, small centipede was collected within an otherwise empty internode.

DISCUSSION

The geologic history of India and Sri Lanka is one of intermittent connection by a land bridge, corresponding with various ice age fluctuations in ocean level. Fossil evidence indicates that numerous plant and animal species traveled this bridge, while others did not seem to make the transition, leading to a mixture of species common to both countries and also numerous endemics on the two land masses. The center of origin for *Humboldtia,* based on current species distribution, is within the Indian Western Ghats, but there is no fossil record indicating how far east, towards Sri Lanka, the genus might have once extended. Based on the fossil record, the southern portion of India was more highly forested in the past, and either *H. brunonis,* or some extinct ancestor, could have existed in close proximity to the Indian-Sri Lankan land bridge, making seed dispersal between the two land masses more probable than today. We do not envision a previous presence of other *Humboldtia* spp. on Sri Lanka with an extinction of all taxa except *H. laurifolia.* Likewise, given the wide range of environments presently occupied by *H. laurifolia,* and its current success within those environments, we do not think that this species once existed in India and then become extinct.

Morphologically, and within a taxonomic framework, *H. brunonis* and *H. laurifolia* are the most closely related species within the genus. Additionally, *H. brunonis* is the sole Indian *Humboldtia* species existing on the eastern side of the Western Ghats. Given the previous forestation of southern India, we hypothesize a seed dispersal event from the Indian subcontinent giving rise to what today is *H. laurifolia.*

If *H. brunonis* and *H. laurifolia* originated by speciation after a seed dispersal event, rather than a vicariant separation of existing species, then the present associated invertebrates evolved their association with these *Humboldtia* spp. *in situ,* and the occupants found in the two tree species represent independent adaptations to a very similar domatium morphology and nectary location, on two separate land masses. Today, the two species exist in similar environments of wet evergreen to wet deciduous forests. These similar habitats probably forecast a somewhat similar invertebrate fauna from which the currently associated organisms evolved their relationship.

Of eleven inhabiting ant taxa, there is no dominant species on *H. brunonis. Technomyrmex albipes* is strongly dominant on *H. laurifolia* across habitats, but this ant is only an occasional occupant of *H. brunonis.* Conversely, *Crematogaster* was found nesting on almost every *H. brunonis* tree, comprising approximately 50% of the domatia inhabitants, but this genus was collected from only 13 internodes out of over 1,300 domatia sampled from *H. laurifolia* in Sri Lanka. *Tapinoma indicum* is a minute ant that was found nesting in two internodes on *H. brunonis,* and four domatia of *H. laurifolia.* All colonies were very strong with hundreds of workers and all stages of larvae and pupa in each internode. *Tapinoma indicum* occurs as a minor occupant in several ant plants in the old world and seems to be able to co-exist with a number of ant species, even in an adjacent domatium on *Humboldtia,* but never dominates all the domatia on even a small branch. The two species of *Polyrhachis* which nest within *H. brunonis* internodes contrast with *P. bugnioni,* associated with *H. laurifolia* in Sri Lanka, which binds leaves together to build its nests and so nests externally to the hollow internodes. *Polyrhachis gracilior* Forel binds leaves of *Humboldtia decurrens* in southern India, just as *P. bugnioni* does in Sri Lanka. Thus, *H. brunonis* is distinct from the other two myrmecophytic *Humboldtia* species in having its associated *Polyrhachis* species nesting within the hollow internodes rather than in leaf nests.

The other four ant species collected from *H. brunonis* domatia, *Camponotus compressus* F., *Monomorium* sp., *Tetramorium pacificum* Mayr, and *Technomyrmex* prob. n. sp., were collected from only one to several internodes each. Of these ant species, *T. pacificum* and the *Monomorium* species are identical to those from *H. laurifolia,* whereas *C. compressus* and *Technomyrmex* prob. n. sp. are unique to *H. brunonis* in our collections.

A major difference between *H. brunonis* and *H. laurifolia* is the lack of a wasp species being associated with *H. brunonis,* and a bee, *Braunsapis* sp. taking that place. A survey of the area to determine the availability of small wasps capable of using the internodes for nest sites would be very interesting, and surveys of other populations of *H. brunonis* in different environments may yet find wasps using the internodes. The bee *Braunsapis* sp. which is a minor inhabitant of *H. laurifolia* becomes a major inhabitant of *H. brunonis* possibly because of the absence of a competing wasp species. It is interesting that a bee or wasp is associated in a major way with both myrmecophytic *Humboldtia* species; this is not just an ant-associated tree.

Representatives of the beetle family Cleridae are associated with *Braunsapis,* probably as a brood predator, on both *H. brunonis* and *H. laurifolia.* However, the pseudoscorpion *Haplochernes warburgi,* a common ant predator on *H. laurifolia,* was absent from *H. brunonis.* Another common aggressive predator associated with numerous *H. laurifolia,* internodes, a new Diptera (Keroplatidae) species, *Platyceridion edax* Chandler and Matile, is absent from our *H. brunonis* population. In fact, there seems to be no strong predator present in the Makut population despite a diverse ant fauna as potential prey. Instead, we find the few Cleridae, Staphylinidae, and diptera larvae to be the only possible predators.

Annelids, perhaps the same undescribed,

arboreal *Perionyx* species, are found in both *Humboldtia* species. In both cases the worms are nocturnal or exit the internodes during light daytime rains. We never found the worms associated with another invertebrate within an internode, but see no obvious method used to exclude competitors from the internodal space.

The population of *H. brunonis* sampled for this study did not possess either the species diversity or density of domatia occupancy found in *H. laurifolia*. Of the 100 *H. brunonis* internodes opened by KVK, 62% were occupied. Domatia occupancy on *H. laurifolia* was always above 90% for a given tree, and reached 100% on several bulk samples collected from single trees. We have reported on a single branch diversity of *H. laurifolia,* with 10 adjacent domatia possessing two ant species, *Technomyrmex albipes* and *Cataulacus taprobanae* F. Smith, the dipteran *Platyceridion edax,* and the wasp *Krombeinictus nordenae* Leclercq (Krombein et al. 1999). We did not find such single-branch diversity on *H. brunonis,* rather *Crematogaster* would usually dominate domatia along a branch, with one of the other invertebrates in single, random internodes.

A very preliminary examination of two small populations of *H. decurrens,* the third myrmecophytic species, in the southern Western Ghats of India, revealed three species of ants, *Polyrhachis gracilior* Forel, *Technomyrmex* prob. *brunneus* Forel, and an undescribed species of *Cataulacus.* This very southern species of *Humboldtia,* which prefers wetter habitats than *H. brunonis,* deserves a complete survey of its associated organisms.

It must be pointed out that of the eleven ant taxa collected from *H. brunonis,* a very common and easily accessible plant, two are new species. These discoveries, along with another undescribed ant collected from a small sample of hollow internodes of *H. decurrens* from southern India, and up to 11 new insect species across three Orders from *H. laurifolia* in Sri Lanka, point out how these cryptic plant cavities have never been collected, and how they harbor a unique fauna along with such common species as the ant *Technomyrmex albipes.*

Finally, it must be mentioned how important the genus *Humboldtia* is in harboring a unique series of organisms relating to local biodiversity. *Humboldtia laurifolia* from evergreen wet locations harbors at least 11 undescribed organisms, while a single population of *H. brunonis,* in a dryer environment, produced four undescribed species, and *H. decurrens,* one new species after vary limited collection. The role of *Humboldtia* and its hollow, self-opening internodes in harboring cryptic, rare species may be unparalleled among invertebrate-associated plants in south Asia.

ACKNOWLEDGMENTS

We thank Raghavendra Gadagkar, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India for facilitating the field collecting by KVK. Collectively we thank the following specialists for identification of various Formicidae: Barry Bolton, The Natural History Museum, London; Rudolf J. Kohout, Queensland Museum, Australia (*Polyrhachis*); T. M. Musthak-Ali, Department of Entomology, University of Agricultural Sciences GKVK Campus, Bangalore, India; and Stephen O. Shattuck, Australian National Insect Collection, Canberra.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 80–99

A CHECKLIST OF COMMONLY INTERCEPTED THRIPS (THYSANOPTERA) FROM EUROPE, THE MEDITERRANEAN, AND AFRICA AT U.S. PORTS-OF-ENTRY (1983–1999). PART 1. KEY TO GENERA

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Abstract.—Although there are more than 1,000 described species of thrips from Europe, the Mediterranean region, and Africa, since 1983 only 130 species have been intercepted in cargo and shipments of plants coming into the various ports-of-entry in the United States. Of these, only 23 species consistently made up ca. 85% of the identifiable thrips. This paper is a checklist of thrips commonly intercepted on plants coming into the U.S. from Europe, the Mediterranean region, and Africa; keys with figures are included for the 57 represented genera. It is the first of a five-part series aimed to facilitate identifications by port identifiers at U.S. Department of Agriculture, Animal and Plant Health Inspection Service (USDA, APHIS), ports-of-entry.

Key Words: thrips, pests of flowers, Europe, Africa

Thrips (Thysanoptera) are a group of minute insects usually less than 1.0 mm in length. Most species are fully alate as adults, with 2 pairs of narrow membranous wings having few or no veins but with well developed fringe-like cilia around the margins. The sexes of thrips are similar in most anatomical structures, but parthenogenesis is common among some species, and males are often rare in other species (Stannard 1968).

Metamorphosis is complex, usually with active larval stages (I and II), a propupa and pupa in Terebrantia and propupa, pupa I and pupa II in Tubulifera, followed by the adult stage (upon which this paper is based). Many species feed on plant tissue of many host plants, including agriculturally important fruits and vegetables, and cutflowers imported into this country from abroad. Some species are host specific or feed on a limited variety of closely related plant species; others are polyphagous; some species are predaceous, feeding on mites

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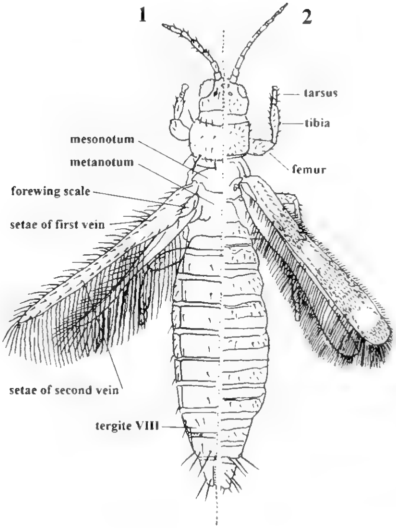
Figs. 1–14. Morphological features of Thysanoptera. 1, Thripidae (*Thrips* sp.), dorsal aspect, showing left half with selected structures. 2, Aeolothripidae (*Stomatothrips* sp.), dorsal aspect, right half. 3, Phlaeothripidae (*Haplothrips* sp.), dorsal aspect, showing right wings only. 4, Head and pronotum of a thrips (*Frankliniella* species), dorsal aspect, showing ocellar setae I, II, and III. 5, *Aeolothrips* pronotum, dorsal aspect. 6, *Melanthrips* pronotum, dorsal aspect. 7, *Retithrips syriacus*, head and pronotum, dorsal aspect. 8, *Aeolothrips* sp., antennal segment III. 9, *Melanthrips* sp., antennal segment III. 10, *Retithrips syriacus*, terminal antennal segments. 11, *Dendrothrips ornatus*, terminal antennal segments. 12, *Heliothrips haemorrhoidalis*, pronotum showing regular sculpturation, dorsal aspect. 13, *Rhipiphorothrips miemsae*, pronotum showing irregular sculpturation, dorsal aspect. 14, *Dendrothrips ornatus*, head and pronotum, dorsal aspect.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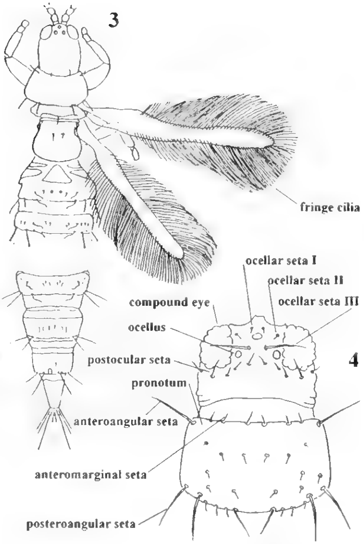
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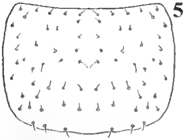
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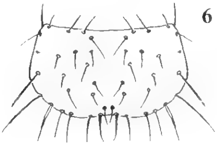
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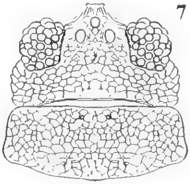
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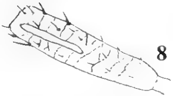
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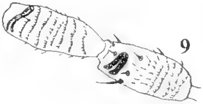
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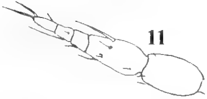
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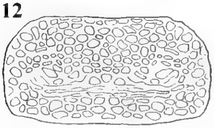
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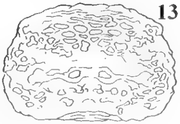
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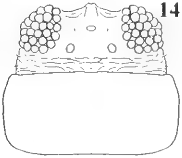
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and small insects or on other thrips (Mound et al. 1976).

Although literature is extensive regarding the biology, systematics, behavior, and pest potential of thrips [e.g., see Kirk (1996), Lewis (1997), and Parker et al. (1991) for reviews with presentations of the literature], there is a need for regional guides to identify species inadvertently transported in international commerce of agricultural and horticultural shipments. This paper is the first of a series of identification guides for the more commonly intercepted thrips from a particular region arriving in ports of the United States and is meant to facilitate identification of those species most frequently found in flowers, fruits, and leaves of a wide range of commodities. It is modeled in part after a similar recently published paper on the identification of larval Pyraloidea (Lepidoptera) intercepted in U.S. ports-of-entry (Solis 1999). It condenses identification keys already in existence on either a worldwide scope (Mound and Kibby 1998) or a more limited regional scope (e.g., parts of Europe only or Africa only) (Dyadechko 1977, Mound et al. 1976, Priesner 1964) to include only the thrips most likely to be encountered in commerce from Europe/Mediterranean Region/Africa. It also makes use of information derived from generic revisions—e.g., *Odontothrips* (Pitkin 1972), *Thrips* (Nakahara 1994), *Frankliniella* (Moulton 1948), *Anaphothrips, Ceratothrips*, and *Tenothrips* (Bhatti 1967, 1973, 1978, 1990)—or of information derived from species lists (e.g., Nakahara 1997, 1999) and catalogs (Jacot-Guillarmod 1970–1977). Obviously, many genera and species have been excluded from this treatment, but conversely, it is unlikely that those species would be received in produce and other commerce that routinely enters the United States. This paper is based on the adult female sex only, partly because males are seldom encountered in the small sampling procedures used by port inspectors and partly because for many species—even some economically important ones—males have not been described or adequately treated. Because life stages of many species have not been fully studied, immature stages also are excluded from this paper, although keys to immature stages are available for selected species, some of which are included herein (Nakahara and Vierbergen 1998).

This paper (Part 1) is the first of a 5-part series directed at identifying thrips from Europe/Mediterranean region/Africa commonly intercepted by USDA/APHIS port identifiers. It is intended to provide an overview of the diversity of thrips entering this country and to indicate the frequency that each species was encountered over a 17-year period from 1983–2000. Clearly, some species commonly are encountered, while others are rare. In order to sort out this diversity, a key to 57 represented genera is included, along with figures (both line drawings and scanning electron micrographs) to facilitate identifications to genus level.

Parts 2 and 3 will treat those species comprising a significant proportion of the intercepted fauna, i.e., thripine species sharing the character of the presence of ctenidia on tergite VIII: part 2 will cover *Frankliniella* and related genera (16 species) and part 3, the genus *Thrips* (23 spp.). Part 4 will treat the 52 remaining species of Thripidae (6 spp. in 5 genera of Panchaetothripinae and 46 spp. in 33 genera of Thripinae). Part 5 will deal with Aeolothripidae (15 spp. in 3 genera) and Phlaeothripidae (21 spp. in 5 genera).

Sources of quarantine interceptions include commercial shipments, inspections of passenger baggage, aircraft or ship quarters, stores, galleys, and mail. In fact, most interceptions are from aircraft quarters. Notwithstanding, nearly 1,000 samples are annually sent the Systematic Entomology Laboratory, USDA, for urgent identification of unknown thrips samples representing species that cannot be reliably identified at ports-of-entry and which require immediate identification for action at the ports.

Table 1. Species of thrips intercepted at ports of entry (Numbers represent accumulated interceptions over the period 1983–1999). Ranges of species in Europe, the Mediterranean, and Africa are indicated with an "x." Establishment or occurrence of any of these species in the United States also is indicated by an "x" under U.S.

		Eur	Med	Afr	U.S
AEOLOTHRIPIDAE					
Aeolothrips Haliday 1836					
brevicornis Bagnall 1915	2			x	
bucheti Bagnall 1934	4			x	
collaris Priesner 1919	5	x	x	x	x
deserticola Priesner 1929	4		x	x	
ericae Bagnall 1920	3	x	x		
fasciatus (Linnaeus 1758)	1	x	x	x	x
intermedius Bagnall 1934	13	x			
linarius Priesner 1948	1		x		
meridionalis Priesner 1948	1	x	x	x	
scabiosatibia Moulton 1930	7			x	
tenuicornis Bagnall 1926	1	x			
undetermined species	31				
Franklinothrips Back 1912					
vespiformis (Crawford 1909)	1	[x]			x
Melanthrips Haliday 1836					
fuscus (Sutzer 1776)	11	x	x	x	
gracilicornis Maltbaek 1931	4	x	x	x	
pallidior Priesner 1919	2	x	x	x	
undetermined species	6				
THRIPIDAE					
Anaphothrips Uzel 1895					
articulosus Priesner 1925	1	?			
obscurus (Müller) 1776	14	x		x	x
sudanensis Trybom 1911	1		x	x	
Apterothrips Bagnall 1908					
apteris Daniel 1904	1				x
secticornis (Trybom 1896)	1	x			x
Aptinothrips Haliday 1836					
rufus (Goeze 1776)	1	x	x	x	x
stylifer Trybom 1894	1	x			x
Ceratothripoides Bagnall 1918					
brunneus Bagnall 1918	7			x	
Ceratothrips Hood 1919					
ericae (Haliday 1836)	7	x			
Chaetanaphothrips Priesner 1957					
undetermined species	4				
Chirothrips Haliday 1836					
aculeatus Bagnall 1927	2	x			x
manicatus (Haliday 1836)	6	x	?		x
meridionalis Bagnall 1927	1	x	x	x	
mexicanus Crawford 1909	1			x	x
Dendrothripoides Bagnall 1923					
innoxius Karny 1914	1			x	x
venustus Faure 1941	1			x	
undetermined species	1				

Table 1. Continued.

		Eur.	Med.	Afr.	U.S
Dendrothrips Uzel 1895					
degeeri Uzel 1895	2	x			
ornatus (Jablonowski 1894)	5	x			x
saltator Uzel 1895	2	x			
undetermined species	1				
Dichromothrips Priesner 1932					
corbetti (Priesner 1936)	1	[?]			x
undetermined species	1				
Drepanothrips Uzel 1895					
reuteri Uzel 1895	4	x			x
Echinothrips Moulton 1911					
americanus Morgan 1913	1	x			x
Frankliniella Karny 1910					
fusca (Hinds 1902)	7	x			x
intonsa (Trybom 1895)	94	x	x		
occidentalis (Pergande 1895)	448	x	x	x	x
pallida (Uzel 1895)	1	x			
schultzei (Trybom 1910)	55	x	x	x	
tenuicornis (Uzel 1895)	136	x	x		x
tritici (Fitch 1855)	3				x
undetermined species	72				
Glaucothrips Karny 1921					
glaucus (Bagnall 1914)	5			x	
Heliothrips Haliday 1836					
haemorrhoidalis (Bouché 1838)	5	x	x	x	x
Hercinothrips Bagnall 1932					
bicinctus (Bagnall 1919)	1			x	
dimidiatus Hood 1937	1			x	
Iridothrips Priesner 1940					
iridis (Watson 1924)	2	x			x
Leucothrips Reuter 1904					
undetermined species	1				
Limothrips Haliday 1836					
cerealium (Haliday 1836)	18	x	x	x	x
denticornis (Haliday 1836)	9	x			x
undetermined species	1				
Megalurothrips Bagnall 1915					
sjöstedti (Trybom 1910)	5			x	
undetermined species	1				
Microcephalothrips Bagnall 1926					
abdominalis (Crawford 1910)	5			x	x
Mycterothrips Trybom 1910					
consociatus (Targioni-Tozzetti 1887)	2	x			
latus (Bagnall 1912)	7	x			
undetermined species	1				
Neohydatothrips John 1929					
samayunkur (Kudo 1995)	13		x	x	
undetermined species	2				

Table 1. Continued.

		Eur.	Med	Afr.	U.S.
Odontothrips Amyot & Serville 1843					
karnyi Priesner 1924	132	x	x	x	
undetermined species	2				
Oxythrips Uzel 1895					
nobilis Bagnall 1927	1	x			
undetermined species	1				
Palmiothrips zur Strassen 1965					
annulicornis zur Strassen 1965	1	x			
Parthenothrips Uzel 1895					
dracaenae (Heeger 1854)	3	x		x	x
Prosopothrips Uzel 1895					
nigriceps Bagnall 1927	1	x	x		
Retithrips Marchal 1910					
syriacus (Mayet 1890)	2		x	x	x
Rhipiphorothrips Morgan 1913					
miemsae Jacot-Guillarmod 1937	2			x	
Scirtothrips Shull 1909					
aurantii Faure 1929	5			x	
dorsalis Hood 1919	3			x	
inermis Priesner 1933	1	x			x
undetermined species	3				
Scolothrips Hinds 1902					
longicornis Priesner 1926	1	x			
Selenothrips Karny 1911					
rubrocinctus (Giard 1901)	1			x	x
Synaptothrips Trybom 1910					
africanus (Moulton 1936)	1			x	
distinctus (Bagnall 1915)	9			x	
gezinae (Faure 1938)	6			x	
undetermined species	7				
Taeniothrips Amyot & Serville 1845					
inconsequens (Uzel 1895)	3	x			x
Tameothrips Bhatii 1978					
tamicola (Bagnall 1914)	1	x			
Tenothrips Bhatti 1967					
discolor (Karny 1907)	9	?	x		
frici (Uzel 1895)	4		x		
undetermined species	5	x			
Thrips Linnaeus 1758					
acaciae Trybom 1910	2			x	
angusticeps Uzel 1895	24	x	x	x	
italicus (Karny 1907)	24	[x]			
atratus (Haliday 1836)	52	x	x		x
australis (Bagnall 1915)	10	x	x	x	x
brevicornis Priesner 1920	3	x			
flavus Shrank 1776	28	x			
fulvipes Bagnall 1923	6	x			
fuscipennis Haliday 1836	200	x			x

Table 1. Continued.

		Eur	Med	Afr	U.S.
trehernei Priesner 1937	1	?			
italicus (Bagnall 1926)	30	x			
major Uzel 1895	178	x	x	x	
mareoticus (Priesner 1932)	1	x			
meridionalis (Priesner 1926)	23	x	x	x	
microchaetus Karny 1920	1			x	
minutissimus Linnaeus 1758	7	x	x		
nigropilosus Uzel 1895	9	x	?	x	x
palmi Karny 1925	11			x	x
physapus Linnaeus 1758	1	x			
pillichi Priesner 1924	1	x			
simplex (Morison 1930)	26	x	x	x	x
spadix Hood 1932	1			x	
tabaci Lindeman 1889	474	x	x	x	x
tenellus Trybom 1912	1			x	
urticae Fabricius 1781	3	x			
vulgatissimus (Haliday 1836)	98	x			x
undetermined species	37				
PHLAEOTHRIPIDAE					
Aleurodothrips Franklin 1909					
fasciapennis (Franklin 1908)	1	x			x
Bolothrips Priesner 1926					
cingulatus (Karny 1916)	1			x	
Elaphrothrips Buffa 1909					
undetermined species	2				
Eparsothrips zur Strassen 1968					
varicornis (Bagnall 1919)	4			x	
Gynaikothrips Zimmermann 1900					
ficorum (Marchal 1908)	1			x	x
Haplothrips Amyot & Serville 1843					
aculeatus Fabricius 1803	4	x		x	
articulosus Bagnall 1926	3			x	
cerealis Priesner 1939	1		x		
clarisetis Priesner 1930	2			x	
distinguendus Uzel 1895	2	x	x		
fulginosus Schille 1912	1	x			
gowdeyi (Franklin 1908)	65	x	x	x	x
nigricornis Bagnall 1910	12			x	
reuteri (Karny 1907)	4	x			
setiger Priesner 1921	1	x			
subtillissimus (Haliday 1836)	2	x			
undetermined species	23				
Hoplandrothrips Hood 1912					
ellisi Bagnall 1914	1	x			
flavipes Bagnall 1923	2			x	x
undetermined species	1				
Karnyothrips Watson 1924					
flavipes (Jones 1912)	2	x	x		x
melaleucus (Bagnall 1911)	1	?			x
undetermined species	2				

Table 2. Complete list of species of thrips intercepted from commerce from Europe and Africa at U.S. ports of entry, 1994–1999 (species in bold font represent most frequently intercepted species, tabulated in Table 3).

- Phlaeothripidae
  - *Haplothrips articulosus* Bagnall 1895?
  - *Haplothrips fuliginosus* Schille 1912
  - ***Haplothrips gowdeyi* (Franklin 1908)**
  - ***Haplothrips nigricornis* Priesner 1910**
  - *Hoplandothrips* sp.
- Aeolothripidae
  - *Aeolothrips brevicornis* Bagnall 1915
  - ***Aeolothrips collaris* Priesner 1919**
  - ***Aeolothrips deserticola* Priesner 1929**
  - *Aeolothrips intermedius* Bagnall 1934
  - *Aeolothrips tenuicornis* Bagnall 1926
  - *Franklinothrips* sp.
  - ***Melanthrips fuscus* (Sulze 1776)**
- Thripidae
  - *Anaphothrips obscurus* Müller 1776
  - *Anaphothrips sudanensis* Trybom 1911
  - *Chirothrips manicatus* (Haliday 1836)
  - *Chirothrips meridionalis* Bagnall 1927
  - ***Dendrothrips ornatus* (Jablonowski 1894)**
  - ***Frankliniella intonsa* (Trybom 1895)**
  - ***Frankliniella occidentalis* (Pergande 1895)**
  - ***Frankliniella schultzei* (Trybom 1910)**
  - ***Frankliniella tenuicornis* (Uzel 1895)**
  - ***Limothrips cerealium* (Haliday 1836)**
  - ***Limothrips denticornis* (Haliday 1836)**
  - ***Neohydatothrips samayunkur* (Kudo 1995)**
  - *Odontothrips karnyi* Priesner 1924
  - *Oxythrips* sp.
  - *Parthenothrips dracaenae* (Heeger 1854)
  - *Taeniothrips inconsequens* (Uzel 1895)
  - *Tenothrips discolor* (Karny 1907)
  - ***Thrips atratus* (Haliday 1836)**
  - ***Thrips australis* (Bagnall 1915)**
  - *Thrips brevicornis* Priesner 1920
  - ***Thrips flavus* (Schrank 1776)**
  - ***Thrips fuscipennis* Haliday 1836**
  - *Thrips italicus* (Bagnall 1926)
  - ***Thrips major* Uzel 1895**
  - ***Thrips meridionalis* (Priesner 1926)**
  - ***Thrips nigropilosus* Uzel 1895**
  - *Thrips physapus* Linnaeus 1758
  - ***Thrips simplex* (Morison 1930)**
  - ***Thrips tabaci* Lindeman 1889**
  - *Thrips trehernei* Priesner 1927
  - ***Thrips vulgatissimus* (Haliday 1836)**

It is an economically expensive proposition to protect U.S. agriculture and horticulture. This protection requires time invested in identifying specimens at each port, sending suspect specimens to taxonomic specialists connected with the Systematic Entomology Laboratory for final identifications, and actions taken once identifications are made to resolve issues involving the entry status of infested shipments. When completed, these papers should provide identifiers and others with a powerful resource for identifying potential European, Mediterranean, and African thrips pests regularly threatening U.S. agriculture and horticulture.

MATERIALS AND METHODS

Two databases of thrips identifications, available to me at the Systematic Entomology Laboratory, were used to determine the species that were intercepted in shipments from European, Near East, and African countries. The first included species intercepted between 1983 and 1993 (Table 1), and the second for species intercepted from 1994 to 1999 (Table 2). Both databases included information concerning the country of origin, the plant host on which the specimen was found, and the identification of the thrips taxon. Records of interceptions originating from The Netherlands are often deceiving, since The Netherlands is host to the international market wherein cut flowers from all parts of the world are auctioned. The Netherlands Plant Protection Service has a staff at the flower market and auction in Alrsmeer. Although cut flowers are inspected entering The Netherlands and other EU countries, consignments transshipped to the U.S. and other countries are usually not inspected, and many thrips are transported with their hosts in cargos. The first database (containing a total of 2,437 interceptions) (Table 1) and the second database (of 497 specimens) (Table 2) provided the basis for this study.

These databases do not include thrips that were intercepted and identified by

Table 3. Most frequently intercepted thrips from Europe and Africa 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.

Species	Rank	Number of Interceptions	% of Total (n = 497)	Cumulative Percent
Thrips tabaci	1	81	20.0	20.0
Frankliniella occidentalis	2	59	14.6	34.6
Thrips fuscipennis	3	41	10.1	44.7
Thrips major	4	32	7.9	52.6
Thrips vulgatissimus	5	22	5.4	58.0
Odontothrips karnyi	6	18	4.5	62.2
Frankliniella intonsa	7	15	3.7	65.9
Haplothrips gowdeyi	8	11	2.7	68.6
Frankliniella tenuicornis	9	10	2.4	71.0
Frankliniella schultzei	10	7	1.7	72.7
Melanthrips fuscus	11	6	1.4	74.1
Thrips meridionalis	12	5	1.2	75.3
Thrips flavus	13	5	1.2	76.5
Limothrips cerealium	14	5	1.2	77.7
Thrips atratus	15	4	0.9	78.6
Haplothrips nigricornis	16	4	0.9	79.5
Aeolothrips collaris	17	3	0.7	79.3
Thrips simplex	18	3	0.7	80.0
Thrips nigropilosus	19	2	0.5	80.5
Neohydatothrips samayunkur	20	2	0.5	81.0
Limothrips denticornis	21	2	0.5	81.5
Aeolothrips deserticola	22	2	0.5	82.0
Thrips australis	23	2	0.5	82.5
Dendrothrips ornatus	24	2	0.5	83.0

APHIS port identifiers. Ports with air flights from Europe and Africa, such as JFKIA (John F. Kennedy International Airport), O'Hare, Atlanta, Houston, Los Angeles, and Seattle, have identifiers with authority to make identifications of some commonly intercepted species without verification from the SEL specialist, and these are not included in this paper. Also, since 1996, routine identifications made by the APHIS/PPQ thrips specialist (Susan Broda) are also excluded. The problem with inclusion of data from APHIS/PPQ is that these data only include information on species that are not already established in the U.S. Thus, the numerous identifications of *Frankliniella occidentalis* and *Thrips tabaci* are not included. Since port identifiers need to identify all species taken at U.S. ports, I decided to use the more complete SEL data. If APHIS/PPQ identifications had been included, the numbers in Tables 2 and 3 would have been skewed toward species that do not occur in the U.S., but it would not have changed the composition of the species list.

In a review of historical records kept by APHIS/PPQ from 1923 to 1984, I noted two trends. (1) Early records are scant. At this time very few records existed of commercial shipments of flowers. Most interceptions were from passenger baggage. These records always were of species found in the top 10 in Table 2, with the exception of *Frankliniella occidentalis* Pergande. This is a U.S. species that has been transported in commerce to other parts of the world in the late 20th century and has become established in Europe and Africa (as well as other parts of the world). It is now one of the most commonly intercepted species (see Tables 2–3). (2) Because of changes in commercial trade, some species that previously were not (or only rarely) intercepted are now more frequently encountered. For example, *Thrips palmi* Karny, a tropical Asian species, became established in Africa and the Western Hemisphere, and more recently has become established in the U.S. (in Florida and Hawaii). After evaluating species interceptions enumerated in the two databases, I determined that at least 25 species should be added to the list of most commonly intercepted thrips, most of them in the genera *Thrips* and *Haplothrips*. One species becoming increasingly common in interceptions is *Neohydatothrips samayunkur* (Kudo), which was established recently in Kenya. Two other recently established species—*Pezothrips kellyanus* (Bagnall) in the Mediterranean region and *Echinothrips americanus* Morgan in greenhouses—are dispersing and may become commonly intercepted in the near future.

Morphological terminology follows Mound et al. (1976) and Nakahara (1994). Morphological features most often used in the keys include the following (Figs. 1–4):

Anteroangular setae (Fig. 4): one pair of elongated setae situated on anterolateral corners of pronotum.

Anteromarginal setae: one pair of elongated setae situated submedially on anterior margin of pronotum.

Basantra: paired praepectal plates on prothoracic sternum of species of Phlaeothripidae.

Crespeda (Figs. 19–20): usually overlapping, scalloped scales or transverse plate on posterior margins of abdominal tergites.

Ctenidia (Figs. 54, 56): comblike row of short microtrichia on distal margins of a lateral stria on tergite VIII either anterior or posterior of spiracles, also present (and usually somewhat less conspicuous) or absent on tergites IV–VII.

Fringe cilia (Figs. 1–3): elongated gracile hairlike setae arranged uniformly around costal, apical, and posterior margins of fore- and often hindwings.

Metafurca (= metasternal furca = metathoracic furca) (see Figs. 15–16): forked endosternal process formed from the inflection of the sternum, and with or without a median anteriorly directed process.

Microtrichia: usually well defined short hairlike structure on body, antennae, and wings; those on posterior margin of tergite VIII being particularly useful in species (and sometimes generic) identification.

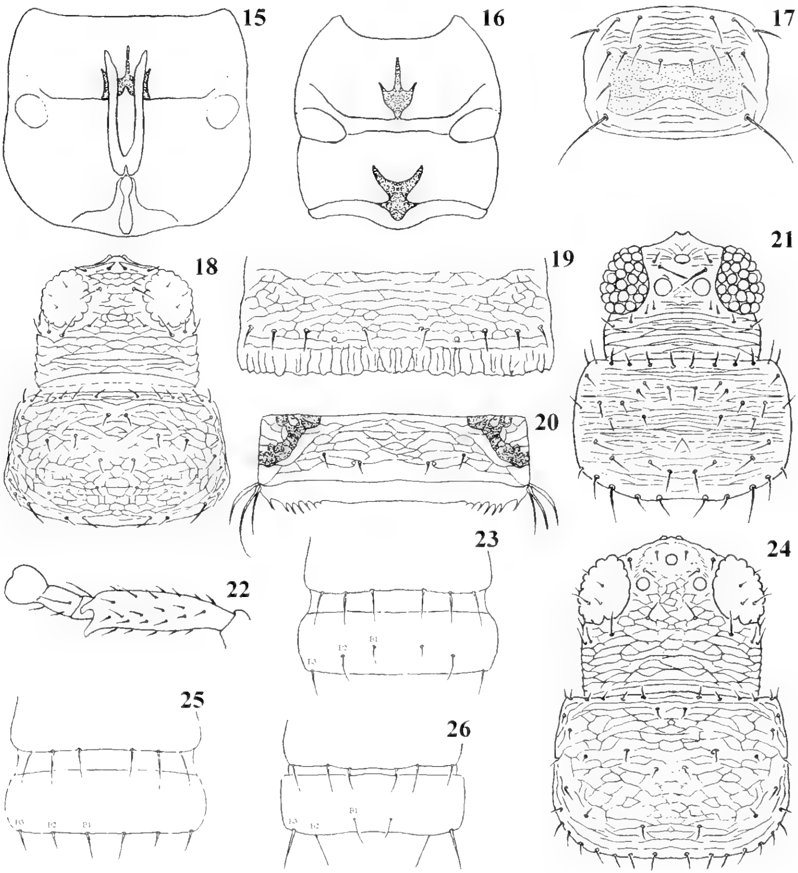
Ocellar setae I, II, III (Fig. 4): pairs of elongated setae situated near ocellar triangle as follows: I, located anterior to fore ocellus; II, located anterolaterad of fore ocellus, and III (or interocellar setae), located usually in triangle formed by ocelli, occasionally laterad of fore ocellus or between hind ocelli.

Postocular setae (Fig. 4): 4–6 pairs of setae located on head in a curved row behind compound eyes or occasionally submedially in posterior part of head.

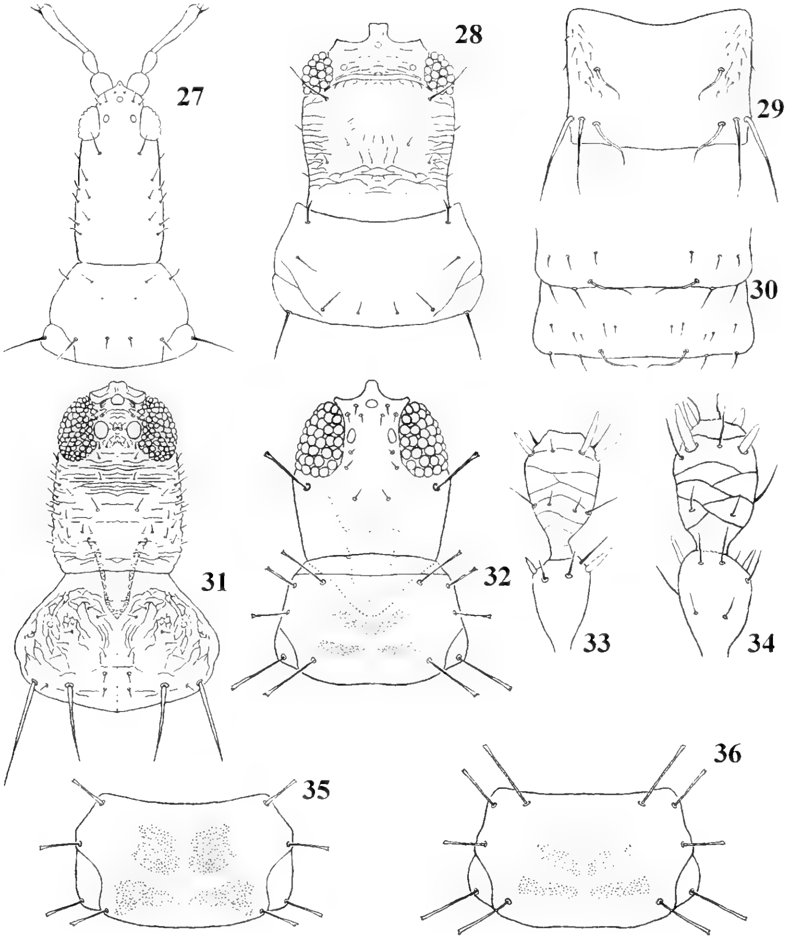
Posteroangular setae (Fig. 4): 1–2 pairs of elongated setae located on or near posterolateral corners of pronotum.

Posteromarginal setae (Fig. 4): setae located on posterior margin of pronotum, usually between posteroangular setae. When setae on posteroangles are not developed, they are also defined as posteromarginal setae.

Specimens used in scanning electron micrographs (SEMs) 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 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 paper points attached to SEM stubs and photomicrographed in a scanning electron microscope. Images were digitally captured and transferred to Adobe Photoshop



Figs. 15–26. Morphological features of Thysanoptera, continued. 15, *Dendrothrips ornatus,* metafurca (lyre-shaped). 16, *Limothrips cerealium,* metafurca (U-shaped). 17, *Neohydatothrips* sp., pronotum, dorsal aspect. 18, *Apterothrips secticornis,* pronotum, showing wider than long. 19, *Apterothrips secticornis,* abdominal tergites, showing crespeda. 20, *Chaetanaphothrips* tergite VIII, showing glandular area, posteromarginal craspedia, posteromarginal microtrichia, and posterolateral margins. 21, *Dichromothrips corbetti,* head and pronotum, showing 2 pairs of ocellar setae. 22, *Odontothrips karnyi,* foretibia (showing 1 or 2 clawlike processes. 23, *Ceratothripoides brunneus,* sternite VIII. 24, *Anaphothrips obscurus,* head and pronotum, showing 3 pairs of ocellar setae. 25, *Ceratothrips ericae,* sternite VII. 26, *Megalurothrips sjöstedti,* sternite VII.



Figs. 27–36. Morphological features of Thysanoptera, continued. 27, *Elaphrothrips* sp., head and thorax. 28, *Bolothrips* sp., head and pronotum. 29, *Elaphrothrips* sp., showing 2 pairs of wing-retaining setae on tergites. 30, *Bolothrips* sp., showing 1 pair of setae. 31, *Gynaikothrips* sp., showing absence of maxillary bridge. 32, *Haplothrips* sp., showing presence of maxillary bridge. 33, *Karnyothrips* sp., antennal segment IV. 34, *Haplothrips* sp., antennal segment IV. 35, *Karnyothrips* sp., basantra. 36, *Haplothrips* sp., basantra.

5.0© for MacIntosh, where they were edited for publication quality.

Line drawings 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.

RESULTS

The 1983–93 database was evaluated to determine the range of species being intercepted from Africa, the Mediterranean Region, and Europe over a ten-year period (Table 1). A total of 2,437 interceptions included 51 genera and 129 identified species distributed among three of the families of thrips: Aeolothripidae, Thripidae, and Phlaeothripidae. In addition, 206 specimens were identified only to genus. Species listed in Table 1 and occurring in the U.S. are also indicated.

The second database (1994–1999) was used to evaluate recent trends in the transport of thrips in commerce from Africa and Europe (Table 2). This database was used to evaluate the most common thrips intercepted in agricultural and horticultural shipments since 1994. In this sample, 497 interceptions were represented by 43 identified species in 18 genera distributed among Aeolothripidae, Thripidae, and Phlaeothripidae. An additional 67 specimens were identified to genus only. From among the 43 species intercepted between 1994 and 1999, 23 represented nearly 85% of the total number of interceptions (Table 3) and comprised 9 genera. From the list of thrips in Table 1, an illustrated key to nearly all of the represented genera is herein provided.

KEY TO PERTINENT FAMILIES OF THYSANOPTERA

(Merothripidae and Heterothripidae are omitted because they lack representation in the database sample.)

1. Forewing with veins, surface with microtrichia; terminal abdominal segment normally not tubular; ovipositor present 2
– Forewing without veins (Fig. 40), surface without microtrichia; terminal abdominal segment tubular (Fig. 41); ovipositor absent . . . . Phlaeothripidae
2. Antenna 9-segmented; segments III and IV with sensoria on surface of segment, either elongate and longitudinally oriented along axis of segment or transversely or diagonally oriented, nearly encircling segment near distal apex; forewing relatively broad with rounded apex and several crossveins . . . . Aeolothripidae
– Antenna 6- to 9-segmented, segments III–IV with sense cones conical, setiform, or forked; forewing narrow with conical apex and one crossvein . . . . Thripidae

KEY TO GENERA

Phlaeothripidae

1. Maxillary stylets broad, band-like, more than 5 μm broad (Idolothripinae, a subfamily of no quarantine importance but sometimes encountered) 2
– Maxillary stylets narrow, less than 2–3 μm broad (Phlaeothripinae) 3
2. Abdominal tergites with at least two pairs of wing-retaining setae (Fig. 29); head elongated, strongly produced forward of eyes (Fig. 27); ocellar setae long . . . . *Elaphrothrips*
– Abdominal tergites with only one pair of wing-retaining setae (Fig. 30); head not produced forward of eyes (Fig. 28); ocellar setae short or absent . . . . *Bolothrips*
3. Abdominal tergites with one pair of wing-retaining setae in macropterous forms; forewings cross-banded, without accessory cilia; abdominal pelta divided into 3 parts; pronotum without epimeral sutures . . . . *Aleurodothrips*
– Abdominal tergites with two pairs of wing-retaining setae in macropterous forms; forewings not banded, with or without shaded areas, with or without accessory cilia; abdominal pelta undivided, consisting of a single plate; pronotum with epimeral sutures (Fig. 32) 4
4. Maxillary stylets with a bridge (Fig. 32); basantra present; forewing medially constricted 5
– Maxillary stylets without a bridge (Fig. 31); basantra absent; forewings parallel-sided 6

5. Antennal segment IV usually with 2–3 (occasionally 4) sense cones (Fig. 33); foretarsus usually with an inner apical curved tooth; abdominal tube with terminal setae 1.5–2.0× length of tube ..... *Karnyothrips*
– Antennal segment IV with 4 sense cones (Fig. 34); foretarsus with or without a tooth on inner margin behind apex; abdominal tube with terminal setae shorter than or only slightly longer than length of tube ..... *Haplothrips*
6. Maxillary stylets wide apart (Fig. 31); pronotum strongly sculptured, consisting of a swirled pattern; metanotum reticulated ..... *Gynaikothrips*
Maxillary stylets nearly touching; pronotum weakly sculptured; metanotum without strong sculpture ..... *Hoplothrips*

Aeolothripidae

1. Antennal segments long and narrow, III 10–15 times longer than wide; abdomen constricted at base, more or less vespiform ..... *Franklinothrips*
Antennal segments only moderately longer than wide, III only 3–6 times longer than wide; abdomen not constricted at base 2
2. Antennal segment III with sensoria elongated and longitudinally oriented (Fig. 8); pronotum with numerous small setae evenly distributed, elongated marginal setae absent (Fig. 5) ..... *Aeolothrips*
– Segment III with sensoria transverse and diagonally oriented (Fig. 9); pronotum with elongated setae on margins, longest on both anterolateral and posterolateral corners (Fig. 6) ..... *Melanthrips*

Thripidae

1. Terminal antennal segment greatly elongated (Fig. 10); head, pronotum, and legs usually with well-developed striated or reticulated sculpturation (Fig. 7) (Panchaetothripinae) 2
– Terminal antennal segment not greatly elongated (Fig. 11); head, pronotum, and legs usually not strongly sculptured (Fig. 12) (Thripinae) 7
2. Anterior margin of forewing interrupted by 2–5 swellings or callosities, without fringe cilia ..... *Retithrips*
– Anterior margin of forewing entire, not interrupted by swellings or callosities; fringe cilia present or absent 3
3. Antenna 7-segmented; forewing surface finely reticulated, with dark bands and patches ..... *Parthenothrips*
– Antenna 8-segmented; forewing surface not reticulated, with or without color patterns 4
4. Antennal segments III and IV with forked sense cones; forewing with long setae and cilia along entire anterior margin; veinal setae long; wavy cilia on posterior margin 5
– Antennal segments III and IV with simple sense cones; forewing without costal setae; veinal setae short, with or without small cilia along distal half of anterior margin; cilia on posterior margin straight 6
5. Tarsi 2-segmented (Fig. 39); pronotum reticulate (Fig. 40); abdominal tergite X deeply medially split ..... *Hercinothrips*
Tarsi 1-segmented; pronotum transversely striate; abdominal tergite X entire, without medial split ..... *Selenothrips*
6. Head without a prominent dorsal constriction or ridge behind eyes (Fig. 41); surface of head and pronotum sculptured with well developed regular polygonal reticules (Figs. 12, 41); anterior margin of forewing with fringe cilia on distal half (Fig. 42) ..... *Heliothrips*
Head with a prominent dorsal ridge behind eyes; surface of head and pronotum with irregular sculpturation (Fig. 13); anterior margin of forewing lacking fringe cilia ..... *Rhipiphorothrips*
7. Metafurca lyre-shaped, greatly enlarged (Fig. 15); forewing with anterior margin acutely curved to meet straight posterior margin; median tergal setae closer to each other than to lateral setae 8
- Metafurca U-shaped (Fig. 16); forewing with apex conical or pointed; median tergal setae usually widely separated from each other 9
8. Antenna 8- or 9-segmented; lateral surface of abdominal tergites irregularly reticulated; apex of antennae blunt; anterior row of cilia on forewing arising submarginally ..... *Dendrothrips*
– Antenna 7-segmented; lateral surface of abdominal tergites smooth; apex of antenna pointed; cilia on anterior margin of forewing arising at margin ..... *Leucothrips*
9. Antenna 6-segmented 10
Antenna 7 or 8-segmented 11
10. Macropterous; median tergal setae widely separated by a distance ≥ length of seta ..... *Drepanothrips*
Apterous; median tergal setae narrowly separated by a distance < length of seta ..... *Aptinothrips* (in part)
11. Lateral surfaces of abdominal tergites with many microtrichia (Fig. 44) 12
Lateral surfaces of abdominal tergites bare or with only a few scattered rows of minute microtrichia 15

12\. Microtrichia on lateral surface of abdominal tergites spinelike, each arising at apex of broad triangulate or dentiform base . . . . *Dendrothripoides*

– Microtrichia on lateral surface of abdominal tergites fine, hairlike, lacking expanded bases (Fig. 44) 14

13\. Antennal segments III and IV with simple sense cones; surface of head and pronotum distinctly reticulated (Figs. 49–50) . . . . *Echinothrips*

Antennal segments III and IV with forked sense cones; surface of head and pronotum striated or variously reticulated 15

14\. Forewing with complete row of setae on forevein; abdominal sternite VII with 3 pairs of setae anterior of hind margin; antennal segment VI with base of sense cone elongate, at least 0.3× length of segment; posterior half of pronotum usually with a median, broad blotch outlined by apodeme (Fig. 17), with sculpturation usually differing from anterior half of pronotum (Fig. 43) . . . . *Neohydatothrips*

– Forewing with an intermittent row of setae on forevein; abdominal sternite VII with 2 pairs of setae anterior of hind margin; antennal segment VI with base of sense cone circular in cross-section, < 0.3× length of segment; posterior half of pronotum lacking such an apodeme . . . . *Scirtothrips*

15\. Brachypterous or apterous species 16

Macropterous species 19

16\. Pronotum without posteroangular setae (Fig. 18); antennal segments III and IV with simple sense cones 17

– Pronotum with 1 or 2 pairs of posteroangular setae; antennal segments III and IV with either simple or forked sense cones 18

17\. Abdominal tergites and sternites with posteromarginal crespeda (Fig. 19); head wider than long (Fig. 18) . . . . *Apterothrips*

Abdominal tergites and sternites without crespeda; head longer than wide . . . . *Aptinothrips* (in part)

18\. Pronotum trapezoidal, distinctly narrowing anteriorly (Fig. 48); antennal segment II usually angulated anterolaterally; antennal segment III with simple sense cones; tergite VIII lacking ctenidia (Figs. 39–40) . . . . *Chirothrips* (in part)

– Pronotum rectangulate or subquadrate; antennal segment II not angulate anterolaterally; antennal segment III with forked sense cones; tergite VIII with ctenidia (Fig. 54) . . . . *Frankliniella* spp. (in part)

19\. Pronotum trapezoidal, distinctly narrowing anteriorly (Fig. 48); antennal segment II usually angulated anterolaterally . . . . *Chirothrips* (in part)

– Pronotum rectangulate or subquadrate; antennal segment II usually not distinctly angulate anterolaterally 20

20\. Abdominal tergite X with a pair of sharp stout spines; head produced anterior of eyes (Fig. 45); pronotum with 1 pair of posteroangular setae (Fig. 46) . . . . *Limothrips*

– Tergite X without sharp stout spines; other characters variable 21

21\. Abdominal tergite VIII (and often V, VI, and VII) with a pair of well-developed ctenidia (Figs. 54, 56) 22

Abdominal tergite VIII without ctenidia but sometimes with irregular microtrichia 24

22\. Ctenidia on tergite VIII situated anterolaterad of spiracle (Fig. 54); head with 3 pairs of ocellar setae (Figs. 4, 53); pronotum with 2 pairs of long posteroangular setae, 1 pair of long anteroangular setae, 1 pair of long anteromarginal setae (Fig. 54); forewing with setae on both forevein and hindvein in complete rows . . . . *Frankliniella* (in part)

– Ctenidia on tergite VIII situated posteromediad of spiracle (Fig. 56); head with 2 pairs of ocellar setae (Fig. 55); pronotum with 2 pairs of posteroangular setae, but no long anteroangular setae or anteromarginal setae 23

23\. Pronotum with 3–4 pairs of posteromarginal setae and 2 pairs of long posteroangular setae; posteromarginal crespeda absent on abdominal tergites II–VII (Fig. 56) . . . . *Thrips*

– Pronotum with 5–6 pairs of posteromarginal setae and 2 pairs of short posteroangular setae (Fig. 36); dentate posteromarginal crespeda present on abdominal tergites II–VII . . . . *Microcephalothrips*

24\. Abdominal segment VIII with glandular area surrounding spiracle and extending medioanteriorly to anterior margin of tergite VIII (Fig. 20); posterolateral margins of tergites II–VII posteriorly with crespeda . . . . *Chaetanaphothrips*

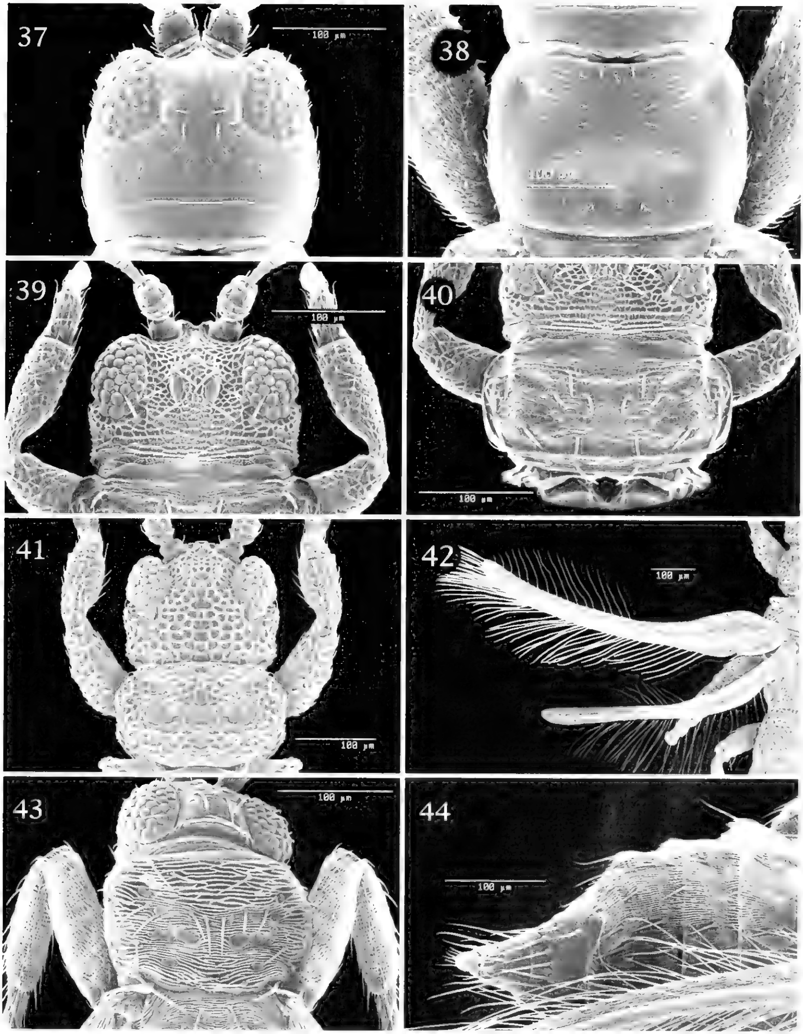
– Abdominal segment VIII lacking glandular area; posterolateral margins of tergites II–VII lacking crespeda 25

25\. Pronotum with 6 pairs of elongate setae . . . . *Scolothrips*

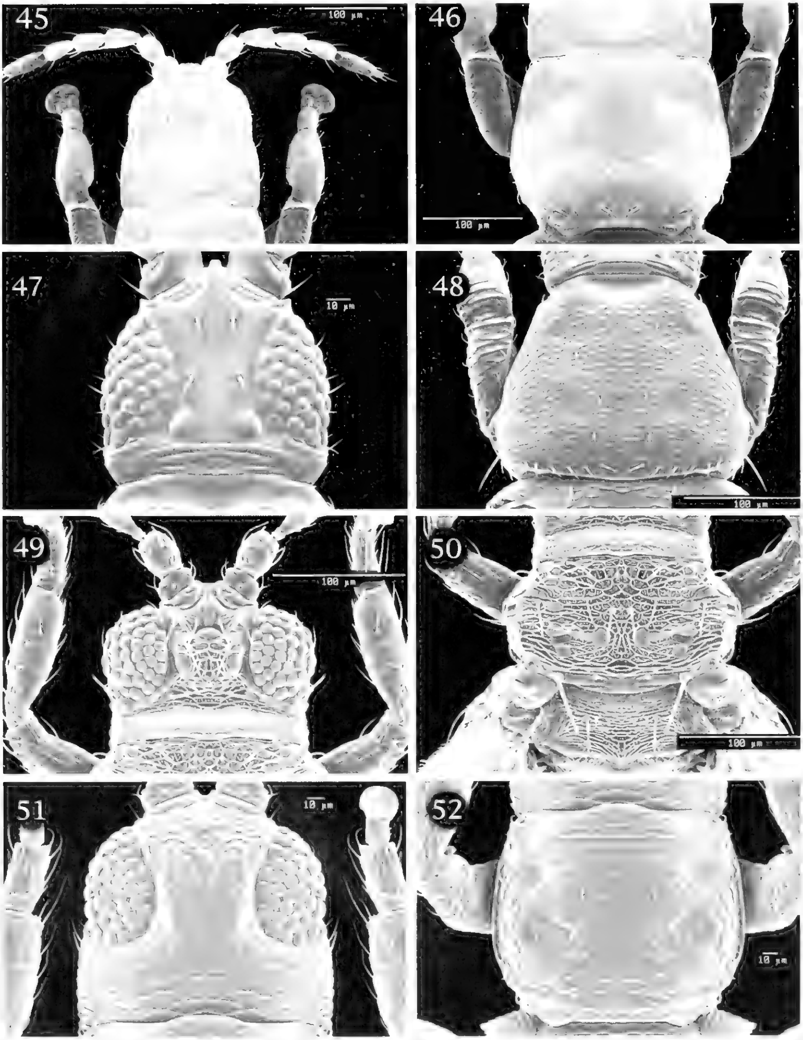
– Pronotum with fewer elongate setae 26

26\. Pronotum without posteroangular setae (Fig. 24) 27

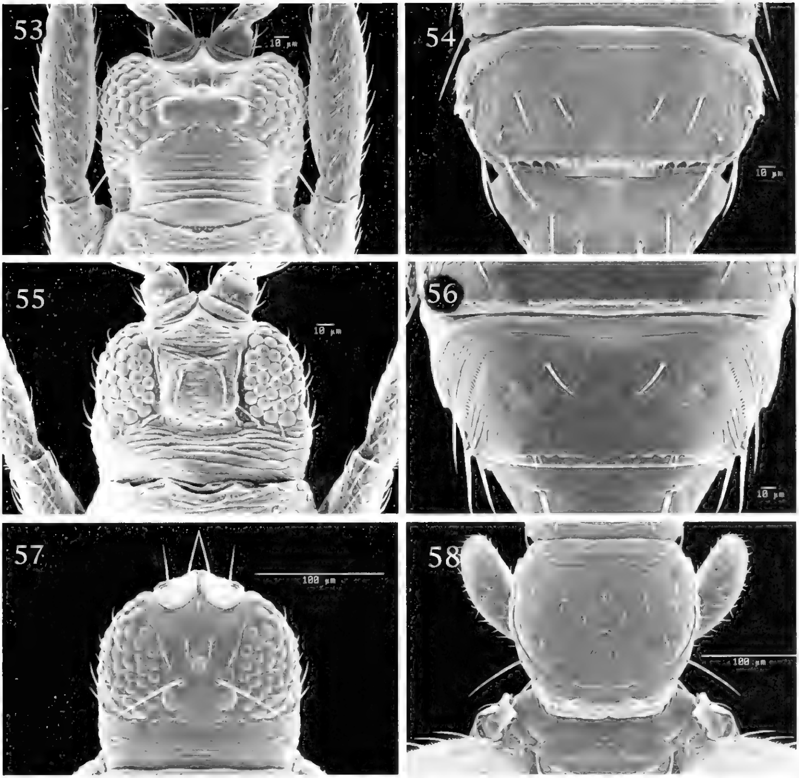
– Pronotum with 1–2 pairs of posteroangular setae (Figs. 21, 58) 29



Figs. 37–44. Scanning electron micrographs of thrips. 37–38. *Aeolothrips collaris*, dorsal aspects. 37. Head. 38. Pronotum. 39–40. *Hercinothrips bruneus*, dorsal aspects. 39. Head. 38. Pronotum. 41–42. *Heliothrips haemorrhoidalis*, dorsal aspects. 41. Head. 42. Left wings. 43–44. *Neohydatothrips samayunkur*, dorsal aspects. 43. Head and pronotum. 44. Left side of abdomen.



Figs. 45–52. Scanning electron micrographs of thrips. 45–46, *Limothrips cerealium*, dorsal aspects. 45, Head. 46, Pronotum. 47–48, *Chirothrips manicatus*, dorsal aspects. 47, Head. 48, Pronotum. 49–50, *Echinothrips americanus*, dorsal aspects. 49, Head. 50, Pronotum. 51–52, *Anaphothrips obscurus*, dorsal aspects. 51, Head. 52, Pronotum.



Figs. 53–58. Scanning electron micrographs of thrips. 53, *Frankliniella occidentalis*, dorsal aspect: head. 54, *Frankliniella tenuicornis*, dorsal aspect: tergite VIII, showing position of ctenidia. 55–56, *Thrips major*, dorsal aspects. 55, Head. 56, Tergite VIII, showing position of ctenidia. 57–58, *Megalurothrips sjöstedti*, dorsal aspects. 57, Head. 58, Pronotum

27. Posterior margin of tergite VIII with a complete, well-developed comb . . . . *Anaphothrips*
Posterior margin of tergite VIII without a comb of setae 28
28. Antenna 8-segmented; postocular setae in a single row; median setae on abdominal tergites VI–VIII long, on tergite VIII more than half length of tergite . . . . *Tameothrips*
– Antenna 9-segmented; postocular setae loosely arranged in 2 rows; median setae on abdominal tergites VI–VIII short, less than half length of tergite . . . . *Palmiothrips*
29. Pronotum with 1 pair of posteroangular setae 30
– Pronotum with 2 pair of posteroangular setae 32
30. Posterior margin of tergite VIII without a comb; head with 3 pairs of ocellar setae; abdominal sternites IV–VI usually with a few discal setae . . . . *Oxythrips*
Posterior margin of tergite VIII with a complete comb; head with 2–3 pairs of ocellar setae; abdominal setae without discal setae 31
31. Head with 2 pairs of ocellar setae; with metasternal spinula; abdominal tergite X without median split; antennal segments III and IV narrowed distally, with rather large forked sense cones . . . *Dichromothrips*

– Head without ocellar setae; without metasternal spinula; abdominal tergite X with median split; antennal segments III and IV weakly narrowed distally, with short forked sense cones . . . . *Glaucothrips*

32. Antennal segment VI sense cone stout, with elongate base; forewing with complete row of veinal setae on forevein or 2 distal setae separated from row; foretibia with 1–2 apical spinelike or clawlike processes (Fig. 22) . . . . *Odontothrips*

– Antennal segment VI sense cone elongate, with short base; veinal setae variable; foretibia without an apical spine or clawlike process 33

33. Metasternal furca with a spinule; forewing with 2 distal setae on foreveins; 2 pairs of pronotal posteromarginal setae . . . . *Mycterothrips*

– Metasternal furca without a spinule; other characters variable 34

34. Head with 2 pairs of ocellar setae . . . . *Taeniothrips*

Head with 3 pairs of ocellar setae 35

35. Forewing scale with 6 veinal setae; discal seta absent; tergite VIII with complete posteromarginal comb of microtrichia; B1 and B2 setae on sternite VII anteriad of posterior margin, B3 on posterior margin (Fig. 23) . . . . *Ceratothripoides*

– Forewing scale with 4 or 5 veinal setae; discal seta present; tergite VIII with posteromarginal comb of microtrichia medially interrupted or absent; B2 and B3 setae on sternite VII on posterior margin (Figs. 25–26); B1 either on or anterior of posterior margin 36

36. Forewing scale with 4 veinal setae; anterior vein of forewing with 2–3 setae in distal ¼ of vein separated from nearly uninterrupted row . . . . *Megalurothrips* (Figs. 26, 57–58)

– Forewing scale with 5 veinal setae; anterior vein of forewing with 2–4 intermittent setae in distal ½ 37

37. All facets of compound eyes unpigmented; B1, B2, and B3 setae on sternite VII on posterior margin (Fig. 25) . . . . *Ceratothrips*

– Compound eye with 5 pigmented facets; B1 setae on sternite VII arising anterior of posterior margin, B2 and B3 on posterior margin (cf Fig. 26) . . . . *Tenothrips*

ACKNOWLEDGMENTS

I thank the following individuals for their help in this project: Joseph Cavey, USDA/APHIS, Hyattsville, MD, and Peter Touhey, SEL, Beltsville, MD, for providing information for the databases, Sueo Nakahara, SEL, USDA (retired), and Douglass R. Miller and Natalia J. Vandenberg, SEL, USDA, for their comments in reviews of the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 100–107

STUDIES OF THE GENUS *CULEX* LINNAEUS IN FLORIDA I. REDESCRIPTION OF THE PUPAE OF *CULEX NIGRIPALPUS* THEOBALD AND *CX. TARSALIS* COQUILLETT, VECTORS OF ST. LOUIS ENCEPHALITIS, AND A KEY TO PUPAE OF *CULEX* SPECIES IN THE EASTERN UNITED STATES (DIPTERA: CULICIDAE)

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Abstract.—The pupal stages of *Culex nigripalpus* and *Cx. tarsalis* are redescribed and illustrated. A key to the pupae of 15 species of *Culex* in the eastern United States is included.

Key Words: pupa, *Culex nigripalpus, Culex tarsalis*

Culex (*Culex*) *nigripalpus* Theobald and *Culex* (*Culex*) *tarsalis* Coquillett are both well known vectors of St. Louis encephalitis virus (Monath 1980, Day and Curtis 1999; Day and Stark 1999). *Cx. tarsalis* is also an important vector of western equine encephalitis virus (Reeves and Hammon 1962). It is necessary that all stages of these important species be adequately described, illustrated and recognizable. To that end, the pupae are treated here.

The pupa of *Cx. nigripalpus* was briefly described and figured by Lane (1953). It was illustrated by Belkin et al. (1970) but "not studied in detail." Lungstrom (1955) figured the abdomen and metanotum of *Cx. tarsalis* using the nomenclature of Knight and Chamberlain (1948). He gave no other description. White (1954) discussed the chaetotaxy of the *Cx. tarsalis* pupa in general also employing the nomenclature of Knight and Chamberlain (1948) for the abdomen and that of Penn (1949) for the cephalothorax. In this work, the pupae of both species are described in detail following the generally accepted nomenclature of Belkin (1962) and Harbach and Knight (1980). Other life stages were described by Carpenter and LaCasse (1955), Belkin et al. (1970, *nigripalpus*), Wood et al. (1979, *tarsalis*).

These pupae may be identified using the key to the pupae of the *Culex* species of eastern United States that appears below and includes 15 of the known 29 species of *Culex* in the United States.

METHODS AND MATERIALS

Specimens of *Cx. nigripalpus* were collected in Indian River and Manatee Counties, Florida, reared individually, and larvae and pupal exuviae mounted in Canada balsam. For details of the techniques, consult Darsie (1998). Pupae of *Cx. tarsalis* examined are listed following the description. In the key that follows the undescribed pupa of *Culex* (*Melanoconion*) *peccator* Dyar and Knab was included. Pupae of this species were collected as follows: Florida, Indian River Co., I-16-70, 11 Pe, J. S. Haeger, and will be described later. Abbreviations used in the descriptions are br = branches, LePe = larval and pupal exuviae.

DESCRIPTIONS

Culex nigripalpus Theobald
(Fig. 1)

Description.—Positions and sizes of setae as figured; ranges and modal branchings in Table 1. *Cephalothorax:* Mostly tan, scuta, coxae and femora brown to dark brown. Setae 1,3-CT long, usually triple; 2,4-CT moderately long, usually double or triple 7,9-CT long, usually double or triple; 5,8-CT long, usually 4- or 5-branched, 6-CT short, usually double; 10,12 CT long, 10-CT with 8–12 br, 11,12 CT with 2–5 br; *Trumpet:* Length 0.75–0.82 mm, $\bar{x}$ 0.79 mm, index 5.35–6.75, $\bar{x}$ 6.24, tracheoid 0.20–0.31 of length $\bar{x}$ 0.26; pinna 0.16–0.19, $\bar{x}$ 0.17 mm, without narrow slit extending from proximal aspect, 0.14–0.24 length of trumpet $\bar{x}$ 0.19. *Abdomen:* Length 3.66–4.14 mm, $\bar{x}$ 3.88 mm; tan, segments I–IV darker, with reticulate pattern in dorsomedian 0.25 of I; sternum II with short, sharp spicules along posterior border. Setae 0-II-VII, 9-I-VI, and 14-III-VIII minute, single. Seta 1-I dendritic, with 6–14 primary br, each usually with 9 or more terminal br; 1-II short with 21–37 fine br; 1-III-VII long, III usually with 9 br; mostly quadruple on IV,V; and usually double on VI,VII. Seta 2-II-VII short, single. Seta 3-I-III rather stout, long on I, moderately long on II,III, double; 3-IV-VII moderately long, 4–8 br on IV, usually single or double on V-VII. Seta 4-I-VI short, moderately long on VII,VIII, usually 7-branched on I, usually 4- or 5-branched on II,III and V,VI; single to 4-branched on IV, VII, VIII. Seta 5-I short, usually triple, 5-II,III moderately long, usually with 4–6 br; 5-IV-VI long to very long, stout, 5-IV usually quadruple, 5-V,VI usually double. Seta 6-I very long, single; 6-II-VI long, with 1–3 br on II, mostly double or triple on III-VI; 6-VII small, with 4–6 br. Seta 7-I,II long, mostly double; 7-III-V short, usually 4- or 5-branched on III,V, double or triple on IV; 7-VI,VII long, single. Seta 8-III-VII short, pedunculate, usually 3- or 4-branched on III, IV and VI; double or triple on V, VII. Seta 9-VII moderately long, stout, with 3–5 primary br, each ending in 2–3 terminal short br; 9-VIII long, stout, usually aciculate, with 6–10 primary br, some ending in 2,3 terminal short br. Seta 10-III-VII long, usually double on III-IV; single (rarely double) on V-VI, 10-VII single. Seta 11-III-VII short, single on III-VI, 1–3 br on VIII. Female genitalia lobe 0.19–0.24 of paddle, $\bar{x}$ 0.21; male genitalia 0.28–0.33 of paddle, $\bar{x}$ 0.30. *Paddle:* Ovoid, light tan, midrib reaching apex, length 0.43–1.03 mm,$\bar{x}$ 0.98 mm; index 1.17–1.51, $\bar{x}$ 1.34; setae 1,2-P short, single.

Specimens examined.—FLORIDA, Indian River Co., Vero Beach, III-29-00, 5 ♀, 6 ♂, LePe, from progeny rearings of females collected by power sweeper in vegetation in wooded area near orange groves (Hussain & Darsie); Manatee Co., Palmetto, VIII-7-2000, 6 ♀, 2 ♂, LePe, from progeny rearings of females collected in miniature light trap with CO_2 (R. Frommer).

Culex tarsalis Coquillett
(Fig. 2)

Description.—Positions and sizes of setae as figured; ranges and modal branchings in Table 2. *Cephalothorax:* Light tan, posterior parts of scutum and mesothoracic wing darker brown. Setae 1,3-CT long, usually triple or quadruple; 2,4-CT moderstely long, double or triple, rarely 4-branched; 5-CT prominent, long, triple or quadruple, rarely 5-branched; 6-CT moderately long, with 2–5 br; 7–9-CT long, 7-CT double; 8-CT 3–6 br; 9-CT double or triple; 10-CT long, aciculate, with 5–9 br; 11-CT long, rather stout, double; 12-CT long, mostly double or triple; an adventitious 4-branched seta near 12-CT on one specimen. *Trumpet:* Conical, dark brown, length 0.62–0.92 mm, $\bar{x}$ 0.82 mm; index 4.7–6.2, $\bar{x}$ 5.4; pinna 0.11–0.32 mm, $\bar{x}$ 0.22 mm and 0.18–0.35 of total length, $\bar{x}$ 0.24 without narrow slit extending from proximal end, tracheoid 0.17–0.23, of total length, $\bar{x}$ 0.19. *Abdomen:* Length 3.47–4.02 mm, $\bar{x}$ 3.79 mm; light

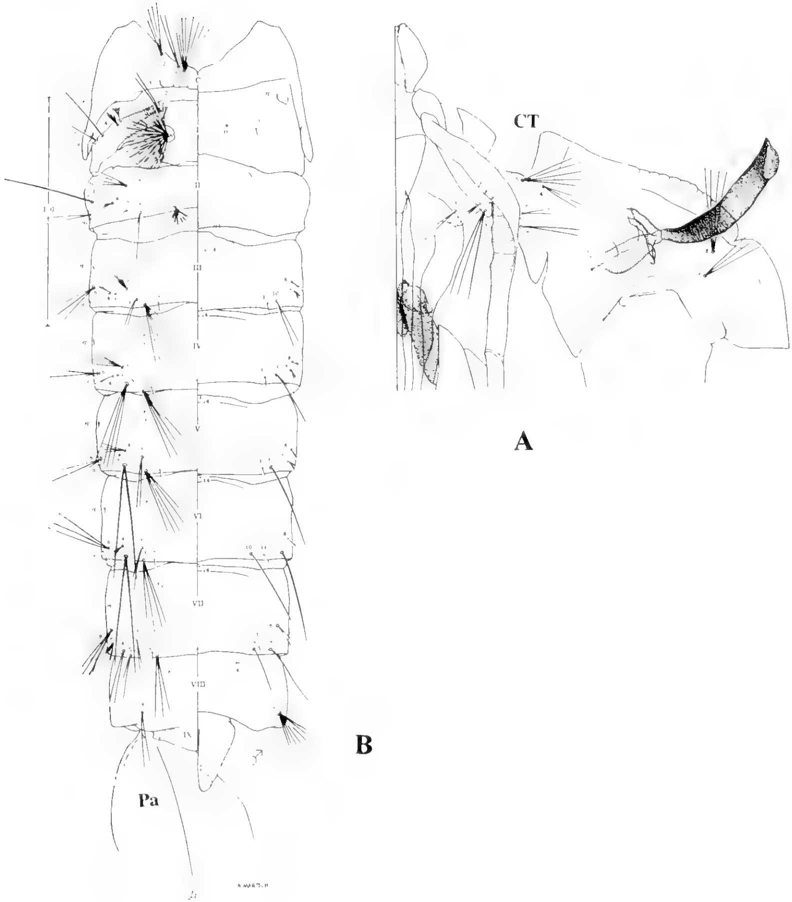

Fig. 1. Pupa of *Culex nigripalpus*. A, Cephalothorax. B, Metanotum and abdomen (from Belkin et al. 1970, by permission). CT—cephalothorax, Pa—paddle.

tan, I–IV somewhat darker, without spicules on sternum II. Setae 0-II-VII, 9-I-VI and 14-III-VIII minute, single. Seta 1-I dendritic, with 8–13 primary branches, each branch with 5–8 terminal branches; 1-II moderately long, with 5–13 br; 1-III-VII long, with 5–12 br on III, with 4–8 br IV, with 3–7, (usually 4) br on V,VI, usually double or triple, seldom with 4 br on VII. Seta 2-II-VII short, single. Seta 3-I long, rather stout, double; 3-II-VII moderately long, double on II,III; with 2–8 br on IV; usually double or triple, rarely single or quadruple on V–VII. Seta 4-I-III short, 4-I

Table 1. Setal branching of the pupa of *Culex nigripalpus* (range is followed in parentheses by the modal branching).

		Abdominal Segments									
Seta	Cephalothorax	I	II	III	IV	V	VI	VII	VIII	IX	Paddle
0	—	—	1	1	1	1	1	1	1	—	—
1	1–4(3)	6–14(9)	21–37(27)	5–10(9)	4–7(6)	3–5(4)	2–4(2)	2–3(2)	—	1	1
2	2–4(2)	1–4(1)	1	1	1	1	1	1	—	—	1
3	2–5(3)	2	2	2	4–8(5)	2	1–2(1)	1–2(2)	1–3(2)	—	—
4	2–6(3)	7–9(7)	2–6(4)	4–8(6)	1–4(1)	3–7(5)	2–4(4)	1–2(2)	—	—	—
5	3–6(5)	2–5(3)	3–7(5)	1–7(4)	2–5(4)	2–3(2)	2–3(2)	1–2(2)	—	—	—
6	1–3(2)	1–2(1)	1–3(1)	2–4(3)	2–4(3)	2–3(3)	2–4(3)	4–6(6)	—	—	—
7	2–4(2)	2–4(2)	1–3(2)	3–5(4)	2–4(2)	4–7(5)	1	1	—	—	—
8	3–5(4)	—	—	4–6(4)	4–6(4)	2–4(2)	1–5(3)	2–4(2)	—	—	—
9	2–4(3)	1	1	1	1	1	1	3–5(4)	6–10(?)	—	—
10	7–10(8)	—	—	1–3(2)	2–3(2)	1–2(1)	1	1	—	—	—
11	2	—	—	1	1	1	1	1–3(1)	—	—	—
12	4–6(5)	—	—	—	—	—	—	—			
14	—	—	—	1	1	1	1	1	1	—	—

with 5–9 br, 4-II,III usually with 5 br; 4-IV usually double or with 3–5 br; 4-V-VIII medium long, usually with 4,5 br on V,VI; 4-VII,VIII single to triple, rarely quadruple. Seta 5-I short, usually with 3–5 br (2–7); 5-II-III moderately long, usually with 4,5 br, seldom with 6 or 7, 5-IV-VI long, stout, double or triple; 5-VII long, usually double. Seta 6-I,II very long, single; 6-III-VI long, usually triple, 6-VII short, mostly with 6–8 br, rarely quadruple. Seta 7-I,II long, single or double; 7-III short, usually with 6 br; 7-IV,V short, usually with 4 or 5 br, 7-VI,VII moderately long or long, single. Seta 8-III-VII short, pedunculate, usually with 3–6 br. Seta 9-VII long, stout, usually aciculate, with 4–6 br, 9-VIII long, stout, aciculate, with 7–9 br, rarely with 2 br apically. Seta 10-III,IV moderately long or long, usually double, 10-V-VII long, single. Seta 11-VII short, with 1–4 br. *Paddle:* Ovoid, length 0.95–1.35 mm, $\bar{x}$ 1.19 mm; index 1.35–1.56, $\bar{x}$ 1.42; seta 1-P short, single, seldom double or triple; 2-P short, single.

Specimens examined.—MONTANA: Phillips Co., Malta, VII-9-72, 2 ♀, 1 ♂, LePe, (Quickenden, Darsie); Ravalli Co., Hamilton, VIII-54, 1 ♀, 1 ♂, LePe, U.S. Public Health Service Rocky Mountain Laboratory colony (J. M. Brennan). CALIFORNIA, San Diego Co., V-7-49, 2 ♀, 1 ♂, LePe; Otay R., V-8-49, 1 ♀, LePe; Lake Henshaw, V-7-49, 2 ♀; Lake Cuyamaca, V-7-49, 1 ♀ Pe (Heid); Los Angeles Co., Agoura, III-22-49, 1 ♂, Pe (Heid).

DISCUSSION

The pupa of *Cx. nigripalpus* was briefly described by Lane (1953), employing the setal nomenclature of Baisas (1935) as modified by Penn (1949). He stated that the cephalothorax has small tufts, while our account gives accurate branching of each seta. He described the "tube," i.e., trumpet, as three times basal width; in Florida *Cx. nigripalpus* pupal trumpets are 7.8–11.1 $\bar{x}$ 8.9 times longer than basal width. Perhaps Lane was not measuring the same species. In all, 13 abdominal setae were characterized by Lane. His setae 6-II-VI were triple; in our study seta 6-II was usually single, and setae 6-III-VI double to quadruple. Lane called five other setae (1-II, 5-IV,V, 9-VII,VIII) "multiple" without precise branching which we include. Seta 5-VI,VII are listed as double; in our study they are single to triple, although modally double. The paddles in our pupae are 1.9–2.3, $\bar{x}$ 2.1 times

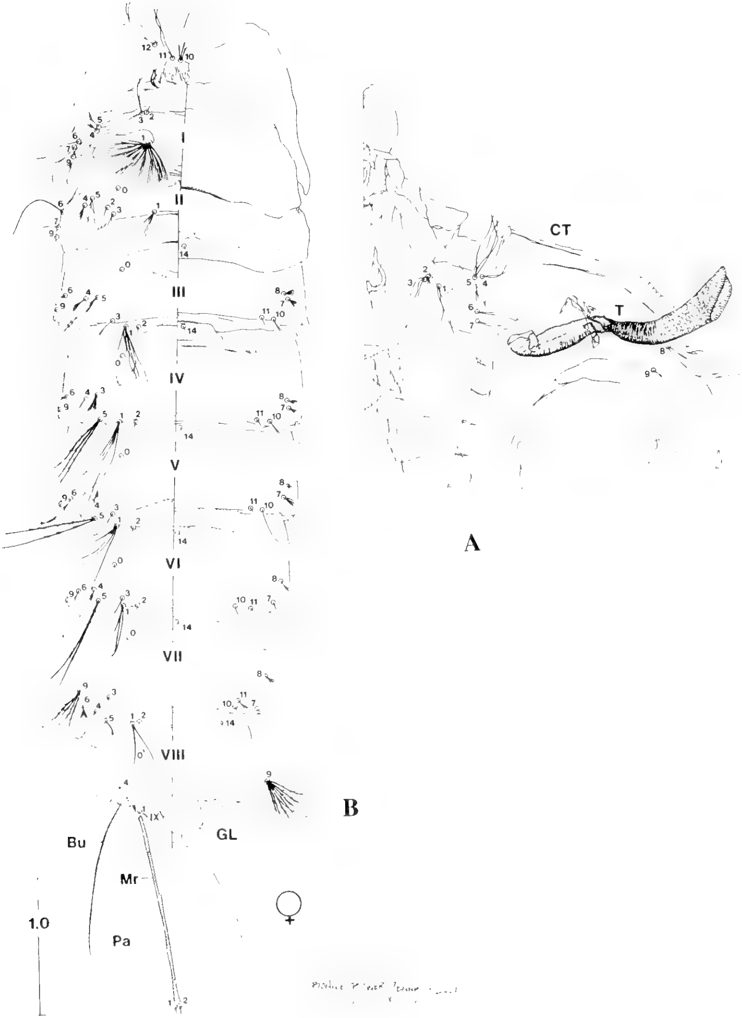

Fig. 2. Pupa of *Culex tarsalis*. A, Cephalothorax. B, Metanotum and abdomen. BU—external buttress, CT—cephalothorax, GL—genital lobe, Mr—midrib of paddle, Pa—paddle, T—respiratory trumpet.

Table 2. Setal branching of the pupa of *Culex tarsalis* (range is followed in parentheses by the modal branching).

Seta	Cephalothorax	Abdominal Segments									
		I	I	III	IV	V	VI	VII	VIII	IX	Paddle
0	—	—	1	1	1	1	1	1	1	—	—
1	2–5(3)	8–13(12)	5–13(7)	5–12(7)	4–8(5)	3–7(4)	3–6(4)	2–4(2)	—	1–3(1)	1
2	2–3(3)	1–2(1)	1–2(1)	1	1	1	1	1	—	—	1
3	3–6(4)	2	2	2	2–8(5)	1–3(2)	2–4(2)	1–3(2)	—	—	—
4	2–4(2)	5–9(5)	2–7(5)	4–6(5)	2–5(2)	3–6(5)	2–5(4)	1–3(2)	2–4(2)	—	—
5	3–5(4)	2–7(5)	4–7(5)	4–8(5)	3–5(4)	2–3(2)	2–3(2)	2–3(2)	—	—	—
6	2–5(4)	1	1	2–3(3)	3	3–4(3)	2–4(3)	4–8(8)	—	—	—
7	2	1–2(2)	1–2(2)	3–7(6)	2–4(4)	3–7()	1	1	—	—	—
8	3–6(5)	—	—	2–6(5)	2–4(3)	2–4(2)	1–4(3)	3–5(3)	—	—	—
9	1–3(3)	1–2(1)	1	1	1	1	1	4–6(4)	5–10(8)	—	—
10	5–9(6)	—	—	1–3(2)	1–2(2)	1	1	1	—	—	—
11	2	—	—	1	1	1–2(1)	1	1–4(1)	—	—	—
12	2–5(3)	—	—					—			
14	—	—	—	1	1	1	1	1	1	—	—

length of segment VIII, but Lane reported the paddle three times lengfh of VIII.

On the other hand, Belkin et al. (1970) includes a complete illustration of the pupa and mentioned only the trumpet not flared, its pinna small, the spicules on the posterior margin of sternun II and seta 5-IV usually with 4 branches. Though few, all agree with our findings

Lungstrom (1955) and White (1964) illustrated the abdomen of *Cx. tarsalis* using the Knight and Chamberlain (1948) nomenclature. They are of questionable quality and neither author offered textual description.

KEY TO THE PUPAE OF *CULEX* IN THE EASTERN UNITED STATES

The key was formulated mostly using descriptions by Darsie (1951), Foote (1954), Belkin et al. (1970) and Zavortink and O'Meara (1999), and specimens from the Florida Medical Entomology Laboratory collection. For assistance in using this key, see Figs. 1–2.

1. Seta 5-CT very long, >5.0 length of seta 4-CT; abdominal tergum VIII with posterior lobe overlying lateral part of tergum IX; seta 1-IX absent (subgenus *Micraedes*) .... *biscaynensis* Zavortink and O'Meara

– Seta 5-CT no more than 2.0 length of 4-CT; abdominal tergum VIII with posterior lobe not overlying lateral part of tergum IX; seta 1-IX present 2

2(1). Meatus of trumpet with narrow slit extending from proximal part of pinna; seta 2-VI usually laterad of seta 1-VI (subgenus *Melanoconion*) 3

– Meatus of trumpet without narrow slit extending from proximal part of pinna; seta 2-VI mesad of seta 1-VI 9

3(2). Seta 9-VIII very near posterolateral corner .... *cedecei* Stone and Hair

– Seta 9-VIII distinctly removed from postero-lateral corner 4

4(3). Seta 5-V double or triple and nearly as long as following tergum 5

– Seta 5-V usually with at least 4 branches, if fewer, then distinctly shorter than following tergum 6

5(4). Seta 1-II with 14 or fewer branches; pinna of trumpet, including slit, less than 0.3 of total length ..... *pilosus* (Dyar and Knab)

– Seta 1-II with 25 or more branches; pinna of trumpet including slit 0.4–0.5 of total length .... *erraticus* (Dyar and Knab)

6(4). Seta 6-IV,V at least 4-branched; seta 5-V usually 5-branched; trumpet index usually >8.5 .... *atratus* Theobald

– Seta 6-IV,V usually triple; seta 5-V usually 4-branched; trumpet index ≤8.0 ... 7

7(6). Pinna including slit ≤0.35 length of trumpet; seta 8-CT single .. *mulrennani* Basham

– Pinna including slit ≥0.4 length of trumpet; seta 8-CT with 3 or more branches 8

8(7). Trumpet lighter in color between apex of tracheoid and base of pinna, flared apically . . . . *iolambdis* Dyar

– Trumpet uniformly dark distal to apex of tracheoid, or if lighter, then remainder of trumpet also lighter, not flared apically . . . . *peccator* Dyar & Knab

9(2).6 Trumpet index ≥7.7; seta 9-VII usually double; seta 9-VIII usually 4-branched (Subgenus *Neoculex*) . . . . . *territans* Walker

– Trumpet index ≤7.0; seta 9-VII usually with 4 or more branches; seta 9-VIII usually 6-branched or more (subgenus *Culex*) 10

10(9). Abdominal tergum I with distinct short spicules posteriorly . . . . *bahamensis* Dyar and Knab

– Abdominal tergum I without short spicules posteriorly 11

11(10). Seta 2-P absent on paddle; seta 1,6-VI usually double . . . . *restuans* Theobald

– Seta 2-P present, rarely absent; seta 1,6-VI usually with 3 branches or more . . 12

12(11). Trumpet index rarely $\bar{x}$ 5.0; seta 1-VII usually with 4 or more branches . . . . *quinquefasciatus* Say

– Trumpet index ≥5.5; seta 1-VII usually double or triple 13

13(12). Seta 1-II with 20 or more branches; posterior border of sternum II with sharp, short spicules . . . . . . *nigripalpus* Theobald

– Seta 1-II with 17 or fewer branches; posterior aspect of sternum II without spicules 14

14(13). Trumpet index about 7.0, pinna short, ≤0.13 of total length . . *salinarius* Coquillett

– Trumpet index ≤6.0. pinna longer, ≥0.16 of total length . . . . *tarsalis* Coquillett

ACKNOWLEDGMENTS

We are indebted to W. J. Tabachnick and N. Hussain for their support and assistance. The manuscript was reviewed by W. J. Tabachnick and C. R. Rutledge. This is Florida Agricultural Experiment Station Journal Series No. R-08423.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 108–119

SUBCORTICAL CAVITY DIMENSION AND INQUILINES OF THE LARVAL LOCUST BORER (COLEOPTERA: CERAMBYCIDAE)

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Abstract.—Subcortical, pre-tunneling cavities made by the locust borer (*Megacyllene robiniae* Forster) on the black locust (*Robinia pseudoacacia* L.) tree were studied in western Maryland on three site types: strip-mine, roadside, and old field-pasture. A number of invertebrates, associated with sap, frass, and boring dust within the cavities, were collected and identified. The more common cavity taxa included two suborders of mites, three nitidulid genera, nematodes, and two dipteran families. Mean numbers of mites were significantly greater in strip-mine sites than in roadside and old field-pasture sites. Cavity size was not related to abundance or diversity of cavity taxa, and cavity taxa did not appear to affect locust borer survival.

Key Words: *Megacyllene robiniae,* inquilines, cavities, survival, *Robinia pseudoacacia*

The locust borer (*Megacyllene robiniae* Forster) is a severe and persistent pest of the black locust (*Robinia pseudoacacia* L., Leguminosae) tree throughout its natural and extended range in North America. Its original range was thought to have been limited to the Appalachian chain from Pennsylvania to Georgia and west to the Ozark Mountain region (Cuno 1930). The locust borer is not present in Europe, however, where black locust has been planted extensively. The borer is univoltine (one generation per year), primary (invading only living trees), and host specific (invading only black locust).

Locust borers deposit eggs into the bark crevices of black locust tree trunks in later summer and fall. Tiny, newly hatched larvae penetrate the inner bark, where they overwinter. In the following spring, they resume their tunneling activities, and enlarge subcortical excavations in cambium and sapwood forming cavities of variable size. From its cavity, a larva extends its tunnel into sapwood and heartwood. The larva maintains the tunnel opening, through which it pushes excess boring dust and frass during development, and through which it emerges as an adult after pupating within its tunnel (Hopkins 1907). The host tree attempts to close a borer wound by depositing tissue around its perimeter; however, a healthy larva normally maintains and enlarges both its tunnel entrance and its cavity. Hall (1942) observed larvae restricting activities to cavity-making, without subsequent tunneling, during a drought year.

As an adult attraction to flowers is a behavioral feature of many cerambycids, locust borer adults are commonly seen congregating on blossoms of goldenrod, *Solidago* spp., particularly *S. altissima.* While on these flowers, in close association with stinging wasps and other vespids, borer adults appear to exhibit Batesian mimicry (Garman 1916, Blackwell and Powell 1981). Madden (1996) stated that when handled, borer stridulation also mimicked that of vespids. Similarly, we have noticed that when handled, borers stridulate rapidly in an apparent excitation mode, and emit an unpleasant odor, apparently in defense.

We also have verified the persistent presence of certain insect groups, particularly those in the Diptera and Coleoptera (Nitidulidae), displaying an attraction to sap and frass exudation at trunk surfaces near locust borer entrance holes. McCann (1992) identified adult insects collected from trunk surfaces on or near (within 10 cm) the entrances of active borer mines, however, his studies did not include the opening of cavities, or any inquiry into inquilines within cavities. He reported nine coleopteran species, representing five families. Little other information is available in the literature. In the present study, outer tree bark was chipped away to fully expose the cavities and analyze their contents. This procedure revealed a protected habitat with a sap and frass food source, inhabited by a guild of other invertebrate species.

Predators and parasitoids appear to have only limited effects on locust borer populations. Locust borer studies have documented predation by a garden spider (*Argiope aurantia* Lucas) on adults (Van Tyne 1983, Harman and Harman 1987, Echaves et al. 1998), woodpeckers on larvae (Hall et al. 1938, Hall 1942, McCann 1992), and ants on eggs (Echaves et al. 1998, Van Tyne 1983). In an unpublished three-week study, from late August through early September, D. Harman and J. McCann observed no instances of avian predation in a field of goldenrod, heavily used by locust borer adults. For this study, an observer sat at the edge of field with binoculars prepared to identify any birds approaching goldenrod blossoms in the field. Observations were conducted for two hours each, in morning (7–9 a.m.), midday (11–1 a.m.), and evening (6–8 p.m.) for 21 days (the last week in August through the second week in September) in 1989. During the borer larval and pupal stages, some predation by woodpeckers occurs. The predation is usually light and varies locally (McCann 1992). The same was observed for predation by garden spiders and ants.

The term inquiline has gained entry into recent biological literature, defined with slightly different slants. An ecological glossary describes the term as "... a type of symbiosis in which one or more organisms exists in the burrow, nest, or abode of another without harming the host" (Lincoln et. al 1986). The term is used for various situations including abodes of mammals, birds, and insects. Inquiline biology addresses a range of biological concepts including such items as phenological timing for nutritional resources (Shibata 2001, Eliason 2000), and the roles of predation and food limitation in species abundance (Kneitel and Miller 2000). This study addressed inquiline response to continuous wounding of living tree tissue by a wood-boring larva, which created the food source.

The cavity inhabitants reported in this study are added to the list of organisms known to live close to borer larvae and may potentially affect or influence larval development. The objectives of this study were: (1) to identify inquilines in locust borer cavities, (2) compare their populations among different habitats and cavity sizes, and (3) to determine whether these inquilines affect locust borer larvae. In overview, this study addressed the subject of strip-mine reclamation and revegetation, as black locust is an important reclamation species. An extensive literature review, which narrowed the scope of the investigation, included few studies addressing biological control of the locust borer.

MATERIALS AND METHODS

Sites that provided a variety of conditions were selected for sampling. Three site types differing in soil disturbance levels were in decreasing order of disturbance: strip-mine, roadside, and old field-pasture. A total of nine sites (three of each site type) were selected within a 50 km radius of Frostburg, Maryland. These habitat types were selected because they were seen as the most prominent and distinct habitats supporting growth of black locust, whose ecology is typically that of a "pioneer" species on open lands. As a minimum size requirement, each site contained an area large enough to accommodate a 15 m × 15 m study plot containing 50 or more trees of approximately 10–20 years of age. Plot corners were established and tree positions were numbered and mapped. In each plot, black locust was the predominant woody species, and stocking densities were similar.

A total of 288 samples of bark sections containing locust borer cavities were removed from each of the nine sites during the period of active larval tunneling, late May through July, 1995. Borer activity was identified by the presence of yellow sap, boring dust, or both, emanating from tunnels and visible on trunk surfaces. Four active larval cavities per site were taken weekly from randomly selected trees. Each tree had two rectangles of bark, approximately 2.5 × 5.0 cm, containing locust borer cavities removed. The bark was carefully removed using a chisel and ax handle, and then placed in a plastic bag. Bark adjacent to the selected cavities was removed, when necessary, to include all parts of larger cavities. Each cavity was placed in a petri dish and examined under a dissecting microscope within 24 hours. To locate all invertebrates, samples were broken into small sections after initial examination. Cavity invertebrates were counted, sorted, and placed in 80% ethanol for further identification.

A second major approach involved trapping. Wire cages stapled over cavities, tunnel entrances, or both were used to capture locust borer adults and associated cavity-dwelling invertebrates as they emerged later in the season. The traps were constructed by folding and stapling finely meshed copper screen into teepee-like forms of approximately 4.0 cm wide × 8.0 cm long. Traps were in place from late June through July, 1995, on trees 5–15 cm in diameter at breast height (dbh). Trap edges were caulked to prevent the escape of inhabitants. For trapping, each of the nine sites was subdivided into thirds, on each of which 15 traps were placed on randomly-selected trees, totaling 405 traps. The number of traps per tree varied from one to five, depending upon numbers of active tunnels. Whenever visible, boring dust was removed from traps and examined for the presence of invertebrates, which were counted and preserved. Entomologists from the Smithsonian Institution, the USDA Systematic Entomology Laboratory, and Frostburg State University assisted in identification of cavity and trap inhabitants. However, specialists were not available for all families and for some, the other sex, life stage, or caste was needed for further determination.

For each cavity, cavity length, width, depth, and adjacent bark thickness were measured at their greatest points, and volume was calculated from these measurements. Field observations indicated that the larvae excavated the cavities prior to tunneling, and that the cavities increased in size only slightly, if at all, after tunneling began. If a tunnel was present, the tunnel diameter was also measured. Success of borer attacks was evaluated using McCann's (1992) criteria and larval status was recorded as "died as an early instar" if little or no tunneling occurred beyond the cavity; "died after tunneling" if tunneling extended into the sapwood, but tunnel entrance diameter measured less than 4 mm; and "emerged as an adult" if tunnel entrance diameter exceeded 4 mm.

All trees within the study plots were mapped and individually numbered. Height, dbh, and resistance to pulsed electric current (an index of vigor) were measured for all trees from which cavities were removed. Three electrical resistance readings per tree were taken in mid-September over a 1-week period, and averaged. The Shigometer® (Model OZ-67, Osmose® Wood Preserving Co. of America, Inc., Buffalo, NY) provided an estimate of tree vigor by delivering a 0.5-A pulsed electric current to the cambium layer (Carter and Blanchard 1977). More healthy trees show lower electrical resistance readings than less healthy ones (Shigo 1982). Readings were taken 1 m above ground level.

To obtain a mean site age, three trees from which cavities were removed were randomly selected for each of the nine sites. Ages were obtained from increment borings. Site indices were calculated from a set of black locust curves (Kellog 1936) for each of the three site types using the heights of trees and mean site age. Site quality relates to the growth in height of most commercial tree species. For a specified age, sites of better quality produce taller trees and a higher index value (Wenger 1984).

Statistical analyses.—The Statistical Analysis System (SAS) (SAS Institute 1988) was used for all statistical analyses. Fisher's least significant difference (LSD) test was used to find possible differences among means of site type and cavity size, site type and tree measurements, and cavity size and borer survival. Cavities of insufficient dimension were excluded from statistical tests. Fisher's LSD test was also used to look for significant differences among means of site type and numbers of species. Only the four most frequent cavity taxa were included in the ANOVA. Chi-square tests were used to compare cavity size class versus borer survival, and versus site type (SAS Institute 1988). Chi-square tests were also used to compare tree vigor, indicated by the classes of electrical resistance readings, and borer survival. Linear regressions compared cavity volume against total invertebrates, and against the four more frequent cavity taxa. Pearson's correlation coefficient tested numerical relationships among the four more frequent cavity taxa.

RESULTS

Cavity taxa.—Invertebrates collected from tree cavities represented 12 orders, 20 families, an estimated 50 genera, and about the same number of species. Invertebrate inquilines starting with the most abundant taxon were mites (Astigmata (97% of all mites) and Mesostigmata), nematodes (Rhabditida and possibly others), nitidulid larvae (primarily *Glischrochilus* spp. and *Crytptarcha* spp.), odiniid larvae—with the preceeding two larval families found in all nine sites, three collembolan families, xylomid larvae (*Solva* sp.), *Armadillidium* sp. (Isopoda), Staphylinidae, ants (Formicidae), and Miridae (Table 1).

Trap taxa.—Invertebrates collected from boring dust in traps on trunks represented 13 orders, 30 families, an estimated 53 genera, and about the same number of species. Invertebrate inquilines starting with the most abundant taxon were nitidulid larvae (primarily *Glischrochilus* spp. and *Cryptarcha* spp.), xylomid larvae (*Solva* sp.), mites (Astigmata and Mesostigmata), dermapterans (Forficulid sp.), collembolans (Poduridae), *Armadillidium* sp., chloropid spp., clerid larvae, and nematomorphs (Gordioidea) (Table 2).

Numbers of species.—Species per cavity ranged from zero to six. The four more frequent cavity taxa followed by the percentage of cavities that they were found in were mites (66%), nitidulid larvae (47%), nematodes (23%), and odiniid larvae (21%). Numbers of species, which included only the four more frequent cavity taxa, were not significantly different among site types ($P > 0.05$). Mean numbers of nematodes, nitidulid larvae, and odiniid larvae were also not significantly different among site types ($P > 0.05$). However, mean numbers of mites were greater on strip-mine sites ($F = 3.70$, df = 2,186, $P = 0.027$) than roadside and old field-pasture sites. Pearson's Correlation Coefficient showed a weak positive relationship between mites and odiniid larvae per cavity ($R = 0.36861$, $P = 0.0078$).

Cavity volume and taxa.—The regression of the total number of insects per cavity versus cavity volume did not show a significant linear relationship ($P > 0.05$), nor did the regressions of the numbers of indi-

Table 1. The more common invertebrate taxa extracted from subcortical cavities in black locust trees, showing numbers of individuals by site type, i.e., strip-mine, roadside, and old field-pasture. This table includes taxa occurring in numbers greater than five, represented in all three site types, or both. Other less common taxa, with their total occurrences, and specific ant spp. include Gastropoda, Stylommatophora, Haplotrematidae, *Haplotrema concavum* (Say) (1); Arachnida, Araneae, Thomisidae (2), Agelinidae (1), Salticidae, *Habrocestum pulex* (Hentz) (1); Acari, Oribatida (4), Prostigmata (1); Diplopoda (1); Insecta, Coleoptera, Cleridae, *Enoclerus* sp. (1), Histeridae, *Hololepta fossularis* Say (2), Coccinellidae (1), Trogositidae (1); Dermaptera, Forficulidae (2); Psocoptera (3); Hemiptera, Anthocoridae, *Calloidis temnostethoides* Reuter (4); Hymenoptera, Encyrtidae (1), Formicidae, *Solenopsis molesta* Say (4), *Crematogaster lineolata* (Say) (2), *Leptothorax ambiguus* Emery (1), *tetramorium caespitum* (L.) (1), *Tapinoma sessile* (Say) (1). Possible Mesostimgata include Uropodidae, Ameroseiidae, and Parasitidae. Immature Nitidulidae are primarily *Glischrochilus* and *Cryptarcha* spp., with some *Soronia* spp. *Solva pallipes* (Loew) identified as most likely sp. as it is more common than the other *Solva* sp. in eastern North America (*S. crepuscula* Hull).

Taxon	Strip-Mine	Roadside	Old Field-Pasture	Total
Nematoda				
Secernentea, Rhabditida	1,378	770	890	3,038
Arthropoda				
Malocostraca, Isopoda, *Armadillidium* sp.		16	1	17
Arachnida, Acari				
Astigmata	4,879	627	2,124	7,630
Mesostigmata	123	44	81	248
Insecta, Collembola				
Entombryidae/Isotomidae	6	16	28	50
Poduridae	7	2	8	17
Hemiptera, Miridae				
Lopidea robiniae Uhler	4	1	1	6
Coleoptera				
Staphlinidae				
Immature	2		6	8
Adult	3		3	6
Nitidulidae				
Immature	182	171	115	468
Adult	8	5	1	14
Carpophilus lugubris Murray	1			1
Erotylidae, *Megalodacne heros* (Say)	1	1	1	3
Diptera, Xylomidae				
Solva pallipes (Loew)—immature	9	4	9	22
Odiniidae—immature	30	27	52	109
Hymenoptera, Formicidae	3	6		9

viduals of the four more common cavity taxa versus cavity volume.

Cavity size and borer survival.—Borers survived to the pupal stage and presumably emerged from 50% of cavities, tunneled into sapwood and died in 13% of cavities, and died before creating a tunnel in 37% of cavities. Some size variation occurs among locust borers, in relation to sex (females larger than males) and other unknown factors, but this feature was not compared with cavity size. When comparing mean cavity measurements and survival of borers, the cavities of adult borers that emerged were significantly longer, wider, deeper, and greater in volume than those of larvae that

Table 2. The ten more common taxa from screen traps placed over borer cavity entrances and the types of sites in which they were located. Other, less common taxa and numbers of each include Gastropoda, Haplotermatidae, *Haplotream concavum* (Say) (1); Arachnida, Araneae, Agelenidae (1), *Agelenopsi* sp. (1), Clubionidae, *Clubiona pallens* (Hentz) (1), Salticidae (1); Insecta, Coleoptera, Erotylidae, *Megalodacne heros* (Say) (3), Histeridae (1), Staphylinidae (5), Trogositidae (3), Nitidulidae, adults (6); Collembola, Entombryidae/Isotomidae (3); Hemiptera, Anthocoridae *Calloides temnostethoides* Reuter (3); Homoptera, Coccidae (1), Membracidae, immature (2), Psyllidae (1); Neuroptera, Chrysopidae, *Chrysoperla rutilabris* (Burm.) (2); Diptera, Anthomyiidae (1), Ceratopogonidae, *Forcipomyia* sp. (1), Loncheidae (1), Odiniidae, immature (4), *Traginops* sp. adult (1); Drosophilidae (8), Phoridae (1), Muscidae (1), Tachinidae (1); Lepidoptera, immature (4); Hymenoptera (1); Proctotrupoidea (2), Formicidae (1), *Formica subsericea* Say (1). Immature Nitdulidae are primarily *Glischrochilus* and *Cryptarcha* spp., with some *Soronia* spp. *Solva pallipes* (Loew) identified as most likely sp. as it is more common than the other *Solva* sp. in eastern North America (*S. crepuscula* Hull). *Gaurax* sp. near *G. pseudostigma* Johnson, likely a new species. S = strip-mine, R = roadside, O = old field-pasture.

Taxon	Site Types	No. Sites	Total Individuals
Nematomorpha			
Gordioidea	S,R	2	9
Arthropoda			
Malacostroca			
Isopoda, *Armadillidium* sp.	S,R	3	16
Arachnida			
Acari, Astigmata	S,O	3	44
Mesostigmata	S	1	16
Insecta			
Collembola, Poduridae	S	2	28
Coleoptera, Nitidulidae—immature	S,R,O	9	184
Cleridae, *Enoclerus* spp.—immature	S,R,O	4	11
Dermaptera, Forficulidae			
Forficula auricularia L.	S,R,O	5	31
Diptera, Xylomidae			
Solva pallipes (Loew)—immature	S,R,O	9	82
Chloropidae (*Fiebrigella catalpae* Mallach—11) (*Coniscella hinkleyi* Malloch—2) (*Gaurax* sp.—1)	R,O	2	14

died shortly after entering the xylem, and those that died after entering sapwood. Mean bark thickness was not significantly different among the three groups (Table 3).

Chi-square test results revealed significant differences in survival of borers among cavity size classes ($\chi^2 = 115.526$, df = 8, $P = 0.001$). Over 95% of borers emerged from cavities $\geq 1{,}001$ mm^3 (class 4 = 1,001–2,000 mm^3 and class 5 = 2,001–6,000 mm^3), while only 13% of borers emerged from cavities ≤ 100 mm^3 (class 1). Sixty-eight percent of borers emerged from cavities 501–1,000 mm^3 (class 3). Cavities from 101–500 mm^3 (class 2) showed little differences among the 3 borer classes (Fig. 1).

Cavity size and site type.—When comparing the means of cavity measurements by site type, cavities in strip-mine sites were significantly larger than roadside and old field-pasture sites in terms of length, width, depth, and volume. Cavities removed from old field-pasture sites were significantly greater in length than those from roadside sites; those from roadside sites

Table 3. Mean ± standard error comparison of cavity measurements by adult borer status. Means not sharing the same lower case letter within columns are significantly different ($P < 0.05$, Fisher's least significant difference test).

	Cavity				
Borer Status	Length (mm)	Width (mm)	Depth (mm)	Volume (mm^3)	Bark Thickness (mm)
Emerged as an adult	15.4 ± 0.5a	17.0 ± 0.6a	4.4 ± 0.2a	1,193.4 ± 80.7a	10.9 ± 0.3a
Died after tunneling	12.4 ± 1.1b	8.8 ± 0.7b	2.5 ± 0.2b	285.2 ± 43.9b	10.6 ± 0.6a
Died as an early instar	11.9 ± 0.7b	9.3 ± 0.6b	1.8 ± 0.1b	226.0 ± 34.1b	10.4 ± 0.4a
ANOVA					
F	9.63	49.32	61.3	57.1	0.56
df	2, 284	2, 284	2, 270	2, 270	2, 271
P	0.0001	0.0001	0.0001	0.0001	>0.05

were significantly deeper than those from old field-pasture sites. Mean bark thickness was significantly less in old-field pasture sites than on roadside and strip-mine sites (Table 4). Chi-square tests revealed significant differences between cavity size classes and site types ($\chi^2 = 30.115$, df = 8, P = <0.0001). Strip-mine sites had fewer cavities in the smallest cavity class ($\leq$100 mm^3), and more cavities in the two larger cavity classes (1,001–6,000 mm^3) compared to roadside and old field-pasture sites (Fig. 2).

Tree measurements and site type.—Mean tree heights (m) were significantly greater ($F = 31.60$, df = 2,285, $P = 0.0001$) in old field-pasture sites (7.7 ± 0.2) than on strip-mine (6.1 ± 0.1) and roadside sites (6.0 ± 0.2); whereas, mean dbh (ranging from 5.9–6.6 cm) was not significantly different among site types ($P > 0.05$). Mean tree age (yr) was significantly greater ($F = 3.41$, df = 2,243, $P = 0.035$) in old-field pasture sites (19.0 ± 0.8) than in roadside sites (16.5 ± 0.7), but not strip-mine sites (17.5 ± 1.1). Mean electrical resistance readings (kohms) on strip-mine (16.6 ± 0.9) and roadside sites (16.0 ± 0.6) were significantly lower ($F = 6.23$, df = 2,277, $P = 0.002$) than readings on old field-pasture sites (19.2 ± 0.8). In contrast, old field-pasture sites had a higher site index value (37) than strip-mine (31) and roadside sites (32). A chi-square test indicated no significant differences in survival of borers among the four classes of electrical resistance readings ($\chi^2 = 7.680$, df = 8, $P = 0.465$).

DISCUSSION

Cavity inquilines did not appear to have a negative effect on locust borer populations. Therefore, use of the term inquiline is qualified as no direct evidence of cavity inhabitants harming the abode-building host was found. However, little is known about the habits of many of these organisms, especially larvae. Nitidulid larvae are saprophagous in general, but may feed on fungal fruiting bodies or spores, and may be predaceous. The three genera found in borer cavities, *Cryptarcha, Glischrochilus,* and *Soronia,* are among genera that occur most often under fermenting bark or in rancid sap (Stehr 1991).

McCann (1992) found three *Glischrochilus* species in or within 10 cm of borer cavities. The species were *G. samquinolentus* (Olivier), *G. quadrisignatus* (Hay), and *G. fasciatus* (Olivier). Since nitidulid larvae in this study were not identified to species, they may have been represented by the *Glischrochilus* spp. McCann (1992) found. *Cryptarcha* species in this study may have been represented by *C. ampla* (Erichson), also found by McCann (1992). *Cryptarcha* spp. are known to eat scolytid eggs and larvae, but are not considered to be obligate predators (Stehr 1991).

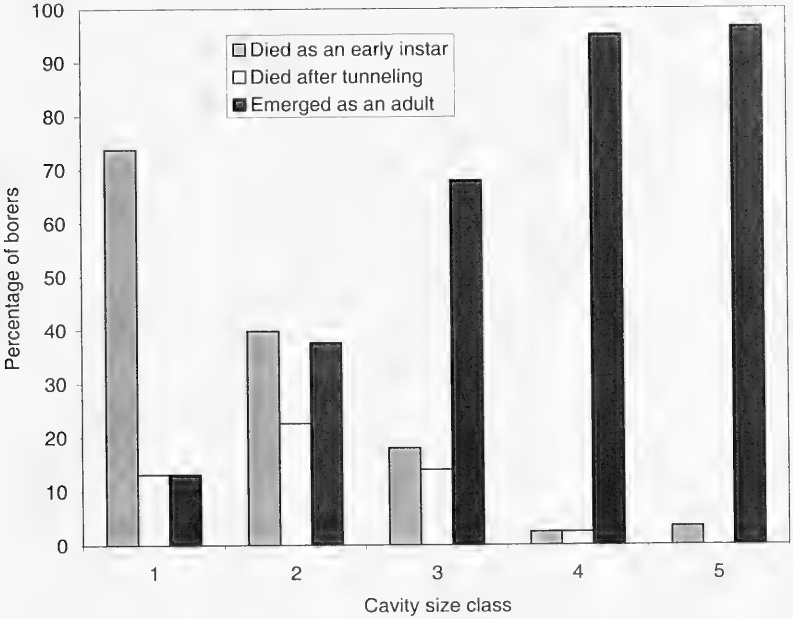

Fig. 1. Locust borer development with regard to cavity size class.

Odiniid larvae are thought to be scavengers of insect frass and other decaying organic matter. They may attack other larvae (Stehr 1991). A *Cryptarcha* larva appeared to retreat upon encountering an odiniid larva during one cavity dissection. Although odiniid larvae might be aggressive towards other cavity taxa, they seemed too small in size and low in number to have an overall negative effect on locust borers.

Xylomid larvae are thought to be scavengers on decaying organic matter or predators of insect larvae (Stehr 1991). Although xylomid larvae may be predaceous, they did not appear to have an overall negative effect on borers. Borer adults presumably emerged from cavities with xylomid larvae twice as often as they failed to emerge from cavities with them.

Mesostigmatids, commonly found in the borer cavities are mostly free-living predators. Many are external or internal parasites of invertebrates, reptiles, birds, and mammals (Krantz 1978). Because the mesostigmatids were most often found alone in the cavities, they did not appear to pose a threat to borer larvae.

Nematodes (Rhabditida and possibly other orders) were a common cavity taxon, but their affect on borer larvae remains unknown. Adult borers presumably emerged from cavities with hundreds of nematodes. Nematodes were found most often in moist cavities within surrounding tissues, and were occasionally found on dead mites and nitidulid larvae. One of the most common nematode inquilines collected from the subcortical cavities, *Myctolaimellus robiniae* n. sp. (Diplogasterida: Cylindrocorporidae), has been described (Harman et al. 2000).

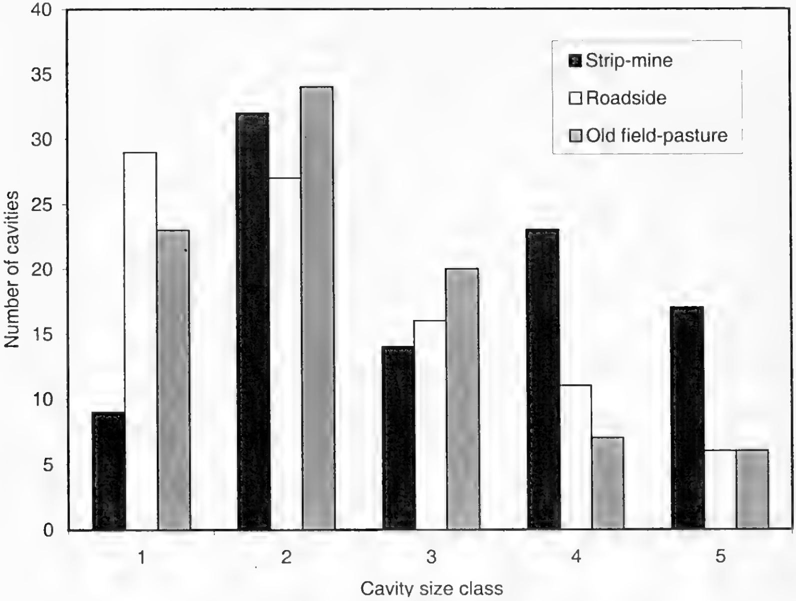

Fig. 2. Number of cavities per site type with regard to cavity size class.

and others are under investigation. The ecological role of these nematodes was not determined, but records stated that most Cylindrocorporids are saprobes, often in symbiotic relationships with insects.

Most species of rove beetles (Staphylinidae), also collected in the present study, appear to be predaceous. Conspecific staphylinid larvae and adults usually consume the same foods (Borror et al. 1989). Nineteen specimens of larvae and adults were collected from cavities and traps. Twelve checkered beetle larvae (Cleridae) were collected primarily from borer traps. Most

Table 4. Mean ± standard error comparison of locust borer cavity measurements by site type. Means not sharing the same lower case letter within columns are significantly different ($P < 0.05$, Fisher's least significant difference test).

	Cavity				
Site Type	Length (mm)	Width (mm)	Depth (mm)	Volume (mm^3)	Bark Thickness (mm)
Strip-mine	16.2 ± 0.8a	15.4 ± 0.8a	4.0 ± 0.2a	1057.4 ± 101.1a	11.4 ± 0.4a
Roadside	11.2 ± 0.6b	11.4 ± 0.8b	3.2 ± 0.2b	610.0 ± 91.8b	10.9 ± 0.4a
Old field-pasture	13.7 ± 0.6c	12.5 ± 0.7b	2.4 ± 0.2c	547.0 ± 68.6b	9.7 ± 0.3b
ANOVA					
F	13.66	7.02	15.43	10.38	5.92
df	2, 284	2, 284	2, 270	2, 270	2, 271
P	0.0001	0.001	0.0001	0.0001	0.003

checkered beetles are predaceous as larvae and adults. They are common on or within trees, where they prey on larvae of wood-boring insects, especially bark beetles (Borror et al. 1989). Both rove beetles and checkered beetles were not thought to pose any threat to locust borers, as they occurred infrequently, and were not present in the three cavity samples containing live borer larvae.

Earwigs (Dermaptera), most often found grouped together, feed primarily on dead or decaying plant matter. Some feed on living plants, and some may be predaceous (Borror et al. 1989). Like rove and checkered beetles, earwigs were thought to occur too infrequently to pose any threat to borers.

Surprisingly, Gordian worms (Nematomorpha) were found in eight traps. Nematomorphs, as juveniles, live within the body cavity of a host, usually an insect, and a host dies after its worm emerges (Pearse et al. 1987). Although Gordian worms may have been killed some borers, adult borers emerged from four traps that contained these worms.

Ants (Formicidae) were occasionally found in borer cavities. They generally appeared to be too small to pose any threat borer larvae and were probably feeding on tree sap and cavity taxa other than borer larvae. Most ant species found in cavities were considered subordinate according to Fellers' (1987) ranking of ants by dominance. Subordinate ants tend to be less aggressive and avoid other ant species.

Coleoptera and Lepidoptera appear to support the greater ranges of parasitoids (Mills 1994). Two parasitoid families (Tachinidae and Phoridae) that utilize coleopteran larvae were collected in borer traps, and one family (Encyrtidae) was collected from a borer cavity. Some Encyrtidae and Tachinidae utilize coleopteran larvae while some phorid parasitoids utilize coleopteran pupae (Mills 1994). Each parasitoid family was represented by only one specimen in this study.

Cavity size is related to advancement and survival of borer larvae, although it appears that many other determinants of cavity size are unknown. Strip-mine sites had significantly larger cavities, indicating more success among borer larvae, and yielded more mites than roadside and old field-pasture sites. A major implication regarding black locust on strip-mine sites is that stress is greater on-mine than off-mine resulting in increased vulnerability to invasion by the borer (Harman et. al. 1985), and other probable organisms. Although the locust borer is a primary invader, its success is still related to the health of its host.

The astigmatid mites found in the cavities appeared to be primarily fungivorous. Many Astigmata are saprophagous, fungivorous, or graminivorous, while some are parasitic (Krantz 1978). A colony of Astigmata from one of the cavities collected from a strip-mined site was maintained for over a year, subsisting on a diet limited to yeast pellets (K. Larson, personal observation 1996). Significantly greater numbers of fungivorous mites on strip-mine sites than off-mine may indicate greater fungal infestation, due to stress at the site.

Hopkins (1906) stated dead areas surrounding cavities, or hibernation cells, penetrate into the wood and appear to assist larvae in boring through inner bark to the wood. He also stated if the surrounding area is healthy, the larvae may not advance their tunnels into the wood (Hopkins 1906). Fungal infestation in less vigorous trees may contribute to the success of borer larvae in creating larger cavities. Wounds made by borer larvae provide an opening for fungi to enter locust trees. Damage by a heart rot fungus *Fomes rimosus* (Berkeley) Cooke a parasite of black locust, causes heartwood to become lightweight and crumbly (Hoffard and Anderson 1982). While borer larvae over-winter, fungal activity around their hibernation cells may weaken surrounding tissue to such an extent that larvae may be able to consume more tissue when they resume activity in spring, thereby increasing cavity size and improving chances of survival.

Selection of varieties of black locust resistant to fungi may reduce damage incurred by borers requiring the presence of fungi for greater survival. Unfortunately, past references to fungi in relation to locust borer ecology have been largely observational. Although mycological aspects were also beyond the scope of this study, the results indicate a need for further studies of the tree-insect-fungal relationship.

Acknowledgments

We thank Gary Hevel (Collembola, Psocoptera, Membracidae, Staphylinidae, Nitidulidae, Drosophilidae, Phoridae, Anthomyiidae, Muscidae, Tachinidae, Trogositidae, Coccinellidae, and Gelechiidae), and O. S. Flint (Chrysopidae), Smithsonian Institution; D. R. Smith (Formicidae and Encyrtidae), Natalia J. Vandenberg (larval Cleridae, Nitidulidae, and Staphylinidae), Peter Touhey (Proctotrupoidea and Lonchaeidae), A. L. Norrbom (Odiniidae), N. E. Woodley (Xylomidae), the late Curtis W. Sabrosky (Chloropidae), Thomas J. Henry (Anthocoridae and Miridae), D. R. Miller (Coccidae and Psyllidae), and David A. Nickle (Forficulidae), Systematic Entomology Laboratory (SEL), Agricultural Research Service, USDA; William L, Grogan (Ceratopogonidae), SEL cooperating scientist, Salisbury University, MD; and Wayne A. Yoder (Araneae, Acari, and Haplotrematidae), Frostburg State University, for assistance with identifications. Partial funding for the study was provided by the Maryland Agricultural Experiment Station.

This manuscript is Science Series Contribution No. 3569 of the University of Maryland, Center of Environmental Studies.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 120–126

SURVIVAL OF LARVAE AND NYMPHS OF *IXODES SCAPULARIS* SAY (ACARI: IXODIDAE) IN FOUR HABITATS IN MARYLAND

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Abstract.—Host-seeking and fed larvae and nymphs of the blacklegged tick, *Ixodes scapularis* Say, were placed in mesh packets and in vials in the leaf litter on the floor of mixed deciduous forest, Virginia pine-southern red oak forest, and white pine plantations with and without Nepal microstegium, *Microstegium vimineum* (Trinius) A. Camus. An introduced shade-tolerant grass, Nepal microstegium, is expanding its range northeastward into areas densely populated with *I. scapularis.* As determined by flag sampling, the density of host-seeking nymphs at the Virginia pine sites was much lower than in the other habitats. None of the four habitats appeared to be consistently more favorable or unfavorable for the survival of confined fed and unfed *I. scapularis* larvae and nymphs. More unfed nymphs survived in vials than in packets in Virginia pine and white pine with Nepal grass sites. Fed larvae and nymphs tended to survive the summer better than unfed ticks.

Key Words: blacklegged tick, immature stages, Nepal microstegium

In the United States, most cases of Lyme disease occur in an area from southern New England through the mid-Atlantic states (Spielman et al. 1985) with Maryland as the southernmost state with a significant Lyme disease problem. The blacklegged tick, *Ixodes scapularis* Say, the principal vector of the agent causing Lyme disease, is also involved in the transmission of the agents of babesiosis and human granulocytic ehrlichiosis (Spielman et al. 1985, Dumler and Bakken 1995). Off-host survival of fed and unfed ticks is affected by a variety of biotic and abiotic factors, such as natural enemies (e.g., predators, pathogens) and micrometeorological conditions (e.g., relative humidity) (Daniel and Dusbabek 1994). These factors seem to be associated with microhabit, but differences in survival of flat (unfed) *I. scapularis* nymphs may vary from one region to another independent of the type of microhabitat (Bertrand and Wilson 1997). Extreme temperatures and low relative humidities are harmful to *I. scapularis* (Stafford 1994, Vandyk et al. 1996). Ginsberg and Zhioua (1996) found that *I. scapularis* nymphs had a greater survival rate in deciduous forest compared to pine forest on Long Island, New York. Lord (1993) reported high mortality of unfed *I. scapularis* nymphs in New York. In Maryland, 64–70% of fed female *I. scapularis* placed in leaf litter in a deciduous forest survived to oviposit at least some eggs (Carroll 1996), but little is known about the survival of free-living larvae and nymphs.

In Maryland, mixed deciduous forests are a common natural habitat, varying in composition of dominant plant species according to soil type, drainage and other factors. Blacklegged ticks are typically found in these deciduous woodlands in Maryland (Schmidtmann et al. 1994, Carroll and Kramer 2001). Often, on well-drained soils practically contiguous with the deciduous forests there are stands of Virginia pine, *Pinus virginiana* Miller, and southern red oak, *Quercus falcata* Michaux. In central Maryland, white pine, *P. strobus* L., does not occur naturally (Elias 1980) but is sometimes planted as ornamental or in monocultures as a form of reforestation. Blacklegged ticks also occur in the pine-dominated habitats. White-tailed deer, *Odocoileus virginianus* (Zimmermann), and other important hosts of *I. scapularis* readily move among all three habitats. Nepal microstegium, *Microstegium vimineum* (Trinius) A. Camus (Poaceae), is a shade-tolerant, non-native species of annual (sometimes perennial) grass. Since being introduced into Tennessee over 80 years ago, *M. vimineum* has attained the status of an invasive weed in the U. S., while expanding its range northeastward into Maryland, New York, and New England (Hunt and Zaremba 1992, Redman 1995, Ehrenfeld 1999). Nepal microstegium has experienced explosive distributional growth in Maryland since the 1980s (Redman 1995). In areas around Loch Raven Reservoir, Baltimore County, where there are extensive plantings of white pine, *M. vimineum* is the dominant understory plant species, covering considerable surface area and attaining heights of ≈0.3 m. *Ixodes scapularis* is abundant in these white pine and adjacent deciduous woodlands (Carroll, unpublished data). Nepal grass forms sprawling colonies that might provide shaded, humid refugia for larvae and nymphs of *I. scapularis* and enhance their survival during late spring and summer. The grass dies and collapses in the fall. The purpose of this study was to obtain preliminary information on the survival of fed and unfed *I. scapularis* nymphs in the deciduous forest, Virginia pine-oak forest, white pine plantations with Nepal grass, and white pine plantations without Nepal grass.

MATERIALS AND METHODS

The deciduous forest study sites were located at Loch Raven Reservoir, Baltimore County, Maryland, as were the white pine plantings with and without Nepal grass. The Virginia pine-southern red oak forests were located in the U. S. Fish and Wildlife Service's Patuxent North Tract in adjoining Anne Arundel County. The deciduous forest was dominated by tulip tree, *Liriodendron tulipifera* L., red maple, *Acer rubrum* L., hickory, *Carya* sp., and black cherry, *Prunus serotina* Ehrhart. Understory vegetation was generally sparse in the deciduous woods, with some ferns and Nepal grass present. Leaf litter in these deciduous forests was notably shallow, and in some places virtually gone by mid–late summer, perhaps due to the abundance of earthworms that were observed. In contrast, leaf litter in the Virginia pine-southern red oak forests remained ≈10 cm deep. Few other species of trees were present in these woods, and blueberries, *Vaccinium* sp., and greenbrier, *Smilax* sp., were common in the understory. The white pine plantations were virtually monocultures, with ferns and Nepal grass being the principal understory species.

For each of the four types of habitat, three sites (≥0.8 km apart) were selected (Fig. 1). Each site was sampled for the presence of *I. scapularis* by flagging with a 0.5 by 0.5 m flannel cloth (crib cloth containing a rubber laminate) 5 times for 30 sec while walking slowly. At each of the three sites, confined ticks were placed in the leaf litter (where loose litter adjoined compacted litter or soil) at each of three locations, with the exception of unfed larvae, which were placed at one randomly selected location at each site in 1999. At each site each group of ticks was placed ≥10 m from the nearest group of confined ticks. The location of each group was marked with a flag. Unfed and fed larvae and nymphs of *I. scapularis* were placed at these locations in 1999 and

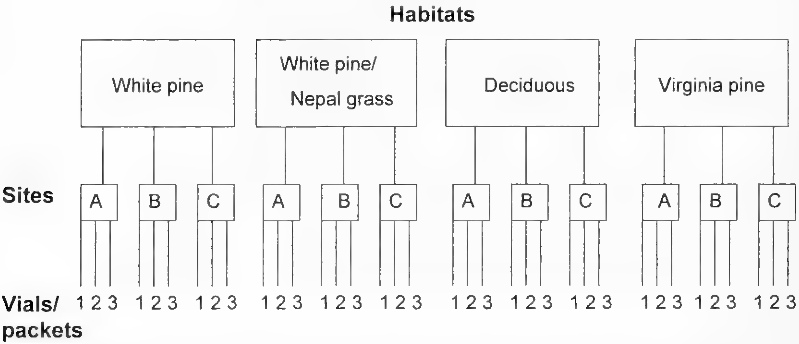

Fig. 1. For each of 4 types of habitat, unfed and fed larvae and nymphs confined in nylon packets or in vials were placed in leaf litter at 3 sites (designated here as A, B and C). At each site the packets and vials were placed at 3 marked locations (designated here as 1, 2 and 3) ≥10 m apart.

2000 when free-living ticks were in the same stage of development. Unfed larvae and nymphs were collected from the field, placed in plastic snap-cap vials and maintained at 24–25° C, R. H. ≈97%, and natural photoperiod. Fed larvae and nymphs were allowed to engorge on white rats in accordance with an approved USDA, ARS, Beltsville Agricultural Research Center, IACUC protocol. Within 4 d after dropping from a rat, the fed larvae and nymphs were placed in nylon packets to be distributed at the study sites. The packets were of 82 by 82 mesh per cm^2 folded once to form a rather flat ≈2 by 5 cm rectangle sealed on two sides by adhesive applied with a glue gun. Once the ticks were placed inside the packet, the fourth side was folded over and closed as securely as possible with a bulldog clip. In 1999, 10 unfed larvae, 5 fed larvae, 6 unfed nymphs, and 3 fed nymphs were placed in each packet. The following year 8 unfed larvae, 6 fed larvae, 3 unfed nymphs, and 3 fed nymphs were placed in each packet. In 1999, unfed nymphs (6 per vial) were placed in plastic snap-cap vials (3 dram) with a 0.8 cm diameter hole in the cap and nylon cloth covering the mouth of the vial. Except in 1999, when one packet containing unfed larvae was placed at one of the three locations (chosen randomly) at each of the three sites for each habitat, one packet or vial containing ticks was distributed to each location at each site. Nymphs were placed out in late spring to early summer, and larvae in August. Unfed ticks were removed from the field and checked for mortality near the end of the natural activity periods for larvae and nymphs (late August to September). Fed ticks were checked after the time that individuals of the same stage in nature should have molted into the next life stage. Standard errors were calculated for surviving ticks by habitat. Mean numbers of ticks in surviving vials and packets were compared using Student's t-test.

RESULTS

At least one nymph or adult of *I. scapularis* was found by flagging at all but one of the study sites where ticks were placed (Table 1). However, the Virginia pine-oak habitat contained few *I. scapularis*. The summer of 1999 and the fall of 2000 were unusually dry, whereas the summer of 2000 was wet. In 1999, unfed larvae survived poorly in all habitats (≤43%), but especially so in the deciduous forest (7%), which had significantly fewer ($P = 0.004$) survivors than the Virginia pine-southern red oak

Table 1. Numbers of *I. scapularis* nymphs and adults captured by flagging 5 times for 30 sec while walking slowly at each study site just before the first packets of ticks were placed in the leaf litter.

	Virginia Pine		Deciduous		White Pine Open		White Pine Grass	
	Nymphs	Adults	Nymphs	Adults	Nymphs	Adults	Nymphs	Adults
Site 1	1	0	9	0	7	0	7	1
Site 2	0	0	7	0	23	0	10	0
Site 3	0	1	6	0	10	0	1	0

sites (Table 2). Survival of unfed larvae was even worse in 2000, with <10% surviving. However, despite overall low levels of survival of unfed larvae in 2000, larval survival was somewhat greater ($P = 0.0496$) in the white pine with Nepal grass sites than the deciduous forest and white pine without Nepal grass sites. In 1999 fewer unfed nymphs in packets survived at the Virginia pine sites than at the deciduous forest sites ($P = 0.014$) (Table 3). At the Virginia pine and white pine with Nepal grass sites, significantly more unfed nymphs survived in vials than in packets ($P < 0.05$). Very few unfed nymphs (≤2%) survived in 2000. In general, substantial proportions of fed *I. scapularis* larvae and nymphs molted to the next stage and no differences in survival of fed ticks among the habitats were detected. In 1999, >72% of fed larvae in all four habitats survived to become nymphs, but in 2000 only about half (36–59%) survived. Most fed nymphs in all habitats survived to become adults, with >62% surviving in 1999 and >83% surviving in 2000.

Discussion

Based on flag sampling of nymphs and adults, the Virginia pine-southern red oak sites in this study appeared to support very few *I. scapularis.* Because Virginia pine habitats are often contiguous with deciduous forests in Maryland, and share deer and other hosts of *I. scapularis,* further comparative sampling of *I. scapularis* in these these habitats is warranted. Ginsberg and Zhioua (1996) also found lower densities of *I. scapularis* in pine (mostly pitch pine, *P. rigida* Miller) woods than deciduous thickets. In New Jersey Schulze et al. (1998) found *I. scapularis* nymphs much more numerous in pitch pine habitats than in three other habitats not dominated by pines at one study area. At a second study area where white pine was the dominant species, num-

Table 2. Numbers of unfed and fed larvae of *I. scapularis* surviving in each of the 4 habitats. Means per location on following line; percentage of ticks surviving in each habitat in parentheses.

	Virginia Pine	Deciduous	White Pine Open	White Pine Grass
Unfed Larvae				
1999	13/30[a] (43%)	2/30 (7%)	9/30 (30%)	10/30 (33%)
	4.3 ± 0.9	0.7 ± 0.7	3.0 ± 0.6	3.3 ± 1.9
2000	3/90 (3%)	2/90 (2%)	2/90 (2%)	8/90 (9%)
	0.3 ± 0.2	0.2 ± 0.2	0.2 ± 0.2	0.9 ± 0.3
Fed Larvae				
1999	15/20 (75%)	33/40 (83%)	18/25 (72%)	22/30 (77%)
	3.8 ± 0.5	4.7 ± 0.2	3.6 ± 0.5	3.8 ± 0.5
2000	32/54 (59%)	23/42 (55%)	15/42 (36%)	23/48 (48%)
	3.6 ± 0.7	3.3 ± 0.7	2.1 ± 0.5	2.9 ± 0.4

[a] Denominators (total number of ticks) vary because not all packets containing ticks were recovered. Some recovered packets were not intact, and all ticks had escaped.

Table 3. Numbers of unfed and fed nymphs of *I. scapularis* surviving in each of the 4 habitats. Means per location on following line; percentage of ticks surviving in each habitat in parentheses.

	Virginia Pine	Deciduous	White Pine Open	White Pine Grass
Unfed Nymphs				
In Packets				
1999	11/54[a] (20%)	26/48 (54%)	19/54 (35%)	9/42 (21%)
	1.2 ± 0.5	3.3 ± 0.5	2.1 ± 0.6	1.3 ± 0.7
2000	1/54 (2%)	0/48 (0%)	1/54 (2%)	0/48 (0%)
	0.1 ± 0.1	0	0.1 ± 0.1	0
In Vials				
1999	29/54 (54%)	23/48 (48%)	20/48 (42%)	25/42 (60%)
	3.2 ± 0.6	2.9 ± 0.6	2.5 ± 0.6	3.6 ± 0.7
Fed Nymphs				
1999	9/9 (100%)	9/12 (75%)	13/21 (62%)	10/12 (83%)
	3.0 ± 0	2.3 ± 0.5	1.9 ± 0.3	2.5 ± 0.3
2000	21/24 (88%)	20/24 (83%)	8/9 (89%)	16/18 (89%)
	2.6 ± 0.2	2.5 ± 0.2	2.7 ± 0.3	2.7 ± 0.2

[a] Denominators (total numbers of ticks) vary because not all packets or vials containing ticks were recovered. Some recovered packets and vials were not intact, and ticks had escaped.

bers of *I. scapularis* nymphs were not higher than in three other habitats not dominated by pines (Schulze et al. 1998).

In the present study, Virginia pine sites did not stand out as inhospitable to the survival of *I. scapularis* larvae and nymphs, rather survival of fed *I. scapularis* larvae and nymphs did not appear to vary consistently among the four types of habitat. As the summers progressed, the leaf litter in the deciduous forests steadily diminished to the extent that in a few instances packets were found exposed on bare soil, at the exact locations where they had been covered with fallen leaves when originally placed. This unusual (in the author's experience in Maryland deciduous forests) phenomenon may account for the comparatively poor survival of flat nymphs in packets in deciduous woods in the drought year 1999. Stafford (1994) found that nymphs of *I. scapularis* require elevated relative humidities for extended survival. Lord (1993) reported high mortality (90% in 45 d) of unfed *I. scapularis* nymphs confined in mesh packets (10 by 20 cm) partly buried in leaf litter and soil in deciduous woods in southern New York. With totally exposed packets subject to more desiccating conditions, it is not surprising that many ticks died. In the following year, which experienced regular summer rains, virtually all unfed nymphs in all habitats died. Only in 2000, when survival of unfed larvae was extremely low at all sites, was there any indication that Nepal grass colonies might be more favorable for survival of either life stage of *I. scapluris* than the open white pine woods. In general, flat nymphs and larvae survived better in 1999 than in 2000 when rainfall was plentiful. Flooding or prolonged submersion of the confined ticks may have caused mortality directly or created conditions favoring fungal or perhaps even bacterial pathogens harmful to the ticks. Using larger packets or cages which extend upward out of the litter would give mobile ticks the opportunity to move to more favorable microenvironments when conditions change (Yuval and Spielman 1990, Lord 1993). However, in the case of Lord (1993), unfed nymphs survived as poorly (<10%) as the unfed nymphs did in this study in 2000. In 1999, 20–54% of unfed nymphs in all four habitats survived the summer. Host-seeking nymphs of *I. scapularis* can disperse ≥5 m, thereby avoiding some deleterious situations (Carroll and Schmidtmann 1996). Although fed larvae and nymphs lack the mobility of their unfed counterparts, much higher percentages of fed than unfed ticks survived in both years.

In the late summer of 1999, an unknown person removed all the flags marking the positions of the tick packets from one open white pine site and a nearby white pine site with Nepal grass. Despite written descriptions of the locations of the packets, some were not found. A few other packets, perhaps removed by rodents or birds, were never recovered. Some packets, which were recovered, were found to have holes through which all the ticks escaped. These losses may have reduced some of the anticipated discriminating power of the study, but enough packets were recovered to detect any gross differences and some more subtle differences in tick survival among the habitats.

In conclusion, even though the study took place during a unusually dry summer and a wet summer, none of the habitats appeared obviously more favorable or unfavorable for survival of confined fed and unfed larvae and nymphs of *I. scapularis*. Further comparative sampling of host-seeking *I. scapularis* in Virginia pine-southern red oak and other Maryland habitats is needed.

ACKNOWLEDGMENTS

I thank Gene Scarpulla, Reservoir Natural Resources Office, Environmental Services Division, City of Baltimore, Department of Public Works, Bureau of Water and Waste Water, Eldersburg, MD, for his cooperation and for encouraging interest in the Nepal microstegium problem. I also express my gratitude to Kenneth Young and Eli Miramontes, USDA, ARS, Parasite Biology, Epidemiology and Systematics Laboratory, Beltsville, MD, for their assistance in making the packets used for confining the ticks.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 127–130

A NEW SPECIES OF *PLUMISPINA* ALBUQUERQUE (DIPTERA: MUSCIDAE) FROM SOUTHERN BRAZIL

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Abstract.—A **new species** of the genus *Plumispina* Albuquerque (Diptera: Muscidae), ***P. similis*** **Costacurta and Carvalho**, from Guarapuava, Paraná, southern Brazil is described, diagnosed and figured. A diagnosis of the genus *Plumispina* and a key to its two known species are provided.

Key Words: *Plumispina,* southern Brazil, systematics, taxonomy

The Neotropical genus *Plumispina* was proposed by Albuquerque (1954) to include a single species, *P. longipilis*, collected in the city of Rio de Janeiro, Brazil. The genus was accepted by Pont (1972) as monobasic, but recently Carvalho et al. (1993) considered *Plumispina* as a junior synonym of *Neodexiopsis* Malloch. In a key to the world genera of the Coenosiini, Couri and Pont (1999) revalidated *Plumispina.* In their cladistic analysis (Couri and Pont 2000) they indicated that *Plumispina* belongs to a larger monophyletic group containing 17 genera, including *Coenosia* Meigen.

In this paper, we describe a new species of *Plumispina* from Guarapuava which also was found in Ponta Grossa and Colombo, southern Brazil, present a diagnosis of the genus, and give a key to its two known species.

MATERIAL AND METHODS

This study is based on material deposited in the following institutions: Department of Zoology of "Universidade Federal do Paraná" (DZUP) and "Museu Nacional, Rio de Janeiro" (MNRJ).

The terminology and abbreviations used for the external morphology, including terminalia, follow McAlpine (1981) and Carvalho (1989).

SYSTEMATICS

Plumispina Albuquerque 1954

Type-species.—*Plumispina longipilis* Albuquerque 1954 (orig. desig.).

Diagnosis.—*Plumispina* is a typical Coenosiini because of the absence of prealar; the proepimeral lower seta directed downwards; and katepisternals with 1:1:1 setae forming an equilateral triangle. This genus belongs to a larger, monophyletic *Coenosia* group *sensu* Couri and Pont (2000). The main diagnostic characters of the genus are: male dichoptic; one pair of reclinate orbital setae; arista with short plumae; and hind tibia with long ciliation on anterodorsal, dorsal, and posterodorsal surfaces. This last character, together with the setulose sternite 1 and the shape of the hypandrium, gonopod and paramere (Fig. 3; Albuquerque

1954: figs. 5, 7–8) could be considered as autapomorphic characters of the genus.

KEY TO SPECIES OF *PLUMISPINA*

(Based on males; females are unknown.)

1. Arista bare on apical third; scutellum with pair of apical setae two-thirds as long as basal one; hind femur and hind tibia with many long hairs on ventral surfaces (Albuquerque 1954: 179, fig. 2); sternite 5 without a median projection on posterior margin (Albuquerque 1954: 179, fig. 9) (Brazil: Rio de Janeiro) . . . . *P. longipilis* Albuquerque

– Arista with short plumae along its length; scutellum with pair of apical setae similar to basal one; hind femur bare on ventral surface; hind tibia with few hairs on ventral surface; sternite 5 with a distinct median projection at posterior margin (Fig. 4) (Brazil: Paraná) . . . . *P. similis* Costacurta and Carvalho, n. sp.

Plumispina similis
Costacurta and Carvalho, new species

(Figs. 1–4)

Diagnosis.—This species is similar to *P. longipilis*, but it can be easily distinguished by the short plumae covering the whole length of the arista, scutellum with the pair of apical setae similar to the basal one, and a distinct projection on sternite 5 (Fig. 4).

Description.—Male: *Head:* 1 pair of reclinate fronto-orbital setae; post-ocellar divergent setae shorter than ocellar ones; 3 pairs of frontal setae; inner verticals reclinate. Antenna yellow; arista covered with short plumae along its length. Parafacialia slender and bare. Proboscis light brown and palpus pale yellow. Gena slender.

Thorax: Ground color dark brown with pruinose pubescence. Mesonotum with 3 slender light brown stripes. 1:3 dorsocentral setae; 2 acrostichals series, presutural setae stronger; 1 post-humeral; 1:1 intra-alar. Prealar setae absent. Scutellum with one pair of apical setae similar to basal one. Two proepisternal setae; 2 proepimerals, lower one downwards directed; 1:1:1 katepisternals, forming an equilateral triangle.

Legs: Yellow. Fore femur with 2 posterior basal setae; 2 posterodorsal; 4 posteroventral. Fore tibia with 1 posterior median seta; 2 posterodorsal; 1 preapical. Mid femur with 2 preapical posterodorsal; 3 ventral on basal ⅓. Mid tibia with 1 anterodorsal, 1 posterodorsal and 1 dorsal setae, all submedian. Hind femur with 2–3 anteroventral setae on apical half; 1 anterodorsal, 1 posterodorsal and 2 dorsal preapical setae. Hind tibia with several long hairs on anterodorsal, dorsal, posterodorsal surfaces and few hairs on ventral surfaces.

Wing: Clear, veins yellowish, bare except costa. Membrane entirely covered with microtrichia. Crossvein r-m about ¼ of length of dm-cu. Calypters and halter yellowish; lower calypter about twice as long as upper one.

Abdomen: Ground color yellowish; tergite 1+2 and anterior part of tergite 3 yellowish; posterior part of tergite 3, tergite 4 and tergite 5 brownish. Tergite 4 with 6 discal setae; tergite 5 with 4 discal setae and 6 marginal ones. Sternite 1 haired.

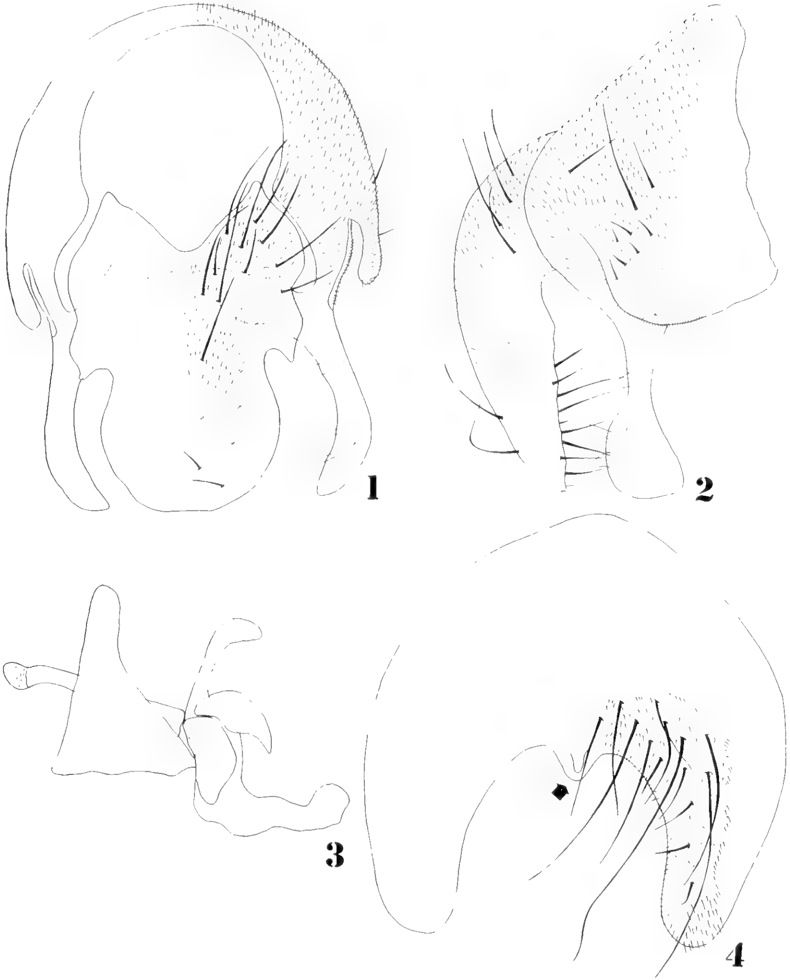
Terminalia: See Figs. 1–4.

Measurements: Length of body, 2.6–3.3 mm ($n = 63$). Length of wing, 2.8–3.9 mm ($n = 63$).

Female: Unknown.

Holotype.—Male in DZUP, labelled as follow: "Guarapuava—Paraná/Est. [resort] Sta. Clara/Brasil 08.ix.1986/Lev. [survey] Ent. [Entomological] PROFAUPAR [Project of fauna of Paraná]/Malaise"; "HOLOTIPO" [red label]. "Plumispina similis sp.n./Costacurta & Carvalho." Specimen in reasonable condition. It lacks the left hind leg. Abdomen in microvial attached to pin.

Paratypes.—Total: 62 ♂ (DZUP, MNRJ). BRAZIL. Paraná: Santa Clara, Guarapuava, 4.viii.1986 (2); ibidem, 11.viii.1986 (13); ibidem, 25.viii.1986 (3); ibidem, 1.ix.1986 (3); ibidem, 15.ix.1986 (5); ibidem, 20.x.1986 (1); ibidem, 27.x.1986 (3); ibidem, 3.xi.1986 (5); ibidem, 19.i.1987 (1); ibidem, 2.ii.1987 (1). Vila Velha, Ponta Grossa, BR [road] 376, 11.viii.1986 (1); ibidem, 6.x.1986 (2); ibidem, 13.x.1986 (1); ibidem, 20.x.1986 (1); ibidem, 27.x.1986 (1); 3.xi.1986 (4); ibidem, 17.xi.1986 (3); ibidem, 24.xi.1986 (1); ibi-



Figs. 1–4. *Plumispina similis.* 1, Epandrium, cercal plate and surstylus, posterior view. 2, Epandrium, cercal plate and surstylus, lateral view. 3, Aedeagus complex, lateral view. 4, Sternite 5, dorsal view (arrow indicates median projection).

dem, 22.xii.1986 (1); ibidem, 29.xii.1986 (3); ibidem 12.i.1987 (1); ibidem, 2.ii.1987 (2); ibidem, 9.iii.1987 (1). Colombo, BR 476, km 20, 24.xi.1986 (1); ibidem, 22.xi.1986 (1); ibidem, 29.xii.1986 (1).

Variation.—Some specimens have darker antennae than others. There is no other significant variation among the specimens.

Etymology.—From the Latin *similis* = similar; the specific name is based on the close general appearance to the other species of the genus.

Comments.—All material of *P. similis* was collected in Malaise traps in well-preserved forest areas.

ACKNOWLEDGMENTS

We thank Gabriel Melo ("Universidade Federal do Paraná"—DZUP) and Denise Medeiros Pamplona ("Museu Nacional do Rio de Janeiro"—MNRJ) for their critical review of the manuscript. We are grateful to the "Conselho Nacional de Desenvolvimento Cientifico e Tecnológico, CNPq," an agency of the Brazilian Government for scientific and technological development, for a grant to CJBC (process number 300043/86-4) and to MSC (process number 300386/80-0). This paper is number 1329 of the "Departamento de Zoologia of Universidade Federal do Paraná—DZUP."

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 131–137

SYMPHYTA (HYMENOPTERA) SPECIES RICHNESS IN MIXED OAK-PINE FORESTS IN THE CENTRAL APPALACHIANS

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Abstract.—Malaise trap sampling in the George Washington National Forest, Augusta Co., Virginia, and the Monongahela National Forest in Pocahontas Co., West Virginia, in the central Appalachian Mountains over a five-year period at 36 sites resulted in the collection of 155 species in eight families of Symphyta. Tenthredinidae were the most species rich with a total of 121 species and Pergidae were the most abundant with a total of 4,529 specimens. A comparison with other long-term, Malaise trap-based sawfly surveys in diverse habitats indicates that there is a relationship between the number of specimens identified and species richness documented.

Key Words: Symphyta, species richness, central Appalachian Mountains

Among insects, larvae of Symphyta are second only to caterpillars (Lepidoptera) as the most commonly encountered foliage-feeding holometabolous insect group. With the exception of one family, the Orussidae, all Symphyta are phytophagous, the majority feeding externally on foliage. While many studies on the diversity and biology of sawflies have been focused on certain economic species and on coniferous pest species, only a few studies have taken a broader approach to the group. Smith and Barrows (1987) sampled sawflies with Malaise traps over a six-year period in urban environments. Smith (1991) documented the diversity of *Macrophya* (Tenthredinidae) sampled over a five-year period in the Piedmont of central Virginia. Sawflies have been included in other Malaise sampling studies that examined total abundance, including comparing trap design in Ontario (Darling and Packer 1988) and general sampling in New York (Matthews and Matthews 1970). A number of unpublished survey reports from Maryland and Virginia has been generated by one of us (DRS) for comparison. The sawfly species collected during our five-year study were taken in the central Appalachian Mountains in mixed oak-pine forests.

This study is part of a larger effort to document potential non-target impacts from aerial application of *Bacillus thuringiensis* Berliner variety *kurstaki* and Gypchek(TM) in gypsy moth inhabited oak-pine forests in the central Appalachians.

MATERIALS AND METHODS

Eighteen 200 ha study plots were set up in the central Appalachian Mountains with nine each in the George Washington National Forest (GWNF) and Monongahela National Forest (MNF) (Fig. 1). The GWNF plots were in Augusta Co., VA,

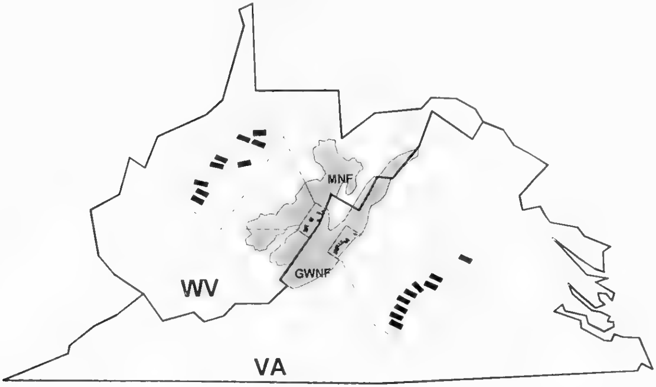

Fig. 1. Location of plots in the George Washington National Forest (GWNF) in Virginia and in the Monongahela National Forest (MNF) in West Virginia.

centered at 38°07′30″N, 79°22′30″W, with traps set at elevations of 561–744 m along the southeast slope of Great North Mountain. The MNF plots were in Pocahontas Co., WV, centered at 38°15′N, 80°00′W, with traps set at elevations of 805–1,232 m. The MNF plots were in groups of three on three different mountains. In addition to oaks (*Quercus* spp.), both sampling areas have high proportions of pines (*Pinus* spp.), hickories (*Carya* spp.), and maples (*Acer* spp.) (Fig. 2). During the sampling period, the MNF study sites had lower average temperatures than the GWNF (Fig. 3). Al-

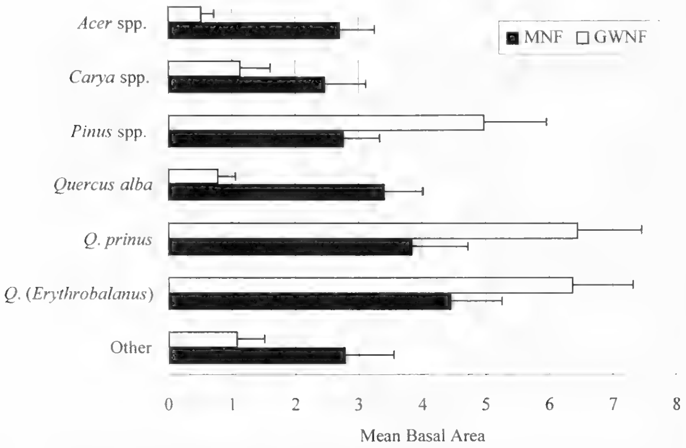

Fig. 2. Abundance of major tree groups as indicated by mean basal area in George Washington National Forest (GWNF) in Virginia and the Monongahela National Forest (MNF) in West Virginia.

though the MNF plots are in a region considered more mesic than the GWNF sampled area (Owenby and Ezell 1992a, b), rainfall during the sampling periods did not clearly reflect this.

A randomly placed 30 ha subplot was established within each study plot. Two Townes-styled Malaise traps (Townes 1972) were set up at different elevations on each subplot, usually with one on a ridge, the other in a valley. Traps were placed on south facing slopes or ridges, and the length oriented east-west with the collecting head up slope. Fifteen weekly samples were taken from mid-May to mid-August from 1995 to 1999. Adult Symphyta were extracted from samples and identified by D.R. Smith. Voucher specimens are deposited in the West Virginia University Arthropod Collection, Morgantown, and the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Results and Discussion

Over the five years of sampling with 36 Malaise traps, a total of 8,884 adult sawflies were collected and identified to 155 species (Table 1). Species richness was less on the GWNF plots than on the MNF plots, with 104 and 127 species identified, respectively (Table 2). Eight families of sawflies were represented, with the Tenthredinidae by far the most diverse with 121 species, followed by the Pamphiliidae with 14 species. Tenthredinidae abundance with 4,240 individuals was less than Pergidae abundance of 4,529 specimens.

There are some distinct differences between the GWNF and MNF study plots that may influence their respective species richness, including elevation, rainfall, and perhaps most importantly, the distribution of the study plots. These factors, in turn, likely influence the plant species present. The GWNF plots are regularly arranged along the broad southeast slope of Great North Mountain, with 23 tree species identified. In contrast, the MNF study plots are scattered on three mountains with various aspects, with a total of 31 tree species identified. Many of the sawflies collected were not tree herbivores, but the eight additional tree species on the MNF plots suggested a greater general plant diversity at MNF and this likely influenced the total sawfly species richness.

The total richness of 155 species is similar to the 117 species reported by Smith and Barrows (1987) in the Washington, DC, metropolitan area environments, located approximately 200 km northeast of the GWNF and MNF plots. Smith and Barrows sampled for six years at two sites in urban environments and two years at two sites in lesser developed environments using similar styled Malaise traps. In terms of specimens examined, they required only 948 specimens to reach 117 species, and the present study included 8,884 specimens. In addition to different trap design and vegetation at the study sites, it should be noted that Smith and Barrows sampled from late March to early November, whereas our sampling period was from mid-May to mid-August; thus, we possibly missed species that fly only in early spring or late summer and fall. This, along with a great variety of environments, may account for the richness Smith and Barrows sampled with less effort.

Smith (1991) studied the species richness of *Macrophya* Dahlbom (Tenthredinidae) over a five-year period with up to 12 Townes-style Malaise traps per year in a 550 acre area in central Virginia. He identified 28 of 44 *Macrophya* species known east of the Rockies (Gibson 1980), compared with 16 species in our study. Although our trapping periods overlapped with the typical flight times of *Macrophya* (Smith 1991), the known host plants (primarily *Sambucus* spp. and *Viburnum* spp.) were not common on our sites as they were on Smith's central Virginia site.

In Malaise samples taken in a New York mesic forest, Matthews and Matthews (1970) found that Tenthredinidae was the most abundant hymenopteran family, other

Table 1. Family species richness sampled 1995–1999 in the George Washington National Forest (G) in Virginia and in the Monongahela National Forest (M) in West Virginia.

Argidae

Arge macleayi (Leach)^{G,M}, *Arge pectoralis* (Leach)^{G,M}, *Arge quidia* Smith^{G,M}, *Arge willi* Smith^{G,M}, *Schizocerella pilicornis* (Holmgren)^{G}, *Sphacophilus celluaris* (Say)^{G}, *Sterictiphora serotina* Smith^{G}

Cephidae

Janus abbreviatus (Say)^{M}, *Janus bimaculatus* (Norton)^{G}, *Janus integer* (Norton)^{G,M}

Diprionidae

Neodiprion sp. (male)^{G}

Pamphiliidae

Acantholyda angulata (MacGillivray)^{M}, *Acantholyda luteomaculata* (Cresson)^{M}, *Acantholyda zappei* (Rohwer)^{G}, *Neurotoma fasciata* (Norton)^{G}, *Onycholyda luteicornis* (Norton)^{G,M}, *Onycholyda quebecensis* (Provancher)^{G}, *Onycholyda rufofasciatus* (Norton)^{M}, *Pamphilius middlekauffi* Shinohara & Smith^{G}, *Pamphilius ochreipes* (Cresson)^{G}, *Pamphilius pallimaculus* (Norton)^{G,M}, *Pamphilius persicum* MacGillivray^{M}, *Pamphilius phyllisae* Middlekauff^{M}, *Pamphilius rileyi* (Cresson)^{G,M}, *Pamphilius semicinctus* (Norton)^{M}

Pergidae

Acordulecera dorsalis Say^{G,M}, *Acordulecera maculata* MacGillivray^{G,M}, *Acordulecera mellina* MacGillivray^{G,M}, *Acordulecera pellucida* (Konow)^{G,M}

Tenthredinidae

Aglaostigma quattuordecimpunctatum (Norton)^{G,M}, *Aglaostigma semiluteum* (Norton)^{M}, *Aglaostigma* sp. #1^{M}, *Ametastegia aperta* (Norton)^{G,M}, *Ametastegia becra* Smith^{G,M}, *Ametastegia pallipes* (Spinola)^{M}, *Ametastegia pulchella* (Rohwer)^{G,M}, *Aneugmenus flavipes* (Norton)^{G,M}, *Caliroa lobata* MacGillivray^{G}, *Caliroa lunata* MacGillivray^{G,M}, *Caliroa obsoleta* (Norton)^{M}, *Caliroa quercuscoccinea* (Dyar)^{G,M}, *Caliroa* spp. (males)^{G,M}, *Caulocampus acericaulis* (MacGillivray)^{M}, *Craterocercus fraternalis* (Norton)^{G,M}, *Craterocercus obtusus* (Klug)^{G,M}, *Dimorphopteryx pinguis* (Norton)^{G,M}, *Dimorphopteryx virginicus* Rohwer^{M}, *Dolerus hebes* Goulet^{G}, *Dolerus nortoni* Ross^{M}, *Empria coryli* (Dyar)^{M}, *Empria maculata* (Norton)^{G,M}, *Empria multicolor* (Norton)^{G,M}, *Erythraspides vitis* (Harris)^{G}, *Eupareophora parca* (Cresson)^{M}, *Eutomostethus ephippium* (Panzer)^{G,M}, *Fenusa ulmi* Sundevall^{M}, *Halidamia affinis* (Fallen)^{M}, *Hemichroa militaris* (Cresson)^{M}, *Hemitaxonus albidopictus* (Norton)^{G,M}, *Hemitaxonus dubitatus* (Norton)^{M}, *Hoplocampa halcyon* (Norton)^{M}, *Hoplocampa marlatti* (Rohwer)^{G,M}, *Leucopelmonus annulicornis* (Harrington)^{G,M}, *Macremphytus tarsatus* (Say)^{G} *Macremphytus testaceus* (Norton)^{G,M}, *Macrophya cassandra* Kirby^{G,M}, *Macrophya flavicoxae*(Norton)^{M}

Table 1. Continued.

Macrophya flavolinea (Norton)^{M}, *Macrophya flavolineata* (Norton)^{M}, *Macrophya flicta* MacGillivray^{G}, *Macrophya formosa* (Klug)^{G,M}, *Macrophya goniphora* (Say)^{G,M}, *Macrophya lineata* (Norton)^{M}, *Macrophya macgillivrayi* Gibson^{M}, *Macrophya masoni* Gibson^{G}, *Macrophya mensa* Gibson^{G}, *Macrophya nigra* (Norton)^{G,M}, *Macrophya pulchella* (Klug)^{G,M}, *Macrophya tibiator* Norton^{G,M}, *Macrophya trisyllaba* (Norton)^{M}, *Macrophya varia* (Norton)^{G}, *Monophadnoides geniculatus* (Hartig)^{G,M}, *Monophadnoides pauper* (Provancher)^{G,M}, *Monophadnus aequalis* MacGillivray^{G,M}, *Monophadnus bakeri* Smith^{M}, *Monophadnus conspiculatus* MacGillivray^{G}, *Monophadnus pallescens* (Gmelin)^{M}, *Monostegia abdominalis* (F.)^{M}, *Nefusa ambigua* (Norton)^{G,M}, *Nematus* sp. #1^{G,M}, *Nematus* sp. #2^{G,M}, *Nematus* sp. #3^{G,M}, *Nematus* sp. #4^{G,M}, *Nematus abbotii* (Kirby)^{G,M}, *Nematus carpini* (Marlatt)^{M}, *Nematus coryli* Cresson^{M}, *Nematus latifasciatus* Cresson^{M}, *Nematus lipovskyi* Smith^{G,M}, *Nematus* near *actriceps* (Marlatt)^{G,M}, *Nematus ostryae* (Marlatt)^{G,M}, *Nematus radialis* Smith^{G,M}, *Nematus tibialis* Newman^{G,M}, *Neopareophora litura* (Klug)^{G,M}, *Pachynematus* sp. #1^{M}, *Pachynematus* sp. #2^{G}, *Pachynematus corniger* (Norton)^{G,M}, *Pachynematus extensicornis* (Norton)^{G}, *Paracharactus rudis* (Norton)^{G,M}, *Periclista albicollis* (Norton)^{G,M}, *Periclista diluta* (Cresson)^{G,M}, *Periclista inaequidens* (Norton)^{M}, *Periclista marginicollis* (Norton)^{G,M}, *Periclista media* (Norton)^{G,M}, *Periclista stannardi* Smith^{M}, *Phymatocera fumipennis* (Norton)^{M}, *Priophorus pallipes* (Lepeletier)^{G,M}, *Pristiphora banksi* Marlatt^{G,M}, *Pristiphora bivittata* (Norton)^{G}, *Pristiphora chlorea* (Norton)^{G,M}, *Pristiphora cincta* (Newman)^{G,M}, *Pristiphora mollis* (Hartig)^{M}, *Pristiphora rufipes* Lepeletier^{M}, *Pristiphora* sp. #1^{M}, *Pristiphora zella* Rohwer^{G}, *Profenusa alumna* (MacGillivray)^{G,M}, *Pseudodineura parva* (Norton)^{M}, *Strongylogaster impressata* Provancher^{M}, *Strongylogaster multicincta* Norton^{G}, *Strongylogaster polita* Cresson^{G}, *Strongylogaster soriculatipes* Cresson^{G}, *Strongylogaster tacita* (Norton)^{M}, *Taxonus borealis* MacGillivray^{G,M}, *Taxonus epicera* (Say)^{G,M}, *Taxonus pallicoxus* (Provancher)^{G,M}, *Taxonus pallidicornis* (Norton)^{G,M}, *Taxonus pallipes* (Say)^{G,M}, *Taxonus proximus* (Provancher)^{G,M}. *Taxonus rufocinctus* (Norton)^{G,M}, *Taxonus spiculatus* (MacGillivray)^{G,M}, *Taxonus terminalis* (Say)^{G,M}, *Tenthredo appalachia* Goulet & Smith^{M}, *Tenthredo fernowi* Goulet & Smith^{G}, *Tenthredo grandis* (Norton)^{M}, *Tenthredo lobata* (Norton)^{G}, *Tenthredo masneri* Goulet & Smith^{M}, *Tenthredo mellicoxa* (Provancher)^{M}, *Tenthredo rufopecta* (Norton)^{G,M}, *Tenthredo* sp. #1^{M}, *Tenthredo verticalis* Say^{M}, *Tenthredo yuasi* MacGillivray^{G,M}

Xiphydriidae

Xiphydria abdominalis Say^{M}, *Xiphydria maculata* Say^{M}, *Xiphydria tibialis* Say^{G,M}

Xyelidae

Xyela alpigena (Strobl)^{G,M}, *Xyela* sp. (males)^{G,M}

Table 2. Family species richness sampled 1995–1999 in the George Washington National Forest (GWNF) in Virginia and in the Monongahela National Forest (MNF) in West Virginia.

Family	Richness		
	GWNF	MNF	Total
Argidae	7	4	7
Cephidae	2	2	3
Diprionidae	1	0	1
Pamphiliidae	8	9	14
Pergidae	4	4	4
Tenthredinidae	79	103	121
Xiphydriidae	1	3	3
Xyelidae	2	2	2
Total	104	127	155

than Ichneumonidae. Smith and Barrows (1987) found the Tenthredinidae to be relatively abundant as well in urban environments, with 590 of the 948 sawflies sampled belonging to this family. Our study also found high abundance of Tenthredinidae, although Pergidae were most abundant, with a single species, *Acordulecera dorsalis* Say, accounting for more than half of the sawflies (4,481 specimens). Two of the preferred hosts of *A. dorsalis*, oaks and hickories, are common trees on our study plots and undoubtedly account for the high abundance of *A. dorsalis*.

D. R. Smith or D. R. Smith and E. M. Barrows have surveyed sawflies in various settings in Maryland and Virginia (D. R. Smith, unpublished data). These studies are similar to their Washington, DC, survey (Smith and Barrows 1987) and the present study in that these surveys with Malaise traps were during most or all of the sawfly flight times for the area surveyed over multiple years. The studies vary in number of traps used, number of years sampled, and numerous habitat characteristics (Table 3). Even with these variables, an interesting correlation exists between the number of specimens identified and the sampled species richness (Fig. 4). The plotted data with just six data points does not show an asymptote to suggest an approximate sample size that may be adequate to estimate species richness in diversely vegetated environments. It only suggests that it may be somewhere above approximately 9,000 specimens. It should be noted that when surveying a highly diverse taxon like the Symphyta with more than 1,100 species in North America (Smith 1979), that passive traps will collect species normally not found at the trapping site. It may be that these "accidentals" and rare species account for the strong sample size-species

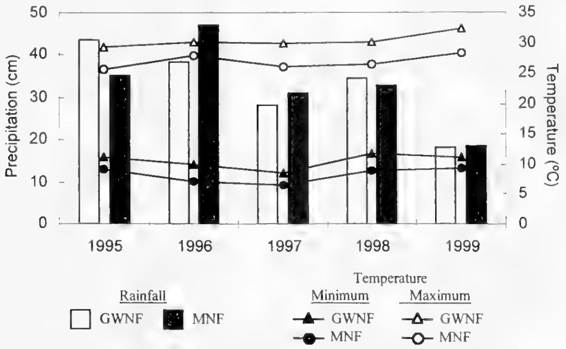

Fig. 3. Temperature and rainfall measurements from mid-May through mid-August for years 1995–1999 in the George Washington National Forest (GWNF) in Virginia and in the Monongahela National Forest (MNF) in West Virginia.

Table 3. Comparison of richness of Symphyta sampled at some survey sites, counts of specimens identified, number of Malaise traps used, and number of years sampled.

Study Area	General Description of Sampling Area	Species Richness	Specimens Identified	Number of Traps	Years of Sampling	Years
Green Ridge State Park, Allegheny Co., MD (E. Barrows, D.R. Smith)	oak-hickory forest, flood plain to ridge	118	3,033	6	3	1990–1992
Finzel Swamp, Garrett Co., MD (E. Barrows, D.R. Smith)	open field, forest edge, swamp edge	139	5,397	2	2	1991–1992
Beltsville Agricultural Research Center, MD (D.R. Smith)	bog, coniferous, deciduous, bottomland	152	8,907	3–4	3	1991–1993
UV Blandy Experimental Farm and State Arboretum, Clarke, Co. VA (D.R. Smith)	forest, forest edges, pond edges	189	21,378	5–11	4	1990–1993
Washington, DC and vicinity (Smith and Barrows 1987)	various urban environments	117	948	5–8	2–6	1980–1986
G. Washington and Monongahela National Forests, VA, WV	oak-pine forests	155	8,884	36	5	1995–1999

richness correlation. Further examination of the unpublished data may explain the apparent relationship.

One of the distinct differences between these studies is the number of Malaise traps used. In our study, we used 36 traps placed in similar forest environments. The two to 11 traps used in the other studies were generally placed along forest margins or in open areas, taking advantage of open flight

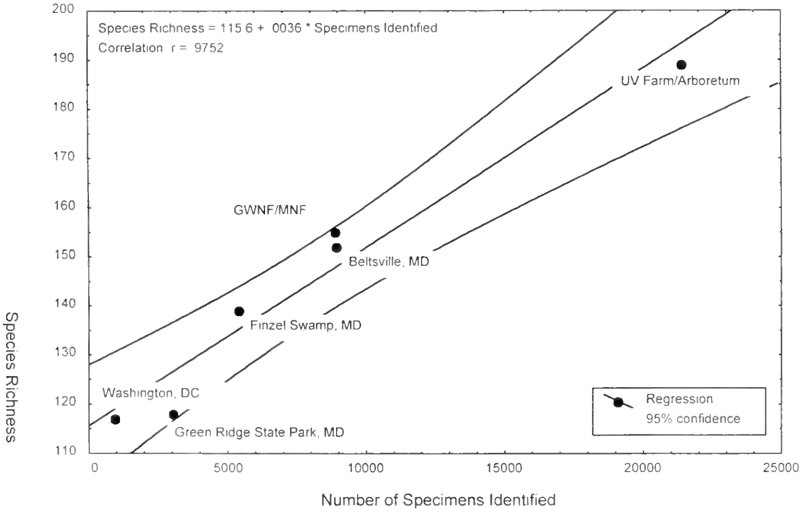

Fig. 4. Regression analysis of species richness and specimens identified in published and unpublished surveys of Symphyta. See Table 3 for study areas.

paths, increased sunlight, and areas of potentially greater host plant diversity. Traps placed in transition zones (i.e., forest margins) may quickly realize large, species-rich samples, but additional traps on either side of transition zones need to be included for more habitat-specific study.

In conclusion, Malaise trapping is effective in collecting large numbers of sawflies to estimate species richness. The species richness of sawflies in old, secondary growth in the central Appalachian Mountains is comparable with other plant species-rich habitats in adjacent areas. In addition, these surveys may indicate that in long-term studies, specimen counts are the most important variable to document taxonomically diverse insect taxa in host or prey species-rich habitats.

ACKNOWLEDGMENTS

This report represents a portion of a study funded by the USDA Forest Service as Cooperative Agreement 42-793; we are grateful for that support. We thank Richard Reardon, USDA Forest Service, and our staff of research assistants, and graduate and undergraduate students. In particular, we thank Crystal B. Mayle and Cathy J. Anderson for their contributions. We thank the following for review of the manuscript: Changlu Wang, Purdue University, Nathan M. Schiff, USDA Forest Service, Stoneville, MS, and Manya B. Stoetzel and Thomas J. Henry, Systematic Entomology Laboratory, USDA, Beltsville, MD, and Washington, DC, respectively. This paper is published with the approval of the Director of the West Virginia University Agricultural and Forestry Experiment Station as Scientific Article #2812.

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105(1), 2003, pp. 138–143

TWO NEW SPECIES OF *HYDROMETRA* LATREILLE (HETEROPTERA: HYDROMETRIDAE) FROM THAILAND

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Abstract.—The water measurers ***Hydrometra chaweewanae* Sites and Polhemus** and ***Hydrometra akekawati* Sites and Polhemus** are described and illustrated. Specimens of both species were collected among emergent vegetation in an anthropogenic pond in Chaiyaphum Province, north-central Thailand. This brings the number of described species of the genus in Thailand to 10.

Key Words: Insecta, Hydrometridae, water measurer, *Hydrometra,* new species, Thailand

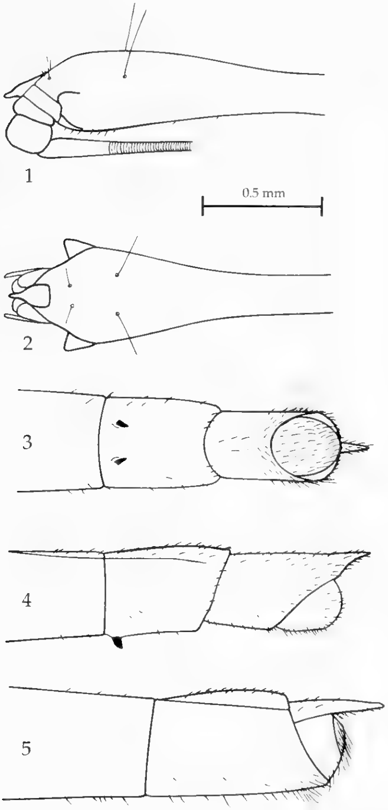
Hydrometrids, or water measurers, typically occur on the surface of still water and floating debris among emergent, marginal vegetation in either lotic or lentic systems. They seldom venture into open water or onto banks except when disturbed, and are weakly predaceous, feeding on dead or dying organisms. The ecology and morphology of Hydrometridae was summarized by Andersen (1982).

The Southeast Asian fauna of *Hydrometra* Latreille was revised by Lundblad (1933) and Hungerford and Evans (1934), following which appeared numerous descriptions of new species scattered throughout the literature. Subsequently, Polhemus and Polhemus (1995) revised the genus for Indochina and the Malay Archipelago, and Polhemus and Lansbury (1997) for Australia, Melanesia, and the southwestern Pacific. The fauna of Indochina and the western Malay Archipelago includes 18 described species of *Hydrometra* (Hungerford and Matsuda 1961, Polhemus and Polhemus 1995), of which 13 are known from the mainland of Indochina. Specifically, the known fauna of *Hydrometra* of Thailand includes eight described species (Zettel and Chen 1996). Presented here are descriptions of two new species from north-central Thailand, bringing the known fauna of *Hydrometra* of Thailand to ten.

METHODS

Collecting was conducted in cooperation with the Faculty of Forestry, Kasetsart University, Bangkok, and with permission of the Royal Forestry Department, Bangkok, Thailand. All measurements are expressed as mm. Because a sufficient number of female specimens were available, length and width are given as a mean and range. For the males, only a range is given. Measurements were taken as described by Polhemus and Polhemus (1995). Body width immediately posterior to the procoxal acetabulae is best observed and measured in ventral view.

The male holotypes are deposited in the Enns Entomology Museum, University of Missouri–Columbia (UMC). Paratypes are deposited in the insect collection of UMC, the Royal Thai Forestry Department, Bang-



Figs. 1–5. *Hydrometra chaweewanae*. 1, Lateral aspect of anterior portion of head. 2, Dorsal aspect of anterior portion of head. 3, Ventral aspect of terminal abdominal segments of male. 4, Lateral aspect of terminal abdominal segments of male. 5, Lateral aspect of terminal abdominal segments of female.

kok, and the J. T. Polhemus Collection, eventually to the Smithsonian Institution, Washington, D.C.

***Hydrometra chaweewanae* Sites and Polhemus, new species**

(Figs. 1–5)

Micropterous male (n = 2).—Length: 7.88–7.97. Width: 0.36–0.40.

Color and texture: Ground color medium brown dorsally, light brown ventrally. Eyes red, maxillary plates white. Head behind eyes and nota with light brown longitudinal stripe on midline. Legs light brown becoming darker brown distally. Femora light brown with medium brown apices. Dorsolateral sinuate light brown stripe on pronotum above dorsal ends of pro- and mesothoracic pleural sutures. Abdominal tergites I–VII light brown. Connexiva with dark brown lateral and mesal margins. Broad longitudinal medium brown stripe below level of spiracles on abdominal sterna I–VII. Tergum VIII and genital operculum clothed with fine pubescence. Abdominal terga I–VI and sterna I–VIII shining. Otherwise, mostly pruinose throughout.

Structure: Head long (2.54), widest at antennal tubercles (0.36). Ventral surface with short, bristlelike, black setae, especially noticeable anteriorly. Maxillary plate subrectangular and not extending anteriorly past anteclypeus and gular lobe. Gular lobe with outer margin rounded, covering base of rostrum (Fig. 1). Rostrum reaching posteriorly to midway between eyes and prosternum. Ratio of anteocular/postocular portions of head (2:1). Ratio of interocular distance to width of compound eye (4:7). Anteclypeus broadly triangular and markedly acuminate anteriorly (Fig. 2). Antennal length ratio I:II:III:IV, 16, 44, 110, 31. Prothorax with row of small pits delimiting collar. Pronotal length 1.08, remainder of thorax 0.96. Abdominal length 3.73. Short, bristlelike, black setae on pro- and mesosternum, becoming sparse except for laterally on metasternum, continuing laterally on abdominal sterna. Intrasegmental distance between coxae: pro- (0.04), meso- (0.06), meta- (0.14). Intersegmental distance between pro- and mesocoxae 0.48, between meso- and metacoxae 0.92. One puncture anterior and posterior to pleural suture on pro- and mesothorax and one puncture on metaepisternum. Paired posteriorly recurved, black, sclerotized hooks near anterior margin of sternite VII (Figs. 3–4).

Micropterous female (n = 7).—Length: $\bar{y}$ = 8.74, range = 8.30–8.80. Width: $\bar{y}$ = 0.41, range = 0.38–0.42.

Similar to male in most respects but with following differences: Metasternum and abdominal sterna with midventral, longitudinal brown stripe, faint anteriorly, becoming more pronounced posteriorly, abruptly pronounced on sternite VII. Abdominal terminalia as in Fig. 5. Tergum VII convex, raised slightly posteriorly. Body of tergite VIII about as long as wide and with pointed apical process. Apical process of tergite VIII slightly deflexed at apex. Tergites VII and VIII with short, recumbent setae.

Macropterous form.—Unknown

Brachypterous form.—Unknown

Type material.—Holotype, micropterous ♂: THAILAND: Chaiyaphum Prov., Amphur Khon Sarn Tumbon Heuy Yang, pond, 2 July 1998, L-228, Vitheepradit & Sawangsak. Paratypes, micropterous: same data as holotype, 2 ♂, 11 ♀.

Additional material examined.—THAILAND: Phang Nga Prov., lake at Samanora Park, 3 km E of Muang District, 13 July 1997, Sites & Permkam, L-141, 1 ♂ (UMC); Songkhla Prov., Hat Yai, PSU campus, 5 January 1995, pond, Sites & Nichols, 1 ♀ (UMC).

Etymology.—This species is named after Dr. Chaweewan Hutacharern, Royal Forestry Department, Bangkok, an alumna of the University of Missouri. On numerous occasions, including for this project, she provided valuable advice for field work and assistance with logistics in Thailand.

Diagnosis.—This species is recognizable in both sexes by the acuminate process at the anterior tip of the anteclypeus. Males have a pair of posteriorly recurved, black, sclerotized hooks near the anterior margin of sternite VII.

Comparative notes.—In this region, males of *H. chaweewanae* most closely resemble those of *H. annamana* Hungerford and Evans, *H. carinata* Polhemus and Polhemus, and *H. cracens* Polhemus and Polhemus because the recurved, black, sclerotized hooks near the anterior margin of sternite VII superficially resemble the brush of hairs possessed by the these species. The males of *H. chaweewanae* more closely resemble males of *H. akekawati* (see description below), but the size and shape of the recurved black hooks are distinct from the black-tipped prongs of the latter. The highly acuminate anteclypeus of both sexes of *H. chaweewanae* will distinguish this species from all other described species in the region. In the key to the species of *Hydrometra* of Indochina and western Malay Archipelago (Polhemus and Polhemus 1995), *H. chaweewanae* will key to couplet 11.

Distribution.—This species was collected at the type locality in north-central Thailand, and in southern Thailand in Phang Nga and Songkhla provinces.

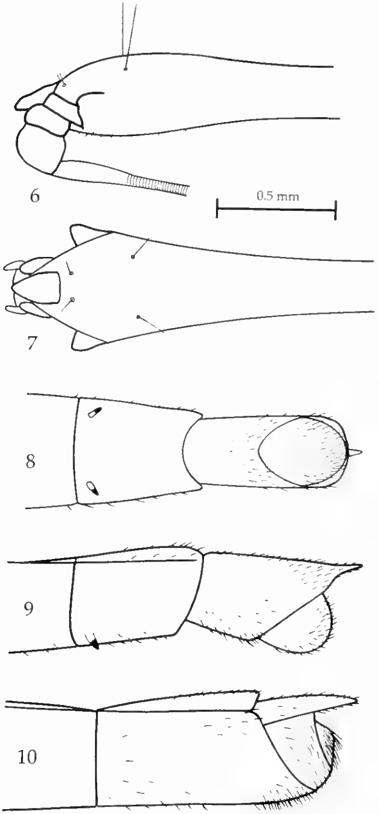
Discussion.—The type locality was a quadrate, apparently anthropogenic pond adjacent to a small gas station and may be viewed in a Locality Image Database via a link from the Enns Entomology Museum web site. The pond was situated between a highway and corn field. The perimeter of the pond was heavily vegetated with emergent and submergent vegetation. This species was collected with five congeners: *H. annamana* Hungerford and Evans, *H. carinata* Polhemus and Polhemus, *H. greeni* Kirkaldy, *H. orientalis* Lundblad, and *H. akekawati* described below.

Hydrometra akekawati
Sites and Polhemus, new species

(Figs. 6–10)

Micropterous male.—(n = 3): Length: 8.30–8.72. Width: 0.42–0.44.

Color and texture: Ground color dorsally medium brown, ventrally head and genital operculum medium brown, thorax and abdomen light brown. Eyes red, maxillary plates white. Pronotum with narrow light brown median longitudinal stripe, metanotum with broad light brown median band. Legs mostly light brown. Femora



Figs. 6–10. *Hydrometra akekawati.* 6, Lateral aspect of anterior portion of head. 7, Dorsal aspect of anterior portion of head. 8, Ventral aspect of terminal abdominal segments of male. 9, Lateral aspect of terminal abdominal segments of male. 10, Lateral aspect of terminal abdominal segments of female.

and tibiae light brown with medium brown apices. Tarsi medium brown. Dorsolateral sinuate light brown stripe on pronotum above dorsal ends of pro- and mesothoracic pleural sutures. Mesothoracic wing extending posteriorly to level of anterior end of connexiva. Abdominal tergum light brown, darker anteriorly and posteriorly. Connexiva medium brown with dark brown lateral and mesal margins. Longitudinal medium brown stripe ventrad of level of spiracles on abdominal sterna I–VII. Terga VII, VIII, and genital operculum clothed with dark brown recumbent setae. Abdominal terga I–VI shining. Otherwise, mostly pruinose throughout dorsally and ventrally.

Structure: Head long (2.54), widest at antennal tubercles (0.37). Ventral surface with short, bristlelike, dark brown setae. Maxillary plate subrectangular and not extending anteriorly past anteclypeus and gular lobe (Fig. 6). Gular lobe with outer margin rounded, covering base of rostrum (Fig. 6). Rostrum reaching posteriorly to ¾ distance between compound eye and prosternum, nearly reaching anterior end of prothoracic trochanter. Ratio of anteocular/postocular portions of head (1.9:1). Ratio of interocular distance to width of compound eye (5:8). Anteclypeus elongate, conical, with sides slightly convex and apex narrowly rounded (Fig. 7). Antennal length ratio I:II:III:IV, 21, 45, 116, 75. Prothorax with coarse punctures delimiting collar and throughout posterior half. Pronotal length 1.24, remainder of thorax 0.76. Abdominal length 4.55. Short, bristlelike, dark brown setae on head, thorax, and abdomen. Intrasegmental distance between coxae: pro- (0.06), meso- (0.10), meta- (0.18). Intersegmental distance between pro- and mesocoxae 0.56, between meso- and metacoxae 0.96. Thoracic pleura punctate: generally, one to three punctures anterior and four posterior to pleural suture 1, three each anterior and posterior to pleural suture 2, one on metaepisternum and row of three to five at anterior margin of mesepisternum. Paired, posteriorly directed, black-tipped, sclerotized prongs near anterior margin of sternite VII (Figs. 8, 9).

Micropterous female.—(n = 7): Length: $\bar{y}$ = 9.44, range = 9.30–9.71. Width: $\bar{y}$ = 0.48, range = 0.44–0.52.

Similar to male in most respects but with following differences: Abdominal terminalia as in Fig. 10. Body of tergum VIII medium brown, pubescent, about as long as wide, and with dark brown pointed apical process subequal in length. Apical process of tergite VIII slightly angled upward throughout its length. Dorsal margin of tergum VIII straight when viewed laterally.

Macropterous form.—Unknown

Brachypterous form.—Unknown

Type material.—Holotype, micropterous ♂: THAILAND: Chaiyaphum Province, Amphur Khon Sarn Tumbon Heuy Yang, pond, 2 July 1998, L-228, Vitheepradit & Sawangsak. Paratypes, micropterous: same data as holotype, 3 ♂, 7 ♀.

Etymology.—This species is named after Mr. Akekawat Vitheepradit, University of Missouri, who collected this species as a component of his masters thesis research.

Diagnosis.—This species is recognizable in males by a pair of posteriorly directed, black-tipped, sclerotized prongs near the anterior margin of sternite VII. Both sexes have an elongate, conical anteclypeus with slightly convex sides and narrowly rounded apex, and a punctate pronotum with many punctures on the pro- and mesothoracic pleura.

Comparative notes.—In this region, males of *H. akekawati* most closely resemble those of *H. annamana, H. carinata* and *H. cracens* because the posteriorly directed, black-tipped, sclerotized prongs near the anterior margin of sternite VII superficially resemble the brush of hairs possessed by these three species. The males of *H. akekawati* more closely resemble males of *H. chaweewanae,* but the size and shape of the black-tipped prongs are distinct from the recurved black hooks. In the key to the species of *Hydrometra* of Indochina and western Malay Archipelago (Polhemus and Polhemus 1995), *H. akekawati* will key to couplet 11.

Distribution.—This species was collected only at the type locality.

Discussion.—The type locality was a quadrate, apparently anthropogenic pond adjacent to a small gas station and may be viewed in an Image Database via a link from the Enns Entomology Museum web site. The pond was situated between a highway and corn field. The perimeter of the pond was heavily vegetated with emergent and submergent vegetation. This species was collected with five congeners: *H. annamana, H. carinata, H. chaweewanae, H. greeni, H. orientalis.*

ACKNOWLEDGMENTS

We thank Chaweewan Hutacharern, Royal Forestry Department, for her kind assistance in obtaining permission to conduct this project and collect in Thailand. This collection was in association with the M.S. thesis field work of Akekawat Vitheepradit, University of Missouri–Columbia. Partial funding was provided by the Enns Entomology Museum and MU project #PSSL0232. This is Missouri Agricultural Experiment Station journal series paper No. 13,170. This is also a research contribution from Colorado State University, where JTP is adjunct faculty, and the Colorado Entomological Museum is an affiliate.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 144–148

A NEW *HOLCOCERA* CLEMENS (LEPIDOPTERA: GELECHIOIDEA: COLEOPHORIDAE: HOLCOCERINI) ASSOCIATED WITH PINACEAE IN NORTH AMERICA

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Abstract.—***Holcocera concolor*, new species**, is described from North America. The imago, wing venation, and male and female genitalia are illustrated. Adults have been reared from larvae collected from several species of Pinaceae.

Key Words: Blastobasinae, conifer, pine

Although the larvae of Blastobasinae (Coleophoridae) usually are considered scavengers, several species in the holcocerine genera *Asaphocrita*, *Calosima*, and *Holcocera* apparently feed on living plants of the Pinaceae. For example, *Asaphocrita aphidiella* (Walsingham) (= *H. confluentella* Dietz) has been reared from cuttings of *Pinus rigida* Miller, *H. panurgella* Heinrich from branches of *Pinus cembroides* Zuccarini, and *H. villella* (Busck) (= *H. augusti* Heinrich) from cones of *Pseudotsuga menziesii* (Mirabel) Franco (= *P. taxifolia* (Lambert) Britton (Heinrich 1920). Larvae of *Calosima dianella* Dietz (= *H. lepidophaga* Clarke) feed on male flowers and vegetative buds and on scale leaves of cones of *Pinus elliottii* Engelmann and *P. palustris* Miller (Clarke 1960). Furthermore, the new species of *Holcocera* described herein has been collected on several species of Pinaceae. Among species in the tribe Blastobasini, *Blastobasis floridella* (Dietz) feeds on a cycad, attacking the female cones of *Zamia integrifolia* Aiton (Zamiaceae) (Dietz 1910). Based on these associations, the use of gymnosperms, especially conifers, by larvae of Nearctic Blastobasinae may be considerably more widespread than is suggested by limited rearing information.

Larvae of *Holcocera concolor* were collected from red pine, *Pinus resinosa* Aiton, at several sites in New England by members of a survey team of the Connecticut Agricultural Experiment Station. The reared moths were sent to the Systematic Entomology Laboratory, USDA, National Museum of Natural History, Smithsonian Institution, Washington, DC, (USNM) for identification. These specimens together with a large series of conspecific moths within the USNM, including several specimens on loan from the Canadian National Collection, Ottawa (CNC), were discovered to represent an undescribed species. The purpose of this publication is to inform North American foresters and researchers about a new conifer-feeding moth that previously has been overlooked.

Kornerup and Wanscher (1978) is used as a color standard for the description of the

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Fig. 1. Holotype of *Holcocera concolor*.

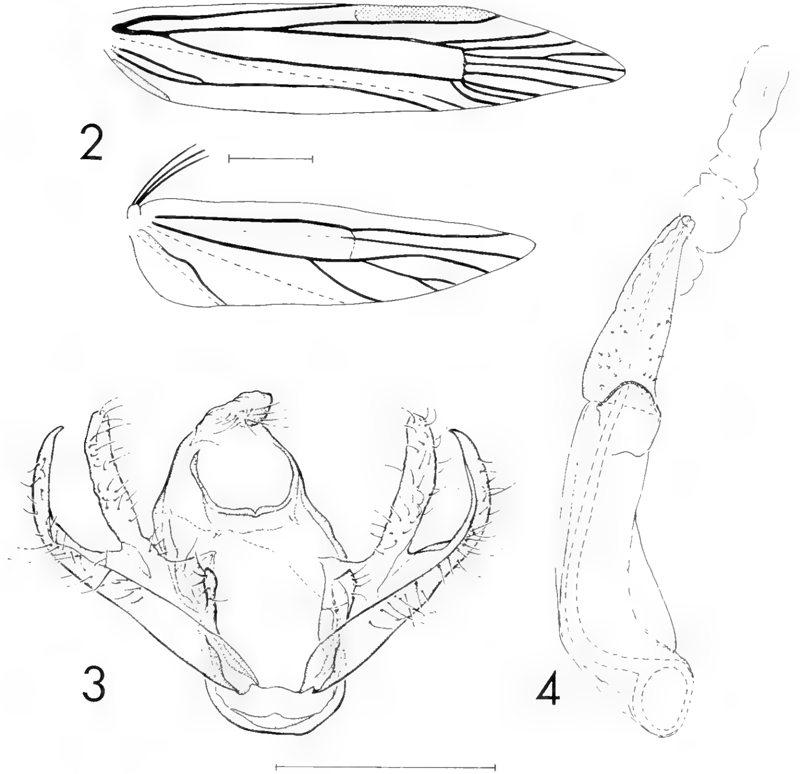
adult vestiture. Genitalia were dissected as described by Clarke (1941), except mercurochrome and chlorazol black were used as stains. Pinned specimens were examined with dissecting and compound microscopes. Measurements of the wings were made by using a calibrated ocular micrometer.

Holcocera concolor
Adamski and Maier, new species
(Figs. 1–5)

Diagnosis.—*Holcocera concolor* is similar to *Calosima lepidophaga* (Clarke) in wing pattern and color, but *H. concolor* is usually darker and less shiny. In addition, the first flagellomere is notched in the male of *H. concolor*, whereas it is unmodified in *C. lepidophaga*. Faded or rubbed females are difficult to identify without dissection because they lack the notch on the first flagellomere. *Holococera concolor* has a more anteriorly arched M_2 in the hindwing, with M_2 usually more approximate to M_1 than in *C. lepidophaga*. The male genitalia of *C. lepidophaga* differ from the male genitalia of *H. concolor* by having a median lobe on the ventral margin of the gnathos, a divided juxta, and a bulbous base of the aedeagus. The female genitalia of *C. lepidophaga* differ from the female genitalia of *H. concolor* by having a more coiled ductus bursae and a more dentate signum. The immature stages of *H. concolor* are unknown.

Description.—Adult. *Head:* Vertex brownish gray; frontoclypeus brownish gray intermixed with pale yellowish-orange scales; outer surface of labial palpus brownish gray intermixed with few pale yellowish-orange scales, gradually darkening to apex of third segment; inner surface of labial palpus pale yellowish orange intermixed with few brownish-gray scales; scape and basal half of flagellum brownish gray, distal half yellowish orange; male first flagellomere with a distal notchlike invagination, female first flagellomere unmodified; proboscis pale yellowish orange.

Thorax: Mesonotum brownish gray; te-



Figs. 2–4. 2, Wing venation of *Holcocera concolor*. Scale = 1.0 mm. 3–4, Male genitalia of *Holcocera concolor*. Scale = 0.5 mm. 3, Genital capsule. 4, Aedeagus.

gula brownish gray basally, yellowish orange distally; legs brownish gray intermixed with pale brownish-gray scales near midsegment of hindfemur, and subapical and apical surfaces of all other segments and tarsomeres. Forewing (Figs. 1–2), length 6.9–8.1 mm (n = 50), yellow orange, undersurface brown; venation (Fig. 2), with all cubital veins longer than width of cell; M_2 often closer to M_1 than to M_3; hindwing pale gray; venation with M_2 broadly arched, closer to M_1 than to M_3; M_3 and CuA_1 stalked for more than half of length of stem.

Male genitalia (Figs. 3–4): Uncus slightly elongate, setose, laterally flattened; gnathos broad, with a slightly emarginate median notch, dorsal arms of gnathos narrow; upper part of valva digitiform and setose; lower part of valva tapered into an elongate, inwardly curved spinelike process; proximal flange forming a small setose triangular support; vinculum narrow; juxta platelike; aedeagus elongate, acutely curved basally;

sclerite of aedeagus elongate, acutely curved posteriorly into a circular basal support; anellus elongate, smooth, with microsetae.

Female genitalia (Fig. 5): Ovipositor telescopic, with three membranous subdivisions; ostium within intersegmental membrane between 7th and 8th sterna, but closer to 8th; 8th sternum widely emarginate anteriorly, mostly setose posteriorly; inception of ductus seminalis anterior to 7th sternum; 7th sternum broadly rounded; ductus bursae elongate, slightly denticulate anteriorly; corpus bursae slightly denticulate, signum wide, platelike.

Type.—Holotype, ♂, [Barnstable Co.], Barnstable, Mass[achusetts], May 25, 1951, C. P. Kimball; USNM ♂ genitalia slide 82257 by D. Adamski. Deposited in USNM.

Paratypes (17 ♂, 30 ♀).—UNITED STATES: MAINE: Aroostook Co., Ashland, July and 3 August 1943, 1 ♀ on genitalia slide 489 by R. B. Selander (2 ♀); Franklin Co., Farmington (1 ♀); Oquossoc, 22, 23 June and 6, 12, 14 July, USNM ♂ genitalia slides 80737, 80738 by D. Adamski, USNM ♂ wing slide 80811 by D. Adamski, USNM ♀ genitalia slide 80789 by D. Adamski (3 ♂, 2 ♀); Hancock Co., Bar Harbor, 12 July 1936, 5 June 1937, A. E. Brower, ♀, lot 405 bred from witches' broom on larch (1 ♂, 1 ♀); Kennebec Co., Augusta, 7 July 1940, A. E. Brower (1 ♀); [Oxford Co.], Parkertown, Tim Pond, 18 July (1 ♀); Penobscot Co., Lincoln, 11 July (1 ♂); Orono, 57-B84 emerged 14 April 1958, and 57-B85 emerged 11 April 1958, both reared from Norway spruce (2 ♀); Patten, 11 July (1 ♂); Somerset Co., Caratunk, 2 July (1 ♀); Jackman, 51C B17 (1 ♀); Moose River, ex. white spruce, emerged 24 April 1952 (1 ♀); Washington Co., Marion, 9 July (3 ♀); [town unknown], 13 August 1997, Carol R. Lemmon, larva collected on *Pinus resinosa* Aiton and reared, DA ♀ genitalia slide 4097 (1 ♀). MASSACHUSETTS: Dukes Co., Martha's Vineyard, 18 April–24 June, F. M. Jones, bred from catkins of *Pinus rigida* Miller, USNM ♀ genitalia slide 81236 by D. Adamski (3 ♂, 1 ♀); Nantucket Co., Nantucket Island, genitalia slides 258, 259 by R. B. Selander (2 ♀); [county and town unknown], 28 May–15 July 1951–52, C. P. Kimball, genitalia slides 289, 290, 293 by R. B. Selander (5 ♂, 8 ♀). CANADA: BRITISH COLUMBIA: Clinton, 12 June 1938, G. S. Walley, ♂ genitalia slide 4492 by D. Adamski (1 ♂). NOVA SCOTIA: South Milford, 25

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Fig. 5. Female genitalia of *Holcocera concolor*. Scale = 1.0 mm.

June 1936, J. McDunnough (1 ♀). ONTARIO: Angus, reared from white spruce as part of Forest Insect Survey in 1942, ♂ genitalia slide 1460, ♂ wing slide 1668, and ♀ genitalia slide 1461 by D. Adamski; (1 ♂, 1 ♀). QUEBEC: Norway Bay, 1 June 1938, E. G. Lester, ♂ genitalia slide 1459 by D. Adamski (most of specimen in gelatin capsule) (1 ♂). SASKATCHEWAN: Big River, reared from cones of *Picea glauca* (Moench) Voss, ♀ genitalia slide 4493 by D. Adamski (1 ♀). All paratypes in USNM, except 5 in CNC, and 1 from Maine in Connecticut Agricultural Experiment Station. Two additional specimens from Monson, Hampden Co., Massachusetts (♀) and Rindge, Cheshire Co., New Hampshire (♂) are lacking their abdomens, and are not included in the paratype series.

Distribution.—*Holcocera concolor* is known from Massachusetts northward to Nova Scotia and westward to British Columbia.

Recorded larval hosts.—Pinaceae: *Larix* sp. (larch) witches' broom; *Picea abies* (Linnaeus) Karsten (Norway spruce); *Picea glauca* (Moench) Voss (white spruce) cones; *Pinus resinosa* Aiton (red pine); *Pinus rigida* Miller (pitch pine); *Pinus strobus* Linnaeus (white pine).

Etymology.—*Holcocera concolor* is named for the uniform yellowish-orange color of the forewings.

ACKNOWLEDGMENTS

We thank Jean-Francois Landry, Canadian National Collection, Ottawa, for the loan of several specimens; Carl Hansen, Office of Imaging, and Photographic Services, Smithsonian Institution, Washington, DC, for the photograph of the holotype of *Holcocera concolor*; Kuniko Arakawa for illustrations 2–5; and Carol Lemmon and Jeffery Fengler for assistance with collecting and rearing recent specimens from New England.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 149–153

A NEW CAVERNICOLOUS *SPELOBIA* SPULER (DIPTERA: SPHAEROCERIDAE: LIMOSININAE) FROM THE EASTERN UNITED STATES

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Abstract.—***Spelobia pickeringi*** **Marshall, new species,** a facultative cavernicolous limosinine sphaerocerid, is described from the eastern United States. It was collected in Santee Cave, South Carolina, and in epigean Malaise and mushroom-baited traps in Georgia and Maryland. Based on a subsample of 727 adult flies, the Santee Cave population had a 1:1 sex ratio. White-eyed mutants and red eyed flies were present in a 1:3 ratio (white to red eyes) in Santee Cave.

Key Words: caves, Diptera, Sphaeroceridae, *Spelobia,* guano, ecology

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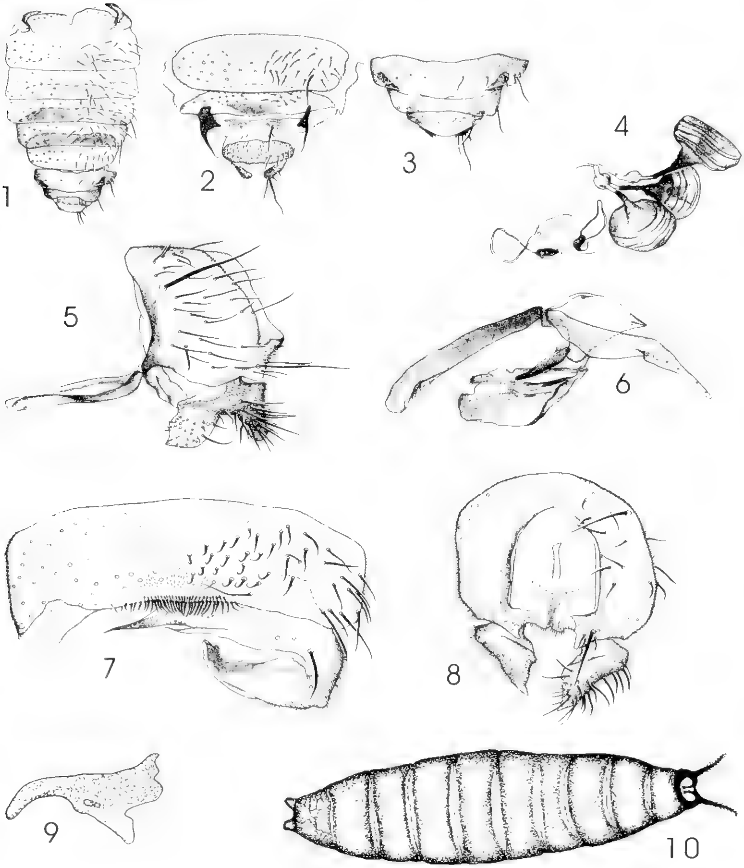
The genus *Spelobia* Spuler is one of the most common and speciose genera of Sphaeroceridae, and several of the 41 North American *Spelobia* species are regularly encountered in a variety of habitats including caves and mammal burrows. The genus is well documented in North America, and is generally well represented in collections. The new species described here was first collected as a single male in a mushroom-baited trap in South Carolina in 1989. Efforts to find additional specimens were unsuccessful, and it was surmised on the basis of its very small eyes that the species lived either in mammal burrows or caves. Dr. John Pickering (University of Georgia) took many more specimens, of both sexes, in Malaise traps in Georgia and Maryland during a biodiversity study in 1992. Repeated Malaise trap collections prompted the tentative conclusion that this small-eyed species inhabited ephemeral habitats such as mammal burrows, because hypogean species in stable habitats such as caves are unlikely to make regular dispersal flights. Other mammal-burrow specialists in the genus *Spelobia*, such as *S. lucifuga* Spuler, have been regularly taken in Malaise traps, while superficially similar cave-inhabiting species such as *Spelobia tenebrarum* (Aldrich) are never caught in surface traps. The new species described here is an exception to this generalization, as it was found breeding in caves in South Carolina in 1999. It is also of special interest because it is a cavernicolous species outside the clade that includes all previously described Nearctic cave and mammal-burrow *Spelobia* (Marshall 1985).

Spelobia pickeringi Marshall, new species
(Figs. 1–10)

Diagnosis.—*Spelobia pickeringi* is easily distinguished from other eastern North American sphaerocerids by its unusual combination of very small eyes, equal interfrontal bristles, and a proximal posterodorsal mid tibial bristle. In Marshall's 1985 key to North American *Spelobia* it keys to *S. frustrilabris* Marshall, a species with



Figs. 1–10. *Spelobia pickeringi.* 1, Male abdomen, dorsal. 2, Female terminalia, ventral. 3, Female terminalia, dorsal. 4, Spermathecae and associated vaginal sclerites. 5, Male terminalia, left lateral. 6, Aedeagus and associated sclerites. 7, Male sternites 5–7. 8, Male terminalia, posterior. 9, Mandible. 10, Puparium.

much larger eyes (eye height 3× genal height) and a very different surstylus.

Description.—Adult: Length 2.2–2.6 mm; light brown, face and gena yellow brown.

Head: Interfrontal plate subequal in height and width, width 0.4× interfrontal width, bordered by 3 equal interfrontal bristles and 2 setulae along anterior margin. Lunule triangular, face concave-carinate. Gena with a long anterior bristle and 2–3 loose rows of marginal bristles; eye height 1.1–1.3× genal height.

Thorax: Dorsocentral bristles in 2 large pairs, posterior pair slightly longer and subequal to scutellar length. Acrostichal setulae small, in 6 rows between anterior dorsocentral bristles, prescutellar pair twice as long as others. Scutellum bluntly triangular, as long as wide. Katepisternum with posterodorsal bristles reaching half way to wing base, most specimens also with a minute anterodorsal bristle. Mid tibia with paired anterodorsal-posterodorsal bristles both proximally and distally, an additional smaller bristle present above each anterodorsal bristle. Tarsomere one of mid leg 0.5–0.6× tibial length. Wing length 1.7–1.8 mm, width 0.4× length, membrane brownish. Alula narrow, width equal to length of crossvein dm-cu. Second costal sector 1.2–1.4× length of third; R_{4+5} straight. Halter brown, apex of knob and stem pale.

Abdomen: Syntergite 1+2 almost twice as long as tergite 3, with a large anteromedial pale area (Fig. 1). Pleural membrane bare on segments 1–2, short-setulose on 3–5.

Male abdomen: Posteromedial comb of sternite 5 comprising 2 long rows of very small, flat setae (Fig. 7). Epandrium with a long dorsolateral bristle, otherwise with only sparse, short bristles. Cercus setulose, with one long bristle. Surstylus setulose on posterior ¾, anterior part with a few short bristles only. Unlike all other members of *Spelobia* s.s., surstylus (Figs. 5, 8) without stout ventral bristles but with flat, truncate, bare process posteroventrally at normal position of stout bristle. Basiphallus with a short, sharply pointed epiphallus, postgonite broad basally, narrow and tapered distally (Fig. 6). Female abdomen: Tergite 8 darkly pigmented dorsally. Tergite 10 broad, bare, with two very widely separated bristles (Fig. 3). Cercus very short, almost transverse, with long apical bristles. Sternite 7 posteromedially convex and setulose; sternite 8 small, depressed medially and convex on each side, each convex part setulose and with a long bristle (Fig. 2). Spermathecae large, tire-shaped, sclerotized parts of ducts short. Internal vaginal sclerotization including two small, dark pieces and thin rings ("spectacles-shaped sclerite") (Fig. 4).

Egg: Length 0.6–0.7 mm, width 0.1 mm; tan brown, slightly curved, ends rounded, dorsal surface arched, ventral surface flattened, with reticulations on chorion; flap-like membranes extend from lateral margins.

Puparium: Length 2.8–3.1 mm, anterior width 0.1–0.3 mm, posterior width 0.1–0.3 mm; color brown, respiratory horns black, cylindrical, nearly straight; ends rounded (Fig. 10).

Cephalopharyngeal skeleton (third instar): Length from posterior tips of dorsal cornua to anterior tips of mouth hooks 0.3–0.4 mm, width at the widest point between dorsal cornua 0.04 mm; heavily sclerotized, opaque, dorsal cornua with partially sclerotized projecting sinuses. Mandibular hooks 0.08 mm long, 0.04 mm wide; sclerotized, separate, lacking accessory teeth (Fig. 9).

Type material.—Holotype: United States. South Carolina. Barnwell Co., near Barnwell State Park, mushroom-baited traps in oak forest, 10–18.iv.1989, S. A. Marshall (1 ♂). Paratypes: United States. Georgia. Clarke Co., 33°54′N, 83°16′W: 22–29.iv.1992, J. Pickering 62 (1 ♀); 03–10.vi.1992, J. Pickering 109 (4 ♂, 3 ♀); 15–22.vi.1992, J. Pickering 143 (1 ♂, 3 ♀); 10–17.vi.1992, J. Pickering 113 (4 ♀); 15–22.vii.1992, J. Pickering 142 (4 ♂, 3 ♀); 12–19.viii.1992, J. Pickering 164 (4 ♂, 3 ♀). Maryland. Pr. Georges Co, 39°03′N, 76°47′W, 20–27.vii.1992, J. Pickering 263 (4 ♂, 3 ♀). South Carolina. Orangeburg Co., Santee Caves 33°29′N, 80°28′W, 17.viii.1999, W. Reeves (8 ♂, 9 ♀); 20.x.1999, W. Reeves (4 ♂, 2 ♀).

The holotype and paratypes are in the University of Guelph Insect Collection, Department of Environmental Biology, University of Guelph. Several thousand non-type specimens are deposited in other museums, including the Natural History Museum of the University of Georgia. All specimens collected by J. Pickering were taken in Malaise traps.

Etymology.—This species is named after Dr. John Pickering, who collected the first long series.

Comments.—Although the surstylus of *Spelobia pickeringi* is strikingly different from any other *Spelobia s.s.*, this species is probably closely related to *Spelobia frustrilabris*, a species with similar midleg chaetotaxy (with a proximal posterodorsal bristle), male sternite 5, and spermathecae. It is easily separated from *S. frustrilabris* by its small eyes and its unusual male genitalia.

BIOLOGY OF *SPELOBIA PICKERINGI* IN SANTEE CAVE, SOUTH CAROLINA

Santee Cave is a coastal plain limestone cave in Santee State Park, Orangeburg County, South Carolina. The largest known chamber in the cave houses a maternity colony of *Myotis austroriparius* (Rhoads) (Vespertilionidae). A two-meter guano pile below the bat colony appears to be the primary energy source for the terrestrial cave community. Reeves (2001) reported *S. pickeringi* (as *Spelobia* sp.) and 26 other invertebrate species on the guano pile. Five of these were guanophilic dipterans, including *Emmersomyia socialis* (Stein) (Anthomyiidae), *Megaselia scalaris* (Loew), *Megaselia spelunciphila* Disney (Phoridae), *Clogmia albipunctatus* (Williston) (Psychodidae), and *Spelobia pickeringi*. Larvae and pupae of *S. pickeringi* live in the moist fresh guano and the older dry guano. Adults were present on the guano, walls, and floor of the chamber. They walk on the guano but were not seen flying in the cave, even when disturbed. *Spelobia pickeringi* flew toward lights when released in the laboratory, and like, other cavernicolous Diptera (e.g., *Megaselia cavernicola* (Brues)), are positively phototactic under laboratory conditions (Reeves and Disney 1999).

Spelobia pickeringi was collected with pitfall traps or forceps. Two plastic pitfall traps with an entrance diameter of 7 cm and a volume of 250 ml were installed below the bat colony and in the chamber floor. Both traps were buried flush with the substrate and filled with 200 ml of ethylene glycol. The trap in the guano pile was partially shielded from falling guano with a cardboard sheet (0.3 m long, 0.15 m wide) placed approximately 9 cm above the trap opening. Traps were installed on 6 October 1999 and retrieved on 20 October 1999. An estimated five to eight thousand *S. pickeringi* were collected in the traps. *Spelobia pickeringi* might have been attracted to the ethylene glycol, but it also appeared to be the most numerous arthropod in the cave.

We used a subsample of 727 specimens to determine sex and eye-color ratio. There were 340 males to 387 females in Santee Cave and a Chi-square test supported a 1:1 ratio ($P < 0.05$). The sex ratio of other cavernicolous dipterans is unknown. *Spelobia pickeringi* in Santee Cave has red, pink or white eyes. The ommatidia of pink-eyed flies were a mix of red and white, indicating partial dominance of the red-eyed gene, but it was not possible to differentiate eye color between some red and pink-eyed flies. The population of *S. pickeringi* in Santee Cave was expected to have no eye-color selection pressure. In our subsample there were 196 white eyed to 531 colored-eyed flies and a Chi-square test supported a 1:3 ratio of white eyed flies to colored eyes in both sexes ($P < 0.05$). The 1 to 3 ratio is expected for a single gene heterozygous recessive trait and indicates that there was no selection pressure on eye color and suggests that eye color is unimportant in total darkness. Eye color does not appear to be sex linked.

Gravid females of *S. pickeringi* had 15 or 16 mature eggs. Eggs had short membranous flaps along their lateral margins. Oviposition was not observed, but the flap might adhere eggs to the substrate or keep them floating on liquid media.

Internal parasites were not detected in the preserved specimens. However deutonymphs of the mite *Histiostoma* sp. (Acari: Histiostomatidae) were attached to the intersegmental thoracic membranes of some flies. This is a saprophytic mite and the phoretic stage does not feed on the host fly.

The mites could be detrimental if they hinder host movement or increase predation. On the guano pile the spiders *Eidmannella pallida* (Emerton), *Gaucelmus augustinus* Keyserling (Araneae: Nesticidae), and *Azilia affinis* Chamberlin (Araneae: Tetragnathidae) fed on *S. pickeringi.*

ACKNOWLEDGMENTS

We thank W. Wills for field assistance, R. Langstaff and M. Reeves for illustrations, and H. Klompen for identifying *Histiostoma* near *piloseta.* Collections in Santee Cave were conducted under South Carolina State Parks Research Permit Number N-2-1999.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 154–179

THE FLEA BEETLE GENUS *APHTHONA* CHEVROLAT (COLEOPTERA: CHRYSOMELIDAE) OF SOUTHERN INDIA, WITH DESCRIPTIONS OF SEVEN NEW SPECIES

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Abstract.—Seven **new species** of *Aphthona* from Southern India are described and illustrated: ***A. chrozophorae***, ***A. glochidionae***, ***A. macarangae***, ***A. mallotae***, ***A. marataka***, ***A. nandiensis***, and ***A. phyllanthae***. A key for adult identification and geographical distribution and host plant data are provided.

Key Words: Chrysomelidae, *Aphthona*, Southern India, new species, host plants

Aphthona Chevrolat is one of the most speciose and morphologically diverse genera of flea beetles containing 93 species just in the Oriental Region (Konstantinov and Lingafelter 2002). Known *Aphthona* larvae are root feeders, whereas the adults feed externally on leaves. The majority are narrowly oligophagous or rarely monophagous on plants of at least 11 families (Konstantinov 1996); however, most *Aphthona* species feed on plants of the family Euphorbiaceae (Konstantinov 1998, Jolivet and Hawkeswood 1995) and hence are potential candidates for the biological control of weedy *Euphorbia* species.

Twelve species of *Aphthona* are known from India (Chûjô 1961, Scherer 1969, Konstantinov and Lingafelter 2002). These do not include *A. azurea* Jacoby and *A. postmaculata* Medvedev which have been removed from *Aphthona* (Konstantinov and Lingafelter 2002). Only three species of *Aphthona* were known from Southern India prior to this study: *A. atripes* (Motschulsky), *A. kanaraensis* Jacoby, and *A. tamila* Konstantinov and Lingafelter. Southern India, as defined here, includes Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala states. The western part includes the southern Western Ghats mountains, which is one of the biologically most diverse regions of India accounting for 22.5% of India's endemic plants (Nayar 1996). This region, along with Sri Lanka, is among 25 globally recognized "biodiversity hotspots" (Myers et al. 2000). Extensive collecting efforts by the senior author yielded seven new species which are described below. The host plants for adults of five of the new species were identified, all of which are Euphorbiaceae, and new host plants were found for adults of *A. nigrilabris* and *A. tamila.*

MATERIAL AND METHODS

The descriptive terminology follows Konstantinov (1998). All the measurements are in millimeters and the mean values are provided in brackets. In the case of male and female genitalia, only a single specimen was measured. Other measurements are from ten randomly picked specimens (five males and females each), wherever available.

The holotypes are deposited in the collection of the National Museum of Natural History, Smithsonian Institution, Washington DC (USNM). Paratypes are deposited in the collections of the University of Agricultural Sciences, Bangalore (UABI); Pusa National Collection, Indian Agricultural Research Institute, New Delhi (PNCI); The Natural History Museum, London (BMNH); National Museum of Natural History, Washington DC; and the personal collection of K. D. Prathapan, Bangalore, India (KPPC). The other depositories for studied material are abbreviated as follows: Institute Royal des Sciences Naturelles de Belgique, Brussels, Belgium (ISNB); Natural History Museum, Basel, Switzerland (NHMB); and Takizawa collection, Oyama Tochigi, Japan (TCOJ).

GENERIC DIAGNOSIS OF *APHTHONA*

Members of this genus are small to moderate in size (1–4 mm), oval or oblong-oval and more or less convex in lateral view. Based on previous cladistic study, three synapomorphic characters define *Aphthona*: elytron length/width ratio less than 2.85; anterior part of metanotal ridge *e* attached below middle of ridge *b*-1; and setae on ventral side of first metatarsomere sinuate (Konstantinov 1998). A combination of a few external, more easily observed characters is also useful for recognizing *Aphthona*: frontoclypeal suture with several rows of short setae; sulci surrounding antennal calli well developed; frontal ridge relatively short and convex in lateral view; anterofrontal ridge as low as frontal ridge, lowering laterally, pronotum with or without antebasal transverse impression (if impression is present, it is shallow and is never limited laterally by longitudinal grooves); procoxal cavity open behind; intercoxal prosternal process and mesosternum narrow; elytral punctation irregular, rarely with irregular striae on disk; dorsal surface of metatibia apically flat, apical spur inserted laterally; first metatarsomere comparatively long, as long as two following tarsomeres combined, but never more than half as long as metatibia.

KEY TO THE SOUTHERN INDIAN SPECIES OF *APHTHONA*

1. Pronotum and elytron black, with or without metallic luster 2
– Pronotum and elytron yellow, sometimes with darker stripe along elytral suture, not metallic 4
2. Metafemur unicolorously dark brown, much darker than pro- and mesofemur 3
– Metafemur bicolorous, mostly yellow, almost as light as pro- and mesofemur, apex with dark brown spot . . . . *A. marataka*, new species
3. Lateral side of elytron with three ridges. Frontal ridge between antennal sockets as wide as length of antennal callus. Anterofrontal ridge in middle as high as frontal ridge . . . . *A. mallotae*, new species
– Lateral side of elytron without ridges. Frontal ridge between antennal sockets much narrower than length of antennal callus. Anterofrontal ridge in middle much lower than frontal ridge . . . . *A. glochidionae*, new species
4. Metafemur dark brown, much darker than pro- and mesofemur 5
– Metafemur yellow, as light or only slightly darker than pro- and mesofemur 6
5. Abdomen dark brown, almost black. All tibiae dark brown. Length 2.26–2.70 mm . . . . *A. atripes* (Motschulsky)
– Abdomen yellow. All tibiae yellow. Length 2.96–3.64 mm . . . . *A. nigrilabris* Duvivier
6. Lateral side of elytron with three ridges . . . . *A. nandiensis*, new species
– Lateral side of elytron without ridges 7
7. Antenna long, reaching beyond basal ⅔ of elytra or elytral apex 8
– Antenna shorter, not reaching beyond basal ⅔ of elytra 9
8. Antennomeres 4 to 7 darker than 8 to 11. Supraorbital sulcus absent. Posterolateral callosity of pronotum wide and long. Apical margin of elytron concave. Median lobe of aedeagus with 1 impression near apex of ventral side. Spermatheca with receptacle longer than pump (Fig. 52) . . *A. chrozophorae*, new species
– Antennomeres 4 to 7 lighter than 8 to 11. Supraorbital sulcus present. Posterolateral callosity of pronotum narrow and short. Apical margin of elytron convex. Median lobe of aedeagus with 2 impressions near apex of ventral side. Spermatheca with receptacle shorter

than pump (Fig. 48) . . . . *A. macarangae*, new species

9. Head dark brown or black. Elytron darkened along suture . . . . *A. tamila* Konstantinov and Lingafelter
– Head yellow or dark yellow. Elytron light along suture 10

10. Median lobe of aedeagus with long appendage apically. Spermathecal duct without coils (Fig. 54) . . . . *A. kanaraensis* Jacoby
– Median lobe of aedeagus with short denticle apically. Spermathecal duct with coils (Fig. 50) . . . . *A. phyllanthae*, new species

Aphthona atripes (Motschulsky)
(Figs. 1, 12, 23, 44, 55, 66)

Teinodactyla atripes Motschulsky 1866: 417 (type locality: Sri Lanka. Type is missing from the Motschulsky collection (ZMMU) not examined). Ogloblin 1930: 94 (transferred to *Aphthona*, redescription, figures of male genitalia). Heikertinger and Csiki 1939: 96 (world catalog). Heikertinger 1944: 112/198, 116/202 (key, catalog, taxonomic notes). Scherer 1969: 71, 76 (key, distribution, synonymic bibliography).

Aphthona nilgiriensis Jacoby 1903: 103 (type locality: Nilgiri Hills, India. Lectotype (BMNH) designated by Konstantinov and Lingafelter (2002), examined). Maulik 1926: 367, 369 (key, redescription, taxonomic notes, distribution, deposition of type specimens). Ogloblin 1930: 94 (synonymy).

Distribution.—India (Jacoby 1903), Sri Lanka (Motschulsky 1866).

Host plants.—Unknown.

Description.—Pronotum and elytron, except suture, yellow. Facial part of head and basal 3 antennomeres dark yellow. Vertex orange. Labrum, apical 8 antennomeres, scutellum, prosternum, pro- and mesofemora, all tibiae and metatarsi brown or dark brown. Elytral suture brownish. Abdomen dark brown almost black. Meso- and metasterna, and metafemur black. Elytral suture light brown.

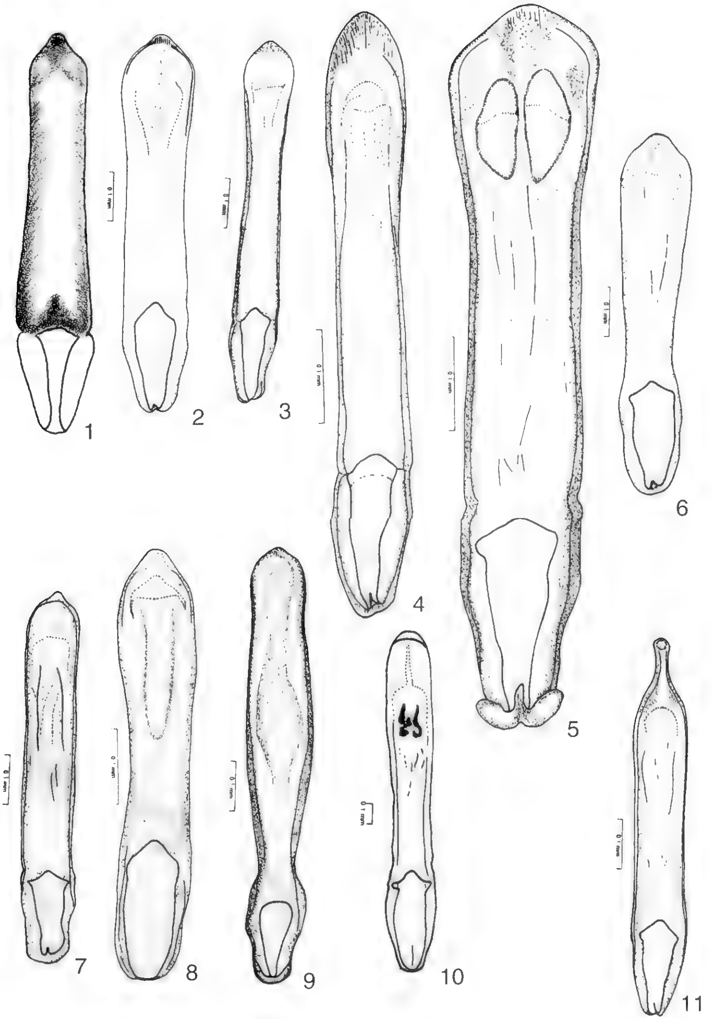
Vertex moderately flat, shiny, densely covered with long wrinkles, and fine punctures. Frontal ridge narrow, short, with sides almost parallel, though maximum width between antennal sockets. Antennal callus moderately flat, trapezoidal, forming obtuse angle to each other. Supracallinal sulcus well developed, slightly curved. Supraorbital sulcus poorly developed. Anterofrontal ridge moderately low in middle, low laterally. Frontoclypeal suture with 2 complete, irregular rows of setae. Clypeus long. Fifth antennomere slightly longer than fourth and sixth, separately. Second antennomere about half as long as fourth.

Pronotum slightly wider basally than apically, with lateral margins nearly straight and almost parallel. Anterolateral callosity moderately low, lower apically than basally, moderately long, concave, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity poorly developed. Disc shiny, sparsely covered with tiny, well defined punctures. Interspaces smooth.

Scutellum wider than long, widely rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides convex, maximum width at apical third. Apical margin slightly convex. Apex obtusely angulate. Surface rugose, moderately densely covered with medium size punctures.

Metatibia convex in lateral view, apically slightly widened, dorsally flat at apical fifth; remainder of surface notably convex. First metatarsomere of male slightly narrower basally than apically, apically not wider than third metatarsomere.

Spermatheca with receptacle much longer than pump. Internal side of receptacle convex, external side nearly straight. Receptacle moderately cylindrical, with maximum width near duct. Pump moderately narrow, short, rounded at apex. Horizontal part of pump longer than vertical, much shorter than receptacle. Duct making small loop away from receptacle (Fig. 44). Tignum curved, not widening anteriorly or posteriorly. Posterior sclerotization without arms (Fig. 66). Vaginal palpus with mem-



Figs. 1–11. Median lobe of aedeagus (ventral view) of *Aphthona*. 1, *A. atripes*. 2, *A. marataka*. 3, *A. mallotae*. 4, *A. nandiensis*. 5, *A. macarangae*. 6, *A. glochidionae*. 7, *A. phyllanthae*. 8, *A. tamila*. 9, *A. chrozophorae*. 10, *A. nigrilabris*. 11, *A. kananraensis*.

branous part in middle longer than sclerotized part anteriorly and posteriorly. Posterior sclerotization nearly as long as anterior. Lateral margin nearly parallel to medial, forming well developed angle to apex (Fig. 55).

Median lobe of aedeagus slightly convex in lateral view; long, sides nearly parallel. Ventral side convex, only apically flattened. Apex triangular, not bent dorsally. Dorsal opening unusually long (Fig. 23).

Measurements (n = 10): Length 2.26–2.70 (2.46), width 1.23–1.43 (1.31), length of pronotum 0.57–0.61 (0.58), width of pronotum 0.77–0.88 (0.81), width across eyes 0.58–0.64 (0.61), distance between eyes 0.36–0.39 (0.37), length of aedeagus 0.87, length of vaginal palpi 0.38, length of receptacle 0.12.

Type material examined.—*Aphthona nilgiriensis*: Lectotype ♀. Labels: 1) Type H.T.; 2) Nilgiri Hills; 3) 922; 4) Jacoby coll. 1909-28a; 5) *Aphthona nilgiriensis* Jac.; 6) Lectotype *Aphthona nilgiriensis* Jacoby des. A. Konstantinov, 1995 (BMNH). Paralectotypes 2 ♀. Labels: 1) Nilgiri Hills; 2) 922; 3) Cotype; 4) *Aphthona nilgiriensis* Jac.; 5) Paralectotype *Aphthona nilgiriensis* Jacoby des. A. Konstantinov, 1995. Paralectotype ♀. Labels: 1) Nilgiri Hills; 2) 922; 3) Type; 4) *Aphthona nilgiriensis* Jac.; 5) Paralectotype *Aphthona nilgiriensis* Jacoby des. A. Konstantinov, 1995 (BMNH).

Material examined.—INDIA: Tamil N. [= Tamil Nadu], Coonoor, 1,700–1,900 m, 29.XI.1978, JAP-IND CO TR (14 TCOJ); Kotagiri, 1700 m, 29.XI.1978, JAP-IND CO TR (15 TCOJ).

Remarks.—*Aphthona atripes* differs from the majority of *Aphthona* species by having the metatibia nearly entirely convex, except for the small flat plate at the apex. Apparently this is the only yellow species with dark pro- and mesotibiae. Some additional characters for distinguishing this species are: meso- and metasterna, abdomen and metafemur black; metatibia and metatarsus dark brown; apex of median lobe triangular, not bent dorsally; dorsal opening of median lobe unusually long.

Aphthona chrozophorae Prathapan and Konstantinov, new species

(Figs. 9, 20, 31, 41, 52, 63, 74)

Distribution.—India (Tamil Nadu, Karnataka).

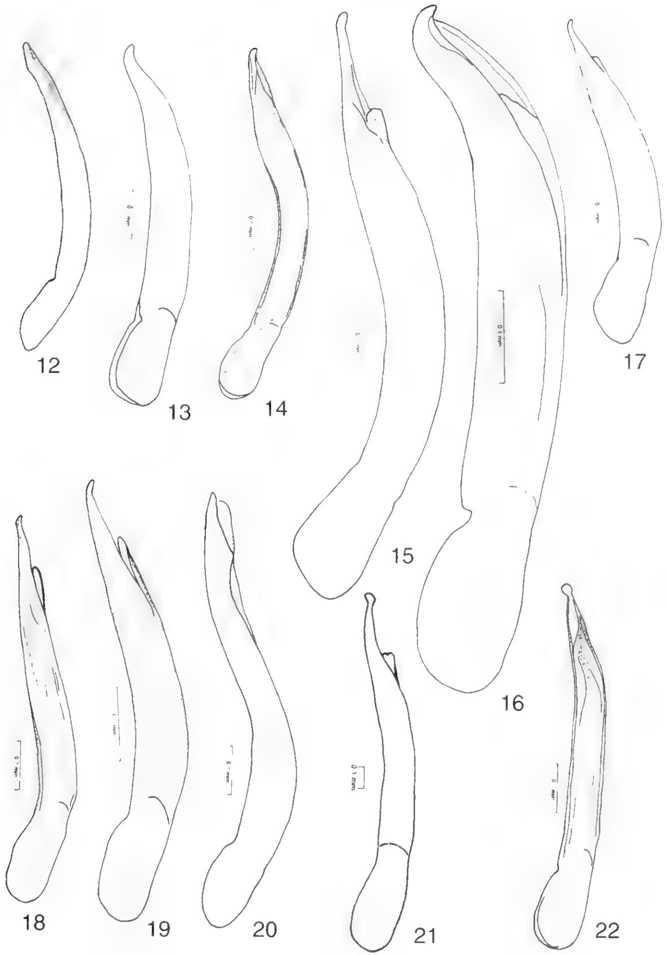
Host plant.—*Chrozophora rottleri* Klotzsch. (Euphorbiaceae).

Description.—Head, labrum, scutellum, suture, apex of metafemur, meso- and metathoracic sterna, and abdomen dark brown to piceous. Antennomeres 4 to 7 light brown. Prothorax, elytron, legs (except for metafemoral apex), antennomeres 1 to 3 and 8 to 11 yellowish.

Vertex impunctate, shiny. All sulci well developed, except for supraorbital. Supracallinal sulcus slightly curved. Antennal calli subquadrate, transverse. Frontal ridge moderately long, broader between antennae, narrower towards anterofrontal ridge. Anterofrontal ridge gently arched, moderately thick, medially slightly lower than frontal ridge. Basal palpomere of maxillary palpus slender, long; second palpomere club shaped, thicker and shorter than first; third palpomere conical, pointed, subequal to second in length. Antenna reaching beyond basal ⅔ of elytron but not reaching apex; first antennomere long, club shaped; second thick, shorter; third slender, longer than second; fourth slightly longer than third; fifth much longer than fourth.

Pronotum slightly wider basally than apically, with lateral margins evenly curved. Anterolateral callosity moderately low, apically as low as basally, moderately short, concave, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity wide and high, well-developed. Disc shiny, sparsely covered with tiny, well defined punctures. Interspaces smooth.

Scutellum wider than long, widely rounded at apex. Elytron with well developed humeral callus, without depression



Figs. 12–22. Median lobe of aedeagus (lateral view) of *Aphthona*. 12, *A. atripes*. 13, *A. marataka*. 14, *A. mallotae*. 15, *A. nandiensis*. 16, *A. macarangae*. 17, *A. glochidionae*. 18, *A. phyllanthae*. 19, *A. tamila*. 20, *A. chrozophorae*. 21, *A. nigrilabris*. 22, *A. kananraensis*.

posteriorly. Sides convex, maximum width at apical third. Apical margin slightly concave. Apex obtusely angulate. Surface rugose, moderately densely covered with medium size punctures.

Metatibia nearly straight in lateral view, apically widened, dorsally flat at apical fourth; remainder of surface notably convex. First metatarsomere of female longer than remaining tarsomeres combined, basally as narrow as apically, apically narrower than third metatarsomere. Metatibial spur longer than half of claw tarsomere.

Spermatheca with receptacle much longer than pump. Internal and external sides of receptacle slightly convex. Receptacle nearly cylindrical, nearly twice longer than wide, with maximum width near middle. Pump moderately narrow, short, rounded at apex. Horizontal part of pump almost as long as vertical, much shorter than receptacle. Duct without coils, making small loop away from receptacle (Fig. 52), points away from receptacle. Tignum nearly straight, not widening posteriorly, slightly widening anteriorly. Posterior sclerotization without arms (Fig. 74). Vaginal palpus with membranous part in middle longer than sclerotized part anteriorly and posteriorly. Posterior sclerotization nearly as long as anterior. Lateral margin not parallel to medial, forming well developed angle to apex (Fig. 63).

Median lobe of aedeagus sinuate in lateral view; distal portion of median lobe slightly curved towards dorsal side, apex bluntly pointed; long, sides sinuate. Ventral side flattened. Apex triangular, not bent dorsally. Dorsal opening longer than broad, covered by a lamina slightly narrower than width of opening but reaches its distal margin (Fig. 31). Arms of tegmen much shorter than stem (Fig. 41).

Measurements (n = 10): Length 1.88–2.25 (2.02), width 0.9–1.08 (0.99), length of pronotum 0.48–0.53 (0.50), width of pronotum 0.65–0.75 (0.69), width across eyes 0.51–0.59 (0.55), distance between eyes 0.25–0.30 (0.27), length of aedeagus 0.89, length of vaginal palpi 0.36, length of receptacle 0.11.

Variability.—Antennal color varies as follows: three basal antennomeres invariably yellowish, next four antennomeres brownish, remaining yellowish brown, however in certain specimens antennomeres four to seven are not distinctly darker.

Type material examined.—Holotype ♂. Labels: 1) India: Tamil Nadu: 28.X.1998, ex. Gudalur Prathapan Coll. 2) Holotype *Aphthona chrozophorae* sp. nov. des. Prathapan & Konstantinov, 2001 (USNM). Paratypes, 3 ♂, 11 ♀. The same labels as holotype (2 BMNH, 5 KPPC, 2 PNCI, 2 UABI, 2 USNM). Paratypes 7 ♂, 5 ♀. Labels: 1) Karnataka: 2.X.1999, ex. Kemmanagundi Prathapan Coll. (12 KPPC).

Etymology.—This species is named after the food plant.

Remarks.—Superficially *A. chrozophorae* can be confused with *Longitarsus* Latreille, especially because of the relatively long antenna (reaching ⅔ of elytron), narrow pronotum and relatively long first metatarsomere. However, we place it in *Aphthona* based on the following characters: sulci surrounding antennal calli well developed; frontal ridge relatively short and convex in lateral view; anterofrontal ridge as low as frontal ridge, lowering laterally. Also, despite the fact that the first metatarsomere is longer than in many other *Aphthona* species, it is less than half the length of the metatibia. *Aphthona chrozophorae* can be easily separated from other Southern Indian *Aphthona* by the median lobe of aedeagus being sinuate in lateral view. It is distantly related to *A. kanaraensis* and *A. nigrilabris* and can be separated from these two species by the lack of a knob at the apex of the median lobe of the aedeagus in lateral view and by long antenna reaching ⅔ of elytron.

Aphthona glochidionae Prathapan and Konstantinov, new species

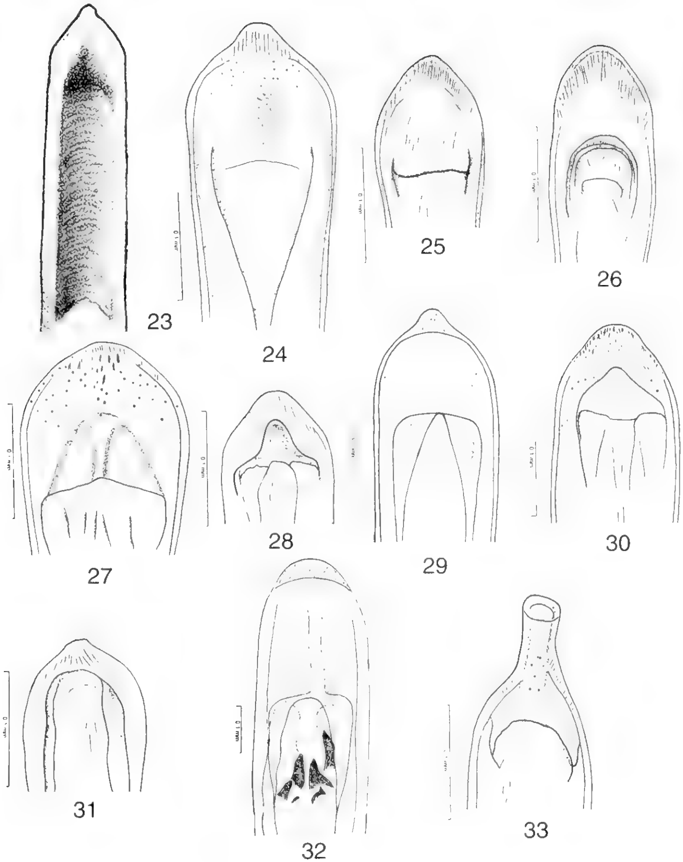
(Figs. 6, 17, 28, 38, 49, 60, 71)

Distribution.—India (Karnataka).

Host plant.—*Glochidion zeylanicum* A. Juss. (Euphorbiaceae).

Description.—Body black, 7 apical antennomeres dark brown or black, metafemur dark brown, bases of pro- and mesofemora light brown. Rest of legs and antenna yellowish.

Vertex impunctate, shiny, with shallow sparse, transverse wrinkles. All sulci well



Figs. 23–33. Median lobe of aedeagus (dorsal view, apical opening) of *Aphthona*. 23, *A. atripes*. 24, *A. marataka*. 25, *A. mallotae*. 26, *A. nandiensis*. 27, *A. macarangae*. 28, *A. glochidionae*. 29, *A. phyllanthae*. 30, *A. tamila*. 31, *A. chrozophorae*. 32, *A. nigrilabris*. 33, *A. kananraensis*.

developed, deep. Supracallinal sulcus slightly curved. Antennal calli trapezoid, transverse. Frontal ridge short, narrow, narrowing towards clypeus. Anterofrontal ridge extremely low, lower than frontal ridge. Basal palpomere of maxillary palpus slender, long; second palpomere club shaped, thicker and shorter than first; third palpomere conical, pointed, subequal to or slightly longer than second. Antenna reaching basal ⅔ of elytron; second antennomere thick, shorter than first and slightly shorter than third; fourth nearly as long as third, shorter than fifth; fifth much longer than fourth and sixth antennomeres separately.

Pronotum slightly wider basally than apically, with lateral margins evenly curved. Anterolateral callosity moderately low, apically as low as basally, moderately short, straight, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity wide and low, well developed. Disc shiny, sparsely covered with tiny, well defined punctures. Interspaces smooth.

Scutellum wider than long, widely rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides convex, maximum width at apical third. Apical margin slightly convex. Apex obtusely angulate. Surface rugose, densely covered with fine punctures.

Metatibia straight in lateral view, apically widened, dorsally flat at apical third. First metatarsomere of male narrower basally than apically, apically not wider than third metatarsomere.

Spermatheca with receptacle much longer than pump. Internal and external sides of receptacle convex. Receptacle nearly cylindrical, much longer than wide, with maximum width between duct and middle. Pump narrow at vertical part and slightly narrower than base of horizontal part, moderately long, nearly straight, without denticle at apex. Horizontal part of pump longer than vertical. Duct long, almost reaching middle of receptacle, making loop away from receptacle, at base pointed in direction of receptacle (Fig. 49). Tignum nearly straight, not widening anteriorly. Posterior part wide, not forming arms (Fig. 71). Vaginal palpus with membranous part in middle nearly as long as sclerotized part posteriorly and anteriorly. Lateral margin nearly parallel to medial, not forming angle near apex. Medial margin slightly curved (Fig. 60).

Median lobe of aedeagus slightly curved in lateral view, long, sides not parallel. Apex with wide denticle (Fig. 6).

Measurements (n = 10): Length 1.58–2.18 (1.83), width 0.8–1.15 (0.92), length of pronotum 0.36–0.5 (0.41), width of pronotum 0.55–0.71 (0.59), width across eyes 0.43–0.54 (0.47), distance between eyes 0.20–0.28 (0.23), length of aedeagus 0.67, length of vaginal palpi 0.3, length of receptacle 0.15.

Type material examined.—Holotype ♂. Labels: 1) India, Karnataka Kemmanagundi, 2.X.1999, K. D. Prathapan Coll. 2) Holotype *Aphthona glochidionae* sp. nov. des. Prathapan & Konstantinov, 2001 (USNM). Paratypes 6 ♂, 5 ♀. The same data as holotype (1 BMNH, 7 KPPC, 1 PNCI, 1 UABI, 1 USNM). Paratypes 4 ♂, 5 ♀. Labels: 1) India, Karnataka: Kottigehara, 16.IX.2001, Prathapan, K. D. Coll. (9 KPPC).

Etymology.—This species is named after the adult food plant.

Remarks.—*Aphthona glochidionae* keys out at the same couplet as *A. mallotae* and can be easily separated from it by the following characters: lateral side of elytron without convex ridges; frontal ridge between antennal sockets much narrower than length of antennal callus; anterofrontal ridge in middle much lower than frontal ridge.

Aphthona kanaraensis Jacoby
(Figs. 11, 22, 33, 43, 54, 65, 76)

Aphthona kanaraensis Jacoby 1896: 255 (type locality: Kanara, India. Lectotype (BMNH) designated by Konstantinov and Lingafelter (2002), examined). Maulik 1926: 367, 368 (key, redescription, taxonomic notes, distribution, deposition of type specimens). Heikertinger and Csiki 1939: 97 (world catalog). Heikertinger 1944: 112/198, 117/203 (key, catalog, taxonomic notes). Kimoto 1972: 47 (distribution in India). Scherer 1969: 71, 77 (key, distribution, synonymic bibliography). Gruev 1985: 39 (faunistics).

Aphthona atriventris Maulik 1926: 367, 368 (type locality: Sanderdhunga Valley, western Almora, India. Lectotype (BMNH) designated by Konstantinov and Lingafelter (2002), examined). Heikertinger and Csiki 1939: 96 (world catalog). Heikertinger 1944: 111/197, 116/202 (key catalog, taxonomic notes). Scherer 1969: 77 (synonymy).

Aphthona imitatrix Lopatin 1963: 362 (type locality: Jalalabad, Afghanistan. Holotype and paratype (HNHM), paratype examined). Gruev 1988: 154 (faunistics). Konstantinov and Lingafelter 2002 (synonymy).

Distribution.—India (Assam, Bihar, Maharashtra, Karnataka, Himachal Pradesh, Uttar Pradesh) (Scherer 1969), Nepal (Gruev 1985), Afghanistan (Lopatin 1963), Sri Lanka (Konstantinov and Lingafelter 2002).

Host plants.—*Eucalyptus rostrata* Sch. (Mathur and Balwant Singh 1959a).

Description.—Color yellow. Last 7 antennomeres, labrum, metasternum and metafemoral apices brown. Rest of legs and antenna yellow.

Vertex flat, shiny, covered with fine wrinkles. Frontal ridge narrow with convex surface, short, with sides almost parallel, maximum width at distal margin of antennal sockets. Antennal calli narrowly connected, flat, moderately wide, trapezoidal, forming obtuse angle to each other. Supracallinal sulcus poorly developed, almost straight. Supraorbital sulcus weakly developed. Anterofrontal ridge high especially in middle, moderately high laterally, without denticle in middle. Frontoclypeal suture with two irregular, complete rows of setae. Clypeus long. Eye normally small, narrower than distance between eyes.

Pronotum slightly wider basally than apically, with sides convex, slightly diverging at basal third. Lateral margin moderately explanate, as wide basally as apically. Anterolateral callosity moderately high, long, concave, forming acute denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity of pronotum longer than lateral margin, lateral margin forming indentation in front of callosity which makes it more prominent. Disc shiny, densely covered with small punctures.

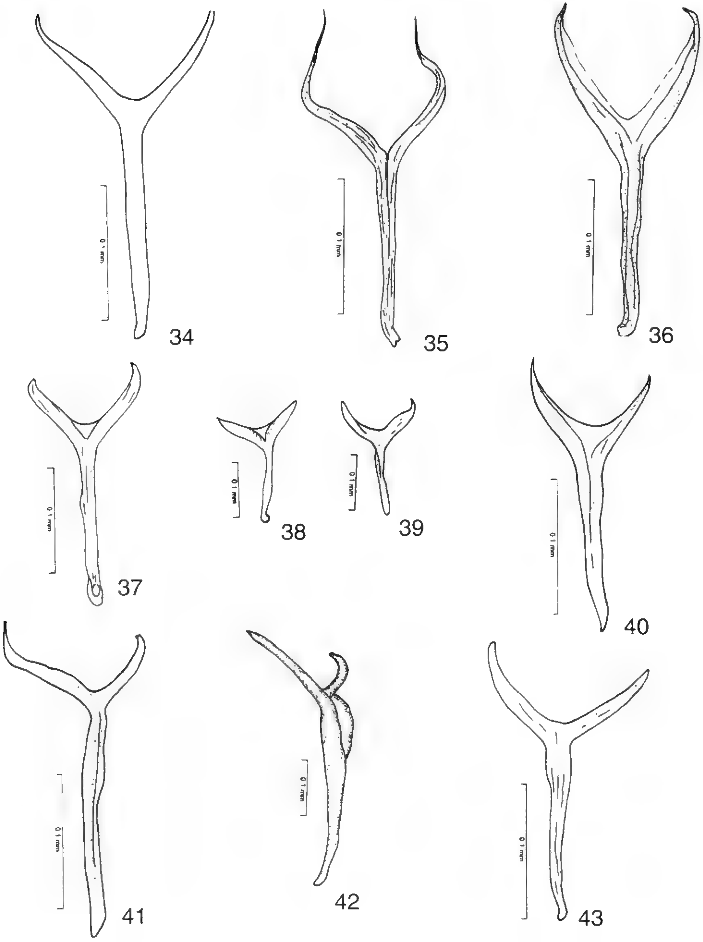
Scutellum wider than long, angulate at apex. Sides nearly straight, converging. Elytron without depression posteriorly. Sides convex, maximum width slightly behind middle. Apical margin convex. Apex obtusely angulate. Surface shiny, covered with moderate sized punctures, their diameter nearly equal to distance between punctures.

Metatibia straight in lateral view, slightly curved from dorsal view, apically widened, dorsally flat at apical half. First metatarsomere of male slightly narrower basally than apically, apically not wider than third metatarsomere. Fourth metatarsomere of male twice as long as third. Claw with large denticle at base and deep invagination in front of it.

Spermatheca with receptacle longer than pump. Internal side of receptacle slightly convex, external side straight. Receptacle nearly cylindrical, much longer than wide, with maximum width close to duct. Pump moderately wide at vertical part and not significantly narrower than base of horizontal part, short, slightly curved, without denticle at apex. Horizontal part of pump much longer than vertical. Duct moderately short, almost reaching middle of receptacle, not making loop away from receptacle, at base pointed in direction of receptacle (Fig. 54). Tignum slightly curved, abruptly widening anteriorly. Posterior sclerotization forming two moderately wide arms with acute angle to each other, posterior sclerotization of arms weak (Fig. 76). Vaginal palpus with membranous part in middle nearly as long as sclerotized part posteriorly and anteriorly. Posterior sclerotization wider than and as long as anterior. Apical sclerotization laterally shorter than medially, straight. Apical membrane oblique. Lateral margin not parallel to medial, not forming angle near apex. Medial margin slightly curved (Fig. 65).

Median lobe of aedeagus slightly curved in lateral view, thin, sides slightly concave in middle. Apex produced into long appendage with small button-shaped structure on top (Fig. 11).

Measurements (n = 10): Length 1.80–2.15 (2.02); width 0.98–1.2 (1.09); length of pronotum 0.45–0.56 (0.50); width of pronotum 0.68–0.83 (0.73); width across



Figs. 34–43. Tegmen of *Aphthona*. 34, *A. marataka*. 35, *A. mallotae*. 36, *A. nandiensis*. 37, *A. macarangae*. 38, *A. glochidionae*. 39, *A. phyllanthae*. 40, *A. tamila*. 41, *A. chrozophorae*. 42, *A. nigrilabris*. 43, *A. kanaraensis*.

eyes 0.49–0.60 (0.54); distance between eyes 0.23–0.29 (0.26); length of aedeagus 0.78; length of vaginal palpi 0.36; length of receptacle 0.13.

Type material examined.—*Aphthona kanaraensis*: Lectotype ♂. Labels: 1) Kanara; 2) Andrewes Bequest. B.M. 1922–21. 3) Lectotype *Aphthona kanaraensis* Jacoby des A. Konstantinov, 1995 (BMNH). Paralectotypes 6 ♂ and ♀, with same labels as lectotype (BMNH). Paralectotype 1 specimen. Labels: 1) Kanara; 2) Type; 3) Andrewes Bequest. B.M. 1922-21. 4) *Aphthona kanaraensis* Jac. type; 5) Paralectotype *Aphthona kanaraensis* Jacoby des A. Konstantinov, 1995 (BMNH). Paralectotypes 3 specimens. Labels: 1) Kanara; 2) 1st Jacoby Coll.; 3) Paralectotype *Aphthona kanaraensis* Jacoby des A. Konstantinov, 1995 (MCZC).

Aphthona atriventris: Lectotype ♂. Labels: 1) Type; 2) Sanderdhunga V. 8–12,000 ft. W. Almora H.G.C.; 3) *Aphthona atriventris* M. Maulik det. type 1925; 4) Lectotype *Aphthona atriventris* Maulik des. A. Konstantinov, 1995 (BMNH). Paralectotypes 5 specimens, with same labels as lectotype (BMNH).

Aphthona imitatrix: Paratypes, 1 ♂, 2 ♀. Labels: 1) O. Afghan. 1963; 2) Kunartal, 500 m, Jalalabad, 30.III; 3) *Aphthona imitatrix* sp. n. I. Lopatin det., 1962 (3 HNHM).

Material examined.—INDIA: Karnataka: 2 ♂, 12.VIII.1998; 2 ♂, 18.VIII.1998; 2 ♂, 14.IX.1998; 4 ♂, 8 ♀, 20.IX.1998; 1 ♂, 1 ♀, Bangalore, 30.IX.1998, K. D. Prathapan coll. (38 KPPC, 2 USNM). SRI LANKA: Kur. Dist. Kurunegala, 3.XI.1966, leg. J. F. G. Clarke & T. M. Clarke (1 USNM).

Remarks.—*Aphthona kanaraensis* can be separated from other species of *Aphthona* by the median lobe of the aedeagus with the apex produced into a long appendage with a small button-shaped callosity on top and tignum with two moderately wide arms forming an acute angle with each other. The spermatheca of this species is quite variable, however this variability is based on the function of the spermatheca as a sperm depository. When the spermatheca is empty, its receptacle is quite narrow with concave sides. When the receptacle is full, its sides are convex.

Maulik (1926) stated that the elytra of *A. kanaraensis* at the base are not wider than the pronotum and that there is no spur at the apex of the metatibia, but both of these observations are incorrect.

Aphthona macarangae Prathapan and Konstantinov, new species

(Figs. 5, 16, 27, 37, 48, 59, 70)

Distribution.—India (Tamil Nadu, Kerala).

Host plant.—*Macaranga peltata* Muell. (Euphorbiaceae).

Description.—Color yellowish, head and 5 apical antennomeres dark yellow. Metasternum and abdomen light piceous.

Vertex impunctate, granulate. Sulci well developed. Supracallinal sulcus narrow and not deep, slightly curved. Antennal calli subquadrate, transverse. Frontal ridge moderately long, between antennae as wide as above anterofrontal ridge. Anterofrontal ridge gently arched, moderately thick, medially with denticle, slightly lower than frontal ridge. Basal palpomere of maxillary palpus slender, long; second palpomere thickened. Third palpomere pointed, slightly longer than second. Antennae reaching to apex of elytra; second antennomere shorter than third; fourth equal to or slightly longer than third; fifth longer than fourth; distal antennomeres not distinctly thickened.

Pronotum slightly wider basally than apically, with lateral margins evenly curved. Anterolateral callosity moderately low, apically as low as basally, moderately short, concave, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity narrow and short, poorly developed. Disc shiny, sparsely covered with wrinkles and tiny, poorly defined punctures.

Scutellum wider than long, widely rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides convex, maximum width at apical third. Apical margin slightly convex. Apex obtusely angulate. Surface rugose, moderately densely covered with large size punctures.

Metatibia curved in lateral view, apically widened, dorsally flat at apical half; remainder of surface notably convex. First metatarsomere of female longer than remaining tarsomeres combined, basally as narrow as apically, apically narrower than third metatarsomere. Metatibial spur longer than half of claw tarsomere.

Spermatheca with receptacle slightly shorter than pump. Internal side of receptacle more convex than external. Receptacle ovoid, only slightly longer than wide, with maximum width below middle. Pump moderately narrow, long, with denticle at apex. Horizontal part of pump longer than vertical. Duct without coils making no loop away from receptacle (Fig. 48), points in same direction as receptacle. Tignum nearly straight, widening posteriorly and anteriorly. Posterior sclerotization with two well-developed, long arms (Fig. 70). Vaginal palpus with membranous part in middle longer than sclerotized part anteriorly and posteriorly. Posterior sclerotization slightly longer than or as long as anterior. Lateral margin not parallel to medial, forming well developed angle to apex (Fig. 59).

Median lobe of aedeagus curved in lateral view; distal portion strongly curved ventrally. Ventral side flattened with two impressions. Apex triangular, bent dorsally. Dorsal opening wider than long, partially covered by transparent lamina (Fig. 27). Arms of tegmen much shorter than stem (Fig. 37).

Measurements (n = 10): Length 1.76–2.2 (2.02), width 0.88–1.19 (1.03), length of pronotum 0.43–0.53 (0.49), width of pronotum: 0.58–0.73 (0.65), width across eyes 0.43–0.56 (0.54), distance between eyes 0.23–0.27 (0.25), aedeagus length 0.77, length of receptacle 0.7, length of vaginal palpi 0.35.

Type material examined.—Holotype, ♂. Labels: 1) India: Tamil Nadu: Coonoor, 27.X. 1998, K. D. Prathapan Coll.; 2) Holotype *Aphthona macarangae* sp. nov. des. Prathapan & Konstantinov, 2001 (USNM). Paratypes, 32 ♂, 14 ♀ with same labels as holotype (2 BMNH, 38 KPPC, 2 PNCI, 2 UABI, 2 USNM); 1 ♂, 1 ♀. Kerala, Vellanikkara, 12.VI.1999 (K. D. Prathapan) (2 KPPC).

Etymology.—This species is named after its host plant.

Variability.—Specimens collected from lower elevations are considerably smaller.

Remarks.—*Aphthona macarangae* resembles *A. chrozophorae* in several features including relatively long antennae and first metatarsomere, but can be readily distinguished by a number of characters: antennomeres 4 to 7 lighter than 8 to 11; supraorbital sulcus present; posterolateral callosity of pronotum narrow and short; apical margin of elytron convex; median lobe of aedeagus with 2 impressions near apex of ventral side; spermatheca with receptacle shorter than pump.

Aphthona mallotae Prathapan and Konstantinov, new species

(Figs. 3, 14, 25, 35, 46, 57, 68)

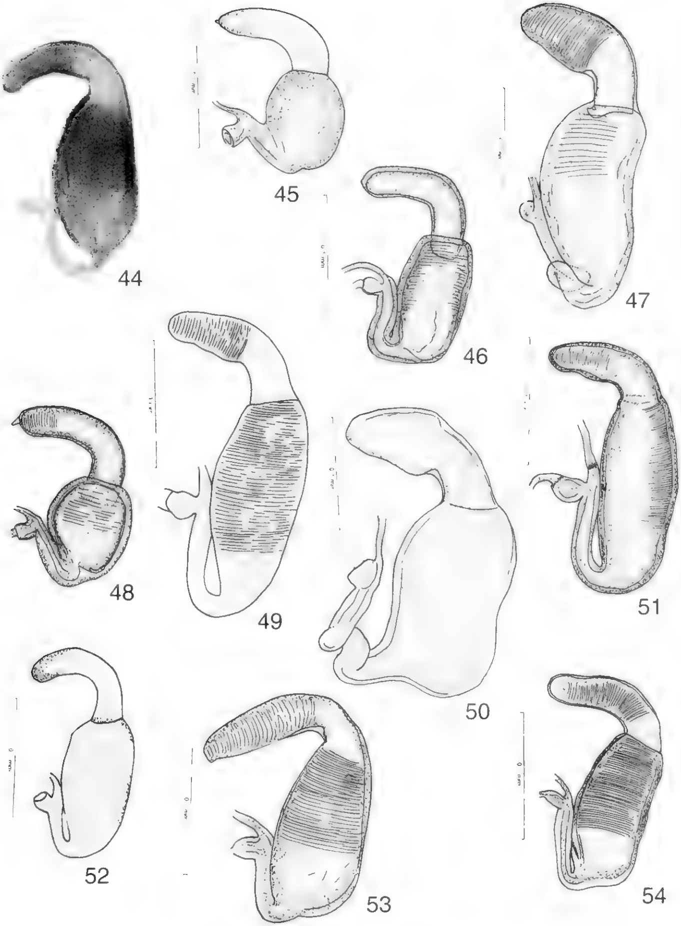
Distribution.—India (Karnataka).

Host plant.—*Mallotus philippinensis* Muell. (Euphorbiaceae).

Description.—Body with metallic green luster. Six apical antennomeres and metafemur brownish. Rest of antenna and legs yellow.

Vertex impunctate, rugose above antennal calli, covered with shallow transverse wrinkles. Sulci well developed. Supracallinal sulcus narrow and not deep, curved. Antennal calli subquadrate, transverse. Frontal ridge moderately long, between antennae wider than above anterofrontal ridge. Anterofrontal ridge gently arched, moderately thick, medially without denticle, as high as frontal ridge. Basal palpomere of maxillary palpus slender, long; second palpomere thickened; third palpomere much narrower than second, pointed. Antenna not reaching basal ⅔ of elytra; second antennomere longer than third; fourth equal to second, longer than third; fifth longer than fourth; distal antennomeres not distinctly thickened.

Pronotum slightly wider basally than api-



Figs. 44–54. Spermatheca of *Aphthona*. 44, *A. atripes*. 45, *A. marataka*. 46, *A. mallotae*. 47, *A. nandiensis*. 48, *A. macarangae*. 49, *A. glochidionae*. 50, *A. phyllanthae*. 51, *A. tamila*. 52, *A. chrozophorae*. 53, *A. nigrilabris*. 54, *A. kananraensis*.

cally, with lateral margins evenly curved. Anterolateral callosity moderately low, apically slightly lower than basally, moderately short, straight, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity moderately narrow and long, well-developed. Disc shiny, sparsely covered with small, well defined punctures.

Scutellum wider than long, rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides convex, with three convex ridges, maximum width at apical third. Apical margin slightly convex. Apex obtusely angulate. Surface rugose, moderately densely covered with large punctures.

Metatibia slightly curved in lateral view, apically widened, dorsally flat at apical third; remainder of surface convex. First metatarsomere of male longer than remaining tarsomeres combined, basally as narrow as apically, apically narrower than third metatarsomere. Metatibial spur straight, longer than half of claw tarsomere.

Spermatheca with receptacle longer than pump. Internal side of receptacle more convex than external. Receptacle nearly cylindrical, much longer than wide, with maximum width near middle. Pump moderately narrow, long, without denticle at apex. Horizontal part of pump longer than vertical. Duct without coils, making no loop away from receptacle (Fig. 46), points away from receptacle. Tignum nearly straight, widening posteriorly and anteriorly. Posterior sclerotization without arms, but with two areas of sclerotization (Fig. 68). Vaginal palpus with membranous part in middle longer than sclerotized part anteriorly and posteriorly. Posterior sclerotization slightly longer than or as long as anterior. Lateral margin not parallel to medial, forming well developed angle to apex (Fig. 57).

Median lobe of aedeagus curved in lateral view; distal portion of median lobe curved ventrally. Ventral side with single sharp ridge before apex and two elongated furrows lateral to it. Apex triangular, bent dorsally. Dorsal opening not covered by lamina (Fig. 25). Arms of tegmen much shorter than stem (Fig. 35).

Measurements (n = 10): Length 1.45–1.85 (1.65), width 0.75–1.03 (0.88), length of pronotum 0.36–0.45 (0.41), width of pronotum 0.55–0.68 (0.6), width across eyes 0.40–0.55 (0.48), distance between eyes 0.21–0.27 (0.24), length of aedeagus 0.69, length of vaginal palpi 0.31, length of receptacle 0.10.

Type material examined.—Holotype ♂: Labels: 1) India: Karnataka: Nandi Hills, 19.IV.1999, K. D. Prathapan Coll. 2) Holotype *Aphthona mallotae* sp. nov. des. Prathapan & Konstantinov 2001 (USNM). Paratypes, 12 ♂, 15 ♀ with same labels as holotype (2 BMNH, 29 KPPC, 2 PNCI, 2 UABI, 2 USNM); 2 ♂, 1 ♀, Nandi Hills, 17.X.1998 K. D. Prathapan Coll. (3 KPPC)

Etymology.—This species is named after its host plant.

Remarks.—*Aphthona mallotae* is similar to *A. marataka* Based in color and proportions of the body. However, these species are easily distinguishable from each other based on the following characters: metafemur unicolorously dark (in *A. marataka* it is bicolorous with the base being bright yellow and apex being dark brown); median lobe of aedeagus slender with sharp ridge ventrally (in *A. marataka* the lobe is much more robust without a ridge).

Aphthona marataka Prathapan and Konstantinov, new species

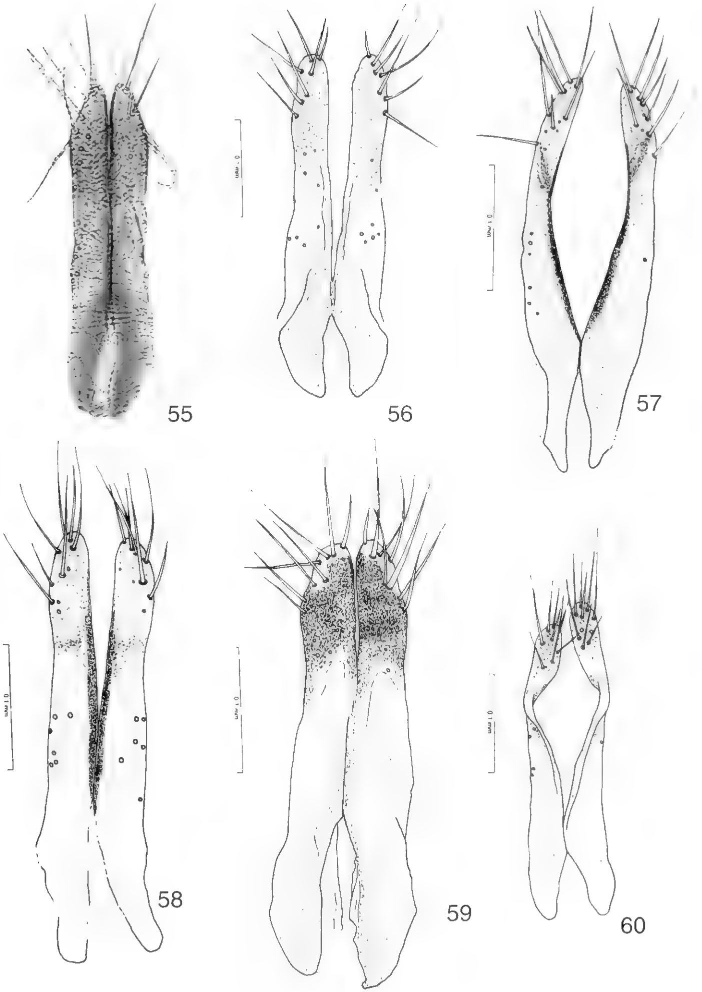
(Figs. 2, 13, 24, 34, 45, 56, 67)

Distribution.—India (Karnataka).

Host plant.—Unknown.

Description.—Body with metallic green luster. Seven apical antennomeres and apex of metafemur brownish. Rest of antenna and legs yellow.

Vertex impunctate, strongly rugose above antennal calli, covered with transverse wrinkles. Sulci well developed. Supracallinal sulcus as wide and deep as other, curved. Antennal calli subquadrate, transverse. Frontal ridge moderately long, between antennae wider than above anterofrontal ridge. Anterofrontal ridge gently arched, moderately thick, medially without denticle, as high as frontal ridge. Basal palpomere of maxillary palpus longer than second; second thickened, subequal to third in length; third palpomere much narrower than second, pointed. Antenna extend beyond basal ⅔ of elytron; second antennomere shorter than third, third to fifth progressively increase in size.



Figs. 55–60. Vaginal palpi of *Aphthona*. 55, *A. atripes*. 56, *A. marataka*. 57, *A. mallotae*. 58, *A. nandiensis*. 59, *A. macarangae*. 60, *A. glochidionae*.

Pronotum slightly wider basally than apically, with lateral margins evenly curved. Anterolateral callosity moderately low, apically slightly lower than basally, moderately short, straight, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity moderately narrow and long, well-developed. Disc shiny, densely covered with relatively large, elongate, well defined punctures, forming longitudinal wrinkles.

Scutellum wider than long, rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides convex, without convex ridges, maximum width at apical third. Apical margin slightly convex. Apex obtusely angulate. Surface rugose, moderately densely covered with large punctures.

Metatibia slightly curved in lateral view, apically widened, dorsally flat at apical third; remainder of surface convex. First metatarsomere of female longer than remaining tarsomeres combined, basally as narrow as apically, apically slightly narrower than third metatarsomere. Metatibial spur curved, longer than half of claw tarsomere.

Spermatheca with receptacle slightly shorter than pump. Internal side of receptacle more convex than external. Receptacle ovoid, only slightly longer than wide, with maximum width below middle. Pump moderately narrow, long, with denticle at apex. Horizontal part of pump longer than vertical. Duct without coils making no loop away from receptacle (Fig. 45), points in same direction as receptacle. Tignum nearly straight, widening posteriorly and anteriorly. Posterior sclerotization with two arms (Fig. 67). Vaginal palpus with membranous part in middle longer than sclerotized part anteriorly and posteriorly. Posterior sclerotization slightly longer than or as long as anterior. Lateral margin not parallel to medial, forming well developed angle to apex (Fig. 56).

Median lobe of aedeagus curved in lateral view; distal portion curved ventrally. Ventral side without ridge before apex, with elongate shallow furrow in middle. Apex wide, triangular, bent dorsally. Dorsal opening not covered by lamina (Fig. 24). Arms of tegmen much shorter than stem (Fig. 34).

Measurements (n = 4, all females): Length 2.18–2.28 (2.21), width 1.06–1.18 (0.12), length of pronotum 0.48–0.53 (0.5), width of pronotum 0.71–0.78 (0.75), width across eyes 0.54–0.60 (0.57), distance between eyes 0.25–3.0 (0.28), length of aedeagus 0.65, length of vaginal palpi 0.3, length of receptacle 0.14.

Type material examined.—Holotype, ♂. Labels: 1) India Karnataka: Kattlekadu, 16.XI.1998 K. D. Prathapan Coll. 2) Holotype *Aphthona marataka* sp. nov. des. Prathapan & Konstantinov, 2001 (USNM). Paratypes, 7 ♀, with same labels as holotype (1 BMNH, 3 KPPC, 1 PNCI, 1 UABI, 1 USNM).

Etymology.—The species name "marataka" means emerald in Sanskrit and refers to the color of the insect.

Remarks.—*Aphthona marataka* is similar to *A. mallotae* in color and proportions of the body. However, these species are easily distinguishable based on the following characters: metafemur bicolorous with base bright yellow and apex dark brown (in *A. mallotae* it is unicolorously dark); median lobe of aedeagus robust without a ridge on ventral side (in *A. mallotae* the lobe is much more slender with sharp ridge ventrally).

Aphthona nandiensis Prathapan and Konstantinov, new species

(Figs. 4, 15, 26, 36, 47, 58, 69)

Distribution.—India (Karnataka).

Host plant.—Unknown.

Description.—Body entirely yellowish except darker 4 or 5 last antennomeres and ventral side of body.

Vertex impunctate, finely rugose above antennal calli, covered with fine transverse wrinkles. Sulci relatively well developed, but not deep. Antennal calli subquadrate, transverse. Frontal ridge moderately short, broad, between antennae slightly wider than above anterofrontal ridge. Anterofrontal ridge gently arched, moderately thick, medially without denticle, as high as frontal ridge. Basal palpomere of maxillary palpus longer than second; second thickened, shorter than third; third palpomere much narrower than second, pointed. Antennae reach apex of elytra; second antennomere thicker but nearly as long as third, third shorter than fourth and fifth.

Pronotum slightly wider basally than apically, with lateral margins evenly curved. Anterolateral callosity moderately low, apically slightly lower than basally, moderately short, straight, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity moderately narrow and long, well-developed. Disc shiny, sparsely covered with medium size, elongate, ill defined punctures, forming longitudinal wrinkles.

Scutellum wider than long, narrowly rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides weakly convex, with three convex ridges, maximum width nearly in middle. Apical margin convex. Apex broadly rounded. Surface rugose, densely covered with large punctures forming striae laterally.

Metatibia nearly straight in lateral view, apically widened, dorsally flat at apical third; remainder of surface convex. First metatarsomere of male longer than remaining tarsomeres combined, basally as narrow as apically, apically slightly narrower than third metatarsomere. Metatibial spur curved, longer than half of claw tarsomere.

Spermatheca with receptacle longer than pump. Internal side of receptacle convex, external side concave. Receptacle elongate, longer than wide, with maximum width nearly in middle. Pump moderately wide, short, without denticle at apex. Horizontal part of pump short, longer than vertical. Duct with coils making no loop away from receptacle (Fig. 47), points in same direction as receptacle. Tignum curved anteriorly, widening posteriorly and anteriorly. Posterior sclerotization without arms (Fig. 69). Vaginal palpus with membranous part in middle longer than sclerotized part anteriorly and posteriorly. Posterior sclerotization slightly longer than or as long as anterior. Lateral margin not parallel to medial, forming well developed angle to apex (Fig. 58).

Median lobe of aedeagus curved in lateral view; distal portion curved ventrally. Ventral side weakly convex, without ridge before apex. Apex wide, triangular, bent dorsally, without denticle. Dorsal opening not covered by lamina (Fig. 26). Arms of tegmen shorter than stem (Fig. 36).

Measurements (n = 1, male): Length 1.21, width 0.68, length of pronotum 0.29, width of pronotum 0.45, width across eyes 0.24, distance between eyes 0.18, length of aedeagus 0.65, length of vaginal palpi 0.3, length of receptacle 0.14.

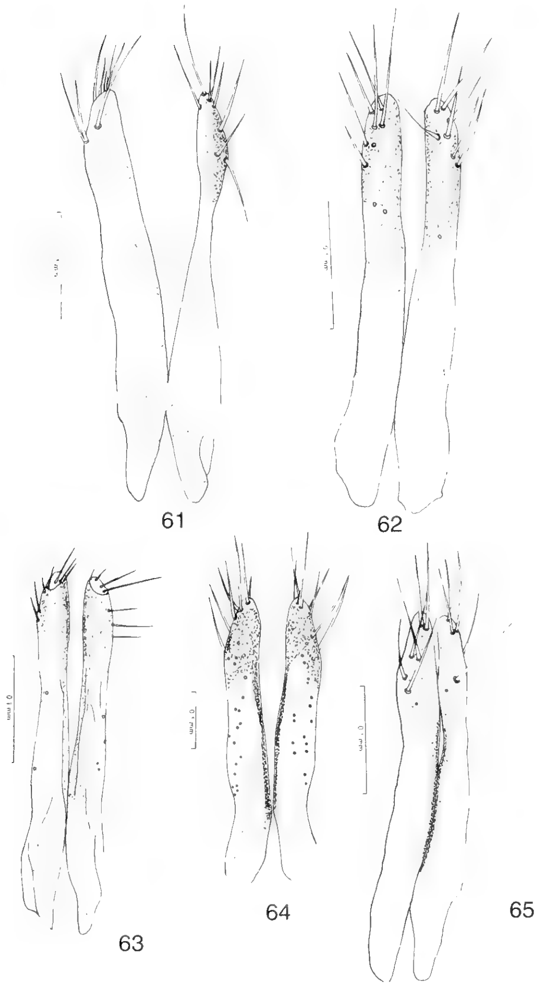
Type material examined.—Holotype ♂. Labels: 1) India: Karnataka: Nandi Hills, 19. IV. 1999 K. D. Prathapan Coll. 2) Holotype *Aphthona nandiensis* sp. nov. des. Prathapan & Konstantinov, 2001 (USNM). Paratypes 2 ♂, 1 ♀. The same labels as holotype (2 KPPC, 1 USNM).

Etymology.—This species is named after the type locality.

Remarks.—*Aphthona nandiensis* is the smallest Southern Indian species of *Aphthona*. It can be easily separated from all other yellow species by the three ridges on the sides of each elytron and unique median lobe of the aedeagus and spermatheca.

Aphthona nigrilabris Duvivier
(Figs. 10, 21, 32, 42, 53, 64, 75)

Aphthona nigrilabris Duvivier 1892: 426 (type locality: Konbir, Bengal, India. Lectotype (ISNB) designated by Konstantinov and Lingafelter (2002), examined). Chen 1934: 370 (key, faunistics). Maulik 1926: 367, 370 (key, redescription, taxonomic notes, distribution, deposition of type specimens). Heikertinger and Csiki 1939: 97 (world catalog). Hei-



Figs. 61–65. Vaginal palpi of *Aphthona*. 61, *A. phyllanthae*. 62, *A. tamila*. 63, *A. chrozophorae*. 64, *A. nigrilabris*. 65, *A. kananraensis*.

kertinger 1944: 111/197, 113/199, 117/203, (key, catalog, taxonomic notes), 1945–1950: 144/130 (key). Gressitt and Kimoto 1963: 866 (key). Scherer 1969: 71, 76 (key, distribution, synonymic bibliography). Takizawa 1983: 75 (list, India), 1988: 9 (list, Nepal). Medvedev and Sprecher-Uebersax 1999: 323 (list, Nepal). Kimoto, 2000: 198, 201 (key, distribution); 2001: 54 (distribution, Nepal).

Longitarsus recticollis Jacoby 1898: 188 (type locality: Calcutta, India. Depository of type specimens is unknown). Heikertinger and Csiki 1939: 97 (synonymy).

Aphthona rubida Chen 1936: 83 (type locality: Bandarawella, Sri Lanka. Deposition of the type specimen is unknown). Konstantinov and Lingafelter 2002 (synonymy).

Distribution.—India (Assam, Bengal, Bihar, Karnataka, Maharashtra, Uthar Pradesh), Bangladesh (Duvivier 1892; Jacoby 1898), Nepal (Medvedev and Sprecher-Uebersax 1999), Sri Lanka, Thailand, Vietnam, Indonesia (Kimoto 2001).

Host plants.—*Euphorbia hirta* L., *E. hypericifolia* L. (Zuka-ur-Rab 1991); *E. pilulifera* (Euphorbiaceae) (Scherer 1969); *Pinus longifolia* Roxb. (Pinaceae) (Mathur and Balwant Singh 1959b). *Ipomaea batatas* Poir. (Convolvulaceae).

Description.—Color greyish yellow. Last 6 antennomeres, labrum, apical part of clypeus, scutellum, meso- and metasterna and metafemur brown. Rest of legs and antenna yellow.

Vertex flat, shiny, densely covered with long wrinkles, and fine punctures. Frontal ridge wide, short, with sides almost parallel, maximum width near anterofrontal ridge. Antennal calli moderately flat, very short, much shorter than wide, moderately wide, trapezoidal, forming obtuse angle to each other. Supracallinal sulcus poorly developed, straight. Supraorbital sulcus poorly developed. Anterofrontal ridge moderately high in middle, low laterally. Frontoclypeal suture with two irregular, complete rows of setae. Clypeus long. Fifth antennomere longer than fourth and sixth separately.

Pronotum slightly wider basally than apically, with lateral margins nearly straight and almost parallel. Anterolateral callosity moderately low, apically lower than basally, long, concave, forming acute denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity poorly developed. Disc shiny, sparsely covered with tiny punctures. Interspaces finely rugose.

Scutellum wider than long, widely rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides convex, maximum width at apical third. Apical margin slightly convex. Apex obtusely angulate. Surface rugose, densely covered with fine punctures. Prosternum short. Intercoxal prosternal process wider apically, curved at apex. Metasternum moderately long, convex in lateral view.

Metatibia slightly convex in lateral view, apically widened, dorsally flat at apical third. First metatarsomere of female slightly narrower basally than apically, apically not wider than third metatarsomere.

Spermatheca with receptacle nearly as long as pump. Internal side of receptacle convex, external slightly concave. Receptacle nearly cylindrical, longer than wide, with maximum width between duct and middle. Pump narrow at vertical part and slightly narrower than base of horizontal part, moderately long, nearly straight, without denticle at apex. Horizontal part of pump longer than vertical. Duct short, not reaching middle of receptacle, not making loop away from receptacle, at base pointed in direction opposite of receptacle (Fig. 53). Tignum slightly curved, gradually widening anteriorly. Posterior part poorly sclerotized, not forming arms (Fig. 75). Vaginal palpus with membranous part in middle longer than sclerotized part posteriorly and as long as sclerotized part anteriorly. Posterior sclerotization slightly narrower than anterior. Apical sclerotization laterally nearly as long as medially, straight. Apical membrane nearly round. Lateral margin nearly parallel to medial, not forming angle near apex. Medial margin slightly curved (Fig. 64).

Median lobe of aedeagus sinuous in lateral view, very long, sides parallel. Ventral side convex, only apically with wide, shallow longitudinal impression. Apex with small button shaped structure (Fig. 21).

Measurements (n = 10): Length 2.96–3.64 (3.27), width 1.58–1.96 (1.77), length of pronotum 0.7–0.84 (0.78), width of pronotum 1.0–1.26 (1.14), width across eyes 0.74–0.88 (0.81), distance between eyes 0.35–0.43 (0.39), aedeagus length 0.71, vaginal palpi 0.49, receptacle 0.2.

Type material examined.—*Aphthona nigrilabris*: Lectotype ♂. Labels: 1) Coll. R.I.Sc.N.B. Inde Konbir P. Cardon; 2) Collect Duvivier; 3) Type; 4) det Duvivier *Aphthona nigrilabris* n.sp.; 5) Lectotype *Aphthona nigrilabris* Duvivier des. A. Konstantinov (ISNB). Paralectotypes 2 ♀, with same labels as lectotype (ISNB).

Material examined.—INDIA: Karnataka, Bangalore, 22.IV.1998, *Ipomaea batatas* Poir., K. D. Prathapan Coll. (19 KPPC); 3 ♂, 7 ♀, Bangalore, 27.IV.1998, K. D. Prathapan Coll. (8 KPPC, 2 USNM); Delhi, New Delhi, 20–23.X.1978, Jap-ind co tr (17 TCOJ); Tamil N. [= Tamil Nadu] Madras, 16–19.XII.1978, Jap-ind co tr (16 TCOJ). NEPAL: 2 km E. Mugling, 27°48.36N, 84°53.68E, 20.IV.2000, leg. Konstantinov, Lingafelter, Volkovitsh (5 USNM); Terrai, W. Narayangadh, small valley Rapti river 26.IV. 2000, 27°42.31N, 84°21.11E, leg. Konstantinov, Lingafelter, Volkovitsh (2 USNM); Terrai, env. Chitawan Nat. Park, river beds 25.IV.2000 27°28.79N, 84°52.54E, leg. Konstantinov, Lingafelter, Volkovitsh (1 USNM); Narayani env. of Narayandagh, pasture 24.IV.2000, leg. Konstantinov, Lingafelter, Volkovitsh (2 USNM). SRI LANKA: Candy, 1,800 ft., 7–14.I.1970, leg. Davis & Rowe (1 USNM). THAILAND: 13–15.IV.1991, Thong Pha Phum 150 m, 14°43′N, 98°39E, Vit Kuban leg. (4 NHMB); Thailand occ. 08–12.IV.1991, Sangkhlaburi, Jan Farkač leg. (2 NHMB, 1 USNM).

Remarks.—*Aphthona nigrilabris* belongs to the *cyparissiae* group of species. In *A. nigrilabris* the apex of the median lobe of the aedeagus has a wide depression ventrally and the eighth abdominal sternite of the female is heavily sclerotized.

Aphthona phyllanthae Prathapan and Konstantinov, new species

(Figs. 17, 18, 29, 39, 50, 61, 72)

Distribution.—India (Karnataka).

Host plants.—*Phyllanthus polyphyllus* Wild. and *P. emblica* L. (Euphorbiaceae).

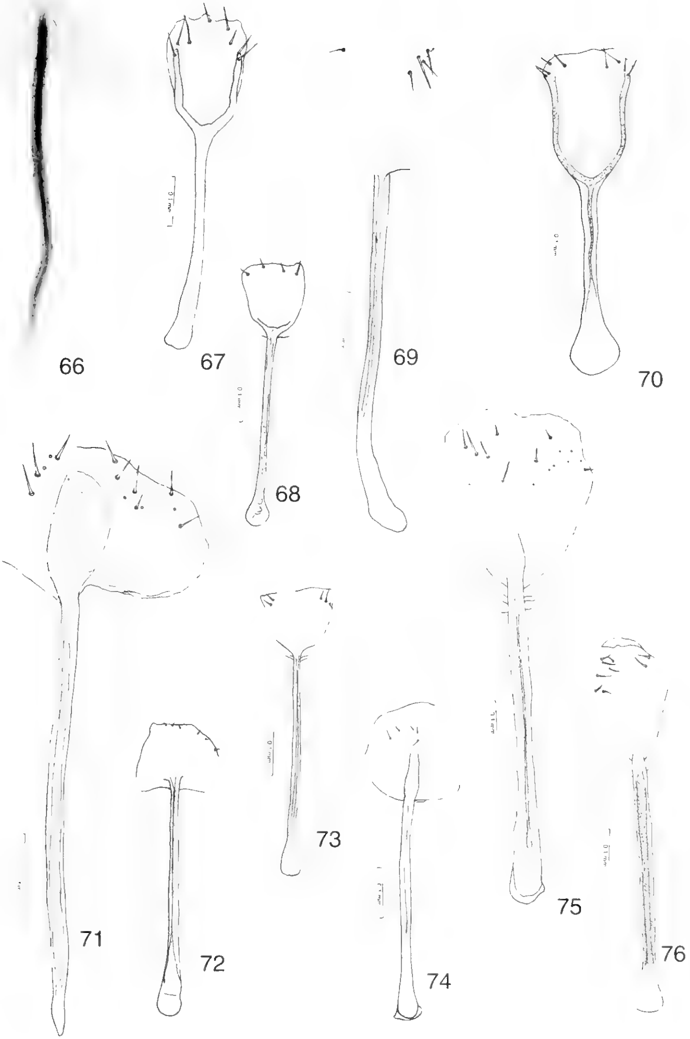
Description.—Body yellowish except darker (light brown) 7 last antennomeres and ventral side of body.

Vertex impunctate, smooth, without wrinkles. Sulci well developed, but not deep. Antennal calli subquadrate, transverse. Frontal ridge moderately short, narrow, between antennae slightly wider than above anterofrontal ridge. Anterofrontal ridge slightly arched, extremely narrow and low, medially without denticle. Basal palpomere of maxillary palpus longer than second; second thickened, shorter than third; third palpomere much narrower than second, pointed. Antenna not reaching basal ⅔ of elytron; second antennomere thicker but nearly as long as third, third shorter than fourth and fifth.

Pronotum slightly wider basally than apically, with lateral margins evenly curved. Anterolateral callosity moderately low, apically slightly lower than basally, moderately short, straight, forming obtuse denticle at setiferous pore. Pore situated at upper posterior face of callosity. Posterolateral callosity moderately wide and long, well-developed. Disc shiny, sparsely covered with small size, round, well defined punctures.

Scutellum wider than long, narrowly rounded at apex. Elytron with well developed humeral callus, without depression posteriorly. Sides convex, without convex ridges, maximum width at apical one third. Apical margin straight. Apex with obtuse denticle. Surface smooth, sparsely covered with small punctures forming poorly developed striae.

Metatibia straight in lateral view, apically widened, dorsally flat at apical two third;



Figs. 66–76. Tignum of *Aphthona*. 66, *A. atripes*. 67, *A. marataka*. 68, *A. mallotae*. 69, *A. nandiensis*. 70, *A. macarangae*. 71, *A. glochidionae*. 72, *A. phyllanthae*. 73, *A. tamila*. 74, *A. chrozophorae*. 75, *A. nigrilabris*. 76, *A. kananraensis*.

remainder of surface slightly convex. First metatarsomere of male longer than remaining tarsomeres combined, basally as narrow as apically, apically slightly narrower than third metatarsomere. Metatibial spur curved, shorter than half of claw tarsomere.

Spermatheca with receptacle longer than pump. Internal side of receptacle convex, external side concave. Receptacle longer than wide, with maximum width above middle. Pump moderately wide, short, without denticle at apex. Horizontal part of pump short, longer than vertical. Duct with coils making loop away from receptacle (Fig. 50), points in opposite direction than receptacle. Tignum straight, slightly widening anteriorly. Posterior sclerotization without arms (Fig. 72). Vaginal palpus with membranous part in middle longer than sclerotized part anteriorly and posteriorly. Posterior sclerotization slightly longer than or as long as anterior. Lateral margin not parallel to medial, forming well developed angle to apex (Fig. 61).

Median lobe of aedeagus nearly straight in lateral view; distal portion of median lobe sinuous. Ventral side weakly convex, without ridge before apex. Apex as narrow as rest of lobe, triangular, slightly bent dorsally, with wide denticle. Dorsal opening nearly three times longer than wide (Fig. 29), distal margin almost straight, partially covered by single lamina narrower than apical opening and tapering towards end. Arms of tegmen shorter than stem (Fig. 39).

Measurements (n = 10): Length 1.65–2.08 (1.70); width 0.75–1.08 (0.95); length of pronotum 0.35–0.45 (0.41); width of pronotum 0.53–68 (0.61); width across eyes 0.43–5.25 (0.50); distance between eyes 0.17–0.23 (0.21); length of aedeagus 0.75; length of vaginal palpi 0.39, length of receptacle 0.15.

Type material examined.—Holotype ♂. Labels: 1) India Karnataka, 1.I.1998, Bangalore, K. D. Prathapan Coll. 2) Holotype *Aphthona phyllanthae* sp. nov. des. Prathapan & Konstantinov, 2001 (USNM). Paratypes 19 ♂, 16 ♀. Same label as holotype except for the date 2.I.1998 (2 BMNH, 27 KPPC, 2 PNCI, 2 UABI, 2 USNM).

Etymology.—This species is named after the genus of the host plants.

Remarks.—*Aphthona phyllanthae* keys out together with *A. kanaraensis*. It can be separated from it by the following characters: median lobe of aedeagus with short denticle apically and spermathecal duct with coils.

Aphthona tamila
Konstantinov and Lingafelter
(Figs. 8, 19, 30, 40, 51, 62, 73)

Aphthona tamila Konstantinov and Lingafelter 2002:185 (type locality: Tamil Nadu, India). Holotype (TCOJ) examined).

Distribution.—India (Tamil Nadu) (Konstantinov and Lingafelter 2002).

Host plants.—*Drypetes* sp. (Euphorbiaceae).

Description.—Color yellow. Head, 8 apical antennomeres, scutellum, narrow stripe along elytral suture, meso- and metasterna, and apex of metafemur dark brown.

Vertex moderately flat, sparsely covered with fine wrinkles and punctures. In some specimens bottom of vertex with shallow, transverse impression. Frontal ridge moderately short and narrow, with convex surface and sides almost parallel, but with maximum width nearly between antennal sockets. Antennal calli moderately flat, almost as wide as long, nearly trapezoidal, forming obtuse angle to each other, widely connected. All sulci well developed. Supracallinal sulcus convex. Anterofrontal ridge with denticle in middle. Anterofrontal ridge in middle lower than frontal ridge. Frontoclypeal suture with two irregular, complete rows of setae. Clypeus long. Orbit narrow. Eye small, narrower than distance between eyes. Second antennomere much wider, but slightly shorter than third. Fifth antennomere slightly longer than fourth and sixth, separately.

Pronotum slightly wider basally than apically, with sides convex. Maximum width nearly at middle. Lateral margin rather narrowly explanate, slightly narrower basally than apically. Anterolateral callosity moderately low, apically as high as basally, long, straight, forming obtuse denticle at setiferous pore. Posterolateral callosity well developed, longer than lateral margin, lateral margin forming indentation in front of callosity making it more prominent. Disc shiny, densely covered with medium sized punctures. Interspaces shagreened, shiny. Basal part of pronotum without any impressions.

Scutellum wider than long, narrowly rounded at apex. Sides nearly straight, strongly converging posteriorly. Elytron with well developed humeral callus, with extremely shallow depression posteriorly. Sides slightly convex, maximum width at apical third. Apical margin convex. Apex obtusely angulate. Surface shiny, covered with moderately small punctures, their diameter 1.5–2.0 times smaller than distance between punctures.

Metatibia moderately long, straight in lateral view, gradually widened apically, dorsally flat at apical half. First metatarsomere of female shorter than half of tibia, as narrow basally as apically, slightly narrower apically than third metatarsomere. In male, first metatarsomere wider apically than basally, nearly as wide as third metatarsomere.

Spermatheca with receptacle much longer than pump. Internal side of receptacle convex, external side slightly concave to straight. Receptacle elongate, much longer than wide, maximum width between middle and pump. Pump moderately wide at vertical part, as wide as base of horizontal part, moderately long, slightly curved, without denticle at apex. Vertical part of pump short, shorter than half of horizontal part. Duct not reaching middle of receptacle, making small loop away from receptacle, at base pointed in direction of receptacle (Fig. 51). Tignum nearly straight, gradually widening anteriorly. Posterior part poorly sclerotized, relatively wide, parallel sided, not forming two arms (Fig. 73). Vaginal palpus with membranous part in middle nearly as long as sclerotized part posteriorly and anteriorly. Posterior sclerotization slightly narrower than anterior. Apical sclerotization laterally shorter than medially, slightly curved. Apical membrane oblique. Lateral margin not parallel to medial, not forming angle near apex. Medial margin slightly curved (Fig. 62).

Median lobe of aedeagus nearly straight in lateral view. Apically wider than basally. Apex of ventral part with narrow, short, and shallow impression (Fig. 8).

Measurements (n = 10): Length 1.52–1.80 (1.68), width 0.83–1.0 (0.90), length of pronotum 0.35–0.43 (0.39), width of pronotum 0.53–0.6 (0.56), width across eyes 0.43–0.48 (0.46), distance between eyes 0.18–0.21 (0.20), length of aedeagus 0.61, length of vaginal palpi 0.29, length of receptacle 0.16.

Type material examined.—*Aphthona tamila*: Holotype ♂. Labels: 1) India: Tamil N. [= Tamil Nadu] Coonoor, 1,700–1,900 m, 23–26.XI.1978, JAP-IND CO TR; 2) Holotype *Aphthona tamila* des. A. Konstantinov & S. Lingafelter (TCOJ). Paratypes, with same labels as holotype (9 TCOJ, 4 USNM). Paratypes. India: Tamil N. [= Tamil Nadu] Kotagiri, Nilgiri, 1,700 m, 29.XI.1978, JAP-IND CO TR. (7 TCOJ, 3 USNM). Paratypes. H. L. Andrewes Nilgiri Hills; Andrewes Bequest B.M. 1922–221 (6 BMNH, 1 USNM).

Material examined.—INDIA: Tamil Nadu, Naduvattom, 26.X.1998, ex. *Drypetes* sp K. D. Prathapan Coll. (38 KPPC, 2 USNM).

Remarks.—*Aphthona tamila* can be separated from other species of *Aphthona* in Southern India by the much darker color of the head and the elytral suture, and also by several unique features of the median lobe of the aedeagus and spermatheca.

ACKNOWLEDGMENTS

We thank M. Cludts (ISNB), M. Brancucci and E. Sprecher-Uebersax (NHMB), and H. Takizawa (TCOJ) for the opportunity to study material in their care. We are also grateful to M. Danilevsky (A. N. Severtzov Institute of Ecology and Evolution, Moscow, Russia), W. Flowers (Florida A&M University, Tallahassee, FL), A. L. Norrbom and A. Solis (Systematic Entomology Laboratory, Washington, DC), and C. Staines (Smithsonian Institution, Washington, DC) for reviewing this manuscript and providing valuable suggestions. The senior author is grateful to Dr. C. A. Viraktamath (Department of Entomology, University of Agricultural Sciences, Bangalore, India) for guidance, support, and constant encouragement; to Dr. Balakrishne Gowda (University of Agricultural Sciences, Bangalore, India) for identifying the plants; to the former and current Directors of the Indian Institute of Spices Research, Dr. K. V. Peter and Dr. Y. R. Sarma, for granting study leave; and to Indian Council of Agricultural Research, New Delhi for awarding him a Senior Research Fellowship.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 180–185

NEW ENCYRTIDAE (HYMENOPTERA) FROM PAPAYA MEALYBUG (*PARACOCCUS MARGINATUS* WILLIAMS AND GRANARA DE WILLINK) (HEMIPTERA: STERNORRHYNCHA: PSEUDOCOCCIDAE)

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Abstract.—Two new Encyrtidae, ***Pseudleptomastix mexicana*** and ***Acerophagus papayae,*** are described and illustrated. Both species have been reared as part of exploration to find parasitoids of the papaya mealybug, *Paracoccus marginatus* Williams and Granara De Willink. Biological control programs currently underway are investigating these species, and we herein provide names and taxonomic information so these parasites can be utilized in the field.

Key Words: parasitoid, mealybug, biological control, Encyrtidae, Pseudococcidae

The papaya mealybug (PM), *Paracoccus marginatus* Williams and Granara De Willink, was described from Central America (Williams and Granara de Willink 1992) and apparently introduced to the Caribbean in 1994, where it spread among many of the islands (D. Meyerdirk, personal communication). It was found in Florida in 1998 (Miller and Miller 2002). The mealybug is believed to be native to Mexico and Central America. PM is a polyphagous feeder reported to attack 50 host plants, including food crops like *Papaya, Carica, Citrus, Capsicum,* and *Casava,* and ornamentals such as *Hibiscus, Plumeria,* and *Acalypha* (D. Meyerdirk, personal communication).

During 2000, fieldwork was conducted by one of us (MES), along with colleagues from the USDA-ARS and Colegio Postgraduados, Veracruz, and Colegio Postgraduados, Texcoco, Mexico to find species of parasitoids that might be of use in the biological control of *P. marginatus.* Several species, including *Anagyrus loecki* Noyes and Menezes, were discovered. These species are now being reared and released in the U.S. Virgin Islands, Puerto Rico, and Florida. We have determined that two of these are undescribed and we take this opportunity to provide names for them.

Abbreviations for morphological structures and museum as follows: AL = aedeagus length; AOL = distance between anterior and posterior ocelli; EL = maximum eye length; EW = maximum eye width; FV = minimum frontovertex width; FWL = forewing length; FWW = forewing width; GL = gonostylus length; HW = head width; HWW = hindwing width; HWL = hindwing length; MS = malar space; MT = midtibia length; OCL = minimum distance between posterior ocellus and occipital margin; OL = ovipositor length; OOL = minimum distance between posterior ocellus and eye margin; POL = minimum distance between posterior ocelli; SL = scape length; SW = maximum scape width.

Abbreviations for Institutions are as follows. BMNH = The Natural History Museum, London, UK; INBIO = Instituto Nacional de Biodiversidad, Santo Domingo de Herdia, Costa Rica; USNM = National Museum of National History, Smithsonian Institution, Washington, DC.

Pseudleptomastix Girault (Tetracneminae)

Diagnosis.—*Female:* Head and mesosoma dark, base of tegula white, funicle 6-segmented, funicle segments longer than broad, subequal in size or shorter distally; clava 3-segmented, with sutures subparallel and never obliquely truncate; frontovertex between anterior ocellus and top of scrobes with very characteristic, regular, hexagonally reticulate sculpture of similar appearance to chicken-wire mesh and of mesh size about one-half to one-third diameter of anterior ocellus or slightly larger than an eye facet; mandibles with two teeth. *Male:* Similar to female but flagellar segments clothed in whorls of long setae, each much longer than diameter of segment; clava solid with subbasal scalelike structures ventrally.

***Pseudleptomastix mexicana* Noyes and Schauff, new species**

(Figs. 1–6)

Female (holotype).—Length 0.97 mm. Head and thorax black with a slight to conspicuous sheen, especially on mesoscutum; frontovertex inconspicuously mixed purple and dark blue, mesoscutum brassy green; radicle dark brown; scape dark brown along dorsal margin to about three quarters along its length, this very nearly connected to ventral margin subapically, base of scape with a very narrow dark brown ring, remainder of scape pale orange; pedicel dark brown in basal half, apical half pale orange; flagellum more or less uniform brown, perhaps apical segments a little darker; tegula very pale yellow with a small brown apical spot; mesoscutum clothed in translucent, silvery white setae; fore coxa pale yellow, mid and hind coxae dark brown; hind femur dark brown, paler towards apex; fore femur and tibia slightly dusky orange; fore tarsus brown; mid and hind legs pale orange, hind tarsus dusky orange; forewing (Fig. 1) completely hyaline, venation brown; gaster dark brown with a coppery and purple sheen proximally otherwise with a brassy sheen.

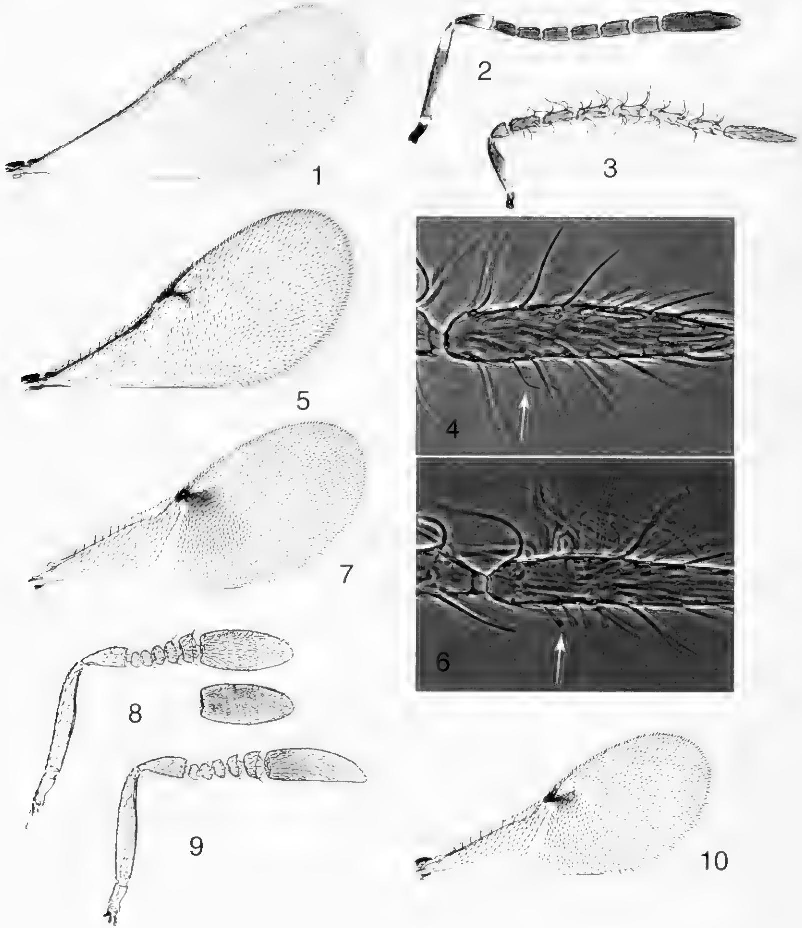
Head with raised, uniformly, polygonal reticulate sculpture on frontovertex of mesh size slightly larger than diameter of a facet; ocelli forming an angle of about 85°; antenna (Fig. 2) with pedicel about 2× as long as F1, funicle segments relatively short and stout, F1 about 2× as long as broad, F6 about 1.6× as long as broad and about 1.4× as long as F1. Relative measurements: HW 58, FV 22, POL 9, AOL 7, OOL 3, OCL 4, EL 41, EW 28, MS 15, SL 31, SW 5.

Mesoscutum shiny with shallow reticulate sculpture of distinctly smaller mesh than frontovertex; scutellum almost matt with clearly deeper, reticulate sculpture; forewing (Fig. 1) about 2.7× as long as broad; postmarginal vein about 2× as long as stigmal. Relative measurements: FWL 148, FWW 55; HWL 100, HWW 19.

Gaster with ovipositor hardly exserted, exserted part much less than 0.1× as long as gaster.

Relative measurements of paratypes: OL 53, GL 13, MT 94.

Male.—Length 0.56–0.84 mm. Generally similar to female in coloration but scape yellow in basal two-fifths or so, apex dark brown; pedicel dark brown; flagellum dark brown to testaceous; tegula white in basal half, apex brown; all funicle segments at least 2× as long as broad and clothed in long setae, longest of which are at least about 3× as long as width of any funicle segment (Fig. 3); clava ventrally with two or three slender, subbasal, apically curved scalelike structures, these difficult to distinguish from setae (Fig. 4); frontovertex about 0.5× head width; ocelli forming a slightly obtuse angle; forewing (Fig. 5) about 2.2× as long as broad; postmarginal



Figs. 1–10. 1–5, *Pseudleptomastix mexicana*. 1, Female forewing. 2, Female antenna. 3, Male antenna. 4, Male clava. 5, Male forewing. 6, *P. squammulata* male clava. 7–10, *Acerophagus papayae*. 7, Female forewing. 8, Female antenna. 9, Male antenna. 10, Male forewing.

vein of forewing mostly about 1.3× as long as stigmal. Relative measurements (specimen 1): HW 45, FV 25, POL 11, AOL 5.5, OOL 5, OCL 2.5, EL 24, EW 19, MS 17, SL 19, SW 6, FWL 113, FWW 48, HWL 76, HWW 15. Relative measurements (specimen 2): AL 32, MT 71.

Variation.—The female varies in length from 0.76–1.03 mm; the hind femur is normally significantly paler in apical one-third or so, the base normally dark brown and the apex normally yellow or yellow brown; the linea calva may vary from being interrupted by four or five lines of setae and closed posteriorly by a single line of setae to more or less completely closed posteriorly by eight or nine lines of setae.

Hosts.—Reared from *Paracoccus marginatus* on *Carica papaya* L. (Caricaceae).

Distribution.—Mexico (Michoacán), Costa Rica.

Material examined.—Holotype ♀, MEXICO, Michoacán, Mpio Gabriel Zamora, Santa Casilda, 9.vi.1999 Coll. #58, H. Gonzalez, J. Villanueva, D.R. Miller (SEL), MxSEL(DRM)-99-4, ex *Paracoccus marginatus* on *Carica papaya*, BIRL-99-Id #16. Paratypes: MEXICO, 39 ♀, 68 ♂, same data as holotype. Other specimens: COSTA RICA, 1 ♂, Guanacaste, Santa Rosa NP, Hacienda 3-0, 1-22.vi.1985 (D. Janzen, I.D. Gauld); 1 ♂, Guanacaste, Santa Rosa NP, Hacienda 2-C, 4-24.v.1986 (D. Janzen, I.D. Gauld); 1 ♀, Guanacaste, Santa Rosa NP, H-1-0, 4-25.iv.1987 (D. Janzen, I.D. Gauld); 2 ♀, Guanacaste, Santa Rosa NP, H-1-0, 16.v-6.vi.1987 (D. Janzen, I.D. Gauld); 1 ♀, Guanacaste, Santa Rosa NP (incorrectly labeled as Guanacaste NP), near HQ, 1-10.iii.1990 (J.S. Noyes); 2 ♀, Guanacaste, Santa Rosa NP, 300 m, 7 km E HQ "small house," 9-10.iii.1990 (J.S. Noyes). Holotype in USNM, paratypes in USNM, BMNH, INBIO.

Etymology.—This species is named for the country of the type locality.

Comments.—*Pseudleptomastix mexicana* is very similar to *P. squammulata* (Girault) and, in fact, the Costa Rican material included here in the type series was identified previously as that species (Noyes 2000). The minor difference in coloration of the scape appears to be consistent. In *P. mexicana,* the ventral margin of the scape is always yellow, whilst in *P. squammulata* the proximal three-quarters of the scape is completely dark brown. At this point we do not know the significance of the relative lengths of the funicle segments in the females. Specimens which have the funicle segments relatively longer with F1 as long as or nearly as long as the pedicel and F6 about 2× as long as broad can be considered typical of *P. squammulata,* whilst specimens which have F1 about half as long as the pedicel and F6 about 1.5× as long as broad, but with the coloration of the scape as in *P. squammulata,* may represent a dark form of *P. mexicana* or an as yet undescribed species. Specimens with relatively shorter funicle segments and darker scape coloration have been examined from Costa Rica (BMNH) and Texas (BMNH). The males can be separated on more robust differences in antennal structure. In *mexicana,* the longest setae on the funicle are only about 3× as long as the diameter of the segments and there are only two or three, very slender, apically curved scalelike structures near the base of the clava on the ventral surface which are relatively difficult to separate from normal setae on the clava (Fig. 4). In *P. squammulata,* the longest setae on the funicle are about 4× as long as the diameter of the segments and there are three or four, spatulate, scalelike structures near the base of the clava on the ventral surface which are very easy to distinguish from normal setae on the clava (Fig. 6). Males of the two species can be separated more reliably than the females. It is likely that the significance of differences in the relative dimensions of the funicle segments of the female antenna could be determined by comparing reared series of the two species which have been subjected to differing environmental conditions.

Acerophagus Smith (Encyrtinae)

Diagnosis.—*Female:* Body yellow or orange with occasional dark markings; antenna unicolorous with 5 short, transverse to quadrate funicles and large 3-segmented clava; mandibles with three teeth, middle tooth longest; ovipositor generally at least slightly exserted. *Male:* Almost identical to female except for genitalia and single segmented clava.

Acerophagus papayae Noyes and Schauff, new species
(Figs. 7–10)

Female (holotype).—Length, including ovipositor, 0.85 mm. Head, including antennae, generally pale orange with F5 and base of clava slightly dusky; ocelli red; thorax generally pale orange; neck of pronotum brown, posterior margin translucent and side a little paler, almost yellow; posterior margin of pronotum, mesoscutum and scutellum clothed in conspicuous, brown setae; tegula very pale orange with apex pale grey brown; side and venter of thorax and legs slightly paler than thoracic dorsum; (Fig. 7) with an inconspicuous, subcircular, infuscate area from stigmal vein to posterior wing margin, otherwise wings hyaline; propodeum mostly pale orange; but brown laterally on dorsum; gaster mostly pale orange but brown near cercal plates and dorsally along posterior margins of tergites III to V (abdominal V to VII) and indistinctly proximally in middle of tergite VI; ovipositor sheath pale orange, apex brown.

Frontovertex slightly shiny with fine, regular, reticulate sculpture of mesh size slightly smaller than diameter of a facet; ocelli forming an angle of about 75°, posterior ocellus slightly closer to eye than to occipital margin; inner eye margins subparallel, frontovertex about twice as long as broad, one-third head width and hardly becoming wider anteriorly; scape about 4.5× as long as broad; other proportions of antenna as in Fig. 8, pedicel nearly as long as F1–F4 combined and clava slightly shorter than pedicel and funicle together with outer suture slightly oblique and complete, third segment slightly more than half length of clava. Relative measurements: HW 47, FV 15, FWL 33, POL 6, AOL 4.5, OOL 2, OCL 3, EL 33, EW 25, MS 18, SL 26, SW 6.

Mesoscutum and scutellum with similar sculpture, both similar to that on frontovertex but slightly finer and distinctly shallower, piliferous punctures distinct but small and separated by much more than their own diameters; forewing venation and setation as in Fig. 7. Relative measurements: FWL 120, FWW 49; HWL 85, HWW 20.

Gaster with exserted part of ovipositor about 0.2× length of gaster or 0.7× length of midtibial spur.

In paratypes, funicle with linear sensilla present only on F5, apical segment of clava nearly 0.6× as long as clava; maxillary palpus 4-segmented. Relative measurements: OL 68, GL 24, MT 59.

Male.—Length 0.44–0.66 mm. Generally very similar to female but for unsegmented clava (Fig. 9) and genitalia. Gaster mostly with apical tergites more extensively darkened than in female; forewing (Fig. 10) with infuscate area less conspicuous, below stigmal vein only and hardly extending towards posterior wing margin. Relative measurements: AL 18.5, MT 47.

Variation.—The female varies in length, including ovipositor about 0.58–0.77 mm. The strength of the infuscation on the forewing of the female can vary, in some specimens it is very indistinct with the forewing medially appearing to be almost hyaline whilst in other specimens it is strong and distinct.

Hosts.—Reared from *Paracoccus marginatus* on *Carica papaya.*

Distribution.—Mexico (Michoacán).

Material examined.—Holotype ♀, MEXICO, Michoacán, Mpio Gabriel Zamora, Santa Casilda, 9.vi.1999 Coll. #58, H. Gonzalez, J. Villanueva, D.E. Miller (SEL), MxSEL(DRM)-99-4, ex *Paracoccus marginatus* on *Carica papaya,* BIRL-99-Id #15. Paratypes: 77 ♀, 48 ♂, same data as holotype. Holotype in USNM, paratypes in USNM, BMNH.

Etymology.—This species is named for the papaya plant on which its host feeds.

Comments.—*Acerophagus papayae* differs from all other described species of the genus by the combination of the relatively narrow frontovertex (about one-third head width or about 2× as long as wide), infuscate forewings and generally yellow or orange colour of the body with dark markings only on the propodeum and dorsum of the gaster. It appears to be closest to *texanus*, females of both species having the third segment of the clava more than half as long as the clava whereas in most other species the third segment is less than half as long as the clava. *Acerophagus papayae* differs from *A. texanus* in the complete outer suture of the clava, the less extensive infuscate areas of the forewing and the banded gaster. In *A. texanus* the outer suture of the clava is incomplete, the forewing is infuscate below the submarginal vein and abdomen is uniformly orange yellow, whilst in *A. papayae* the forewing is completely hyaline below the submarginal vein and the propodeum is marked with brown and the gaster has at least two transverse, brown bands visible dorsally. *Acerophagus papayae* seems to be close to *A. californicus* or *A. nubilipennis*, these species also having the forewing with an infuscate area medially below the stigmal vein and the gaster pale with dark cross bands from the cercal plates. However, these species have a broader frontovertex and relatively short third segment of clava. In both *A. californicus* and *A. nubilipennis* the frontovertex is about 1.5× as long as wide and the third segment of the clava is less than 0.5× as long as the clava. In Rosen's (1969) key to species of *Acerophagus*, females of *A. papayae* run to couplet 5. The other species which run here (*A. debilis*, *A. luteolus* and *A. antennalis*) have the forewing completely hyaline or only faintly yellow in the proximal half. The males would run to best to *A. antennalis* or *A. texanus*. The new species differs from *A. antennalis* in the presence of a weak infuscate cloud below the stigmal vein and slightly more transverse funicle segments. In males of *A. antennalis* the forewing is hyaline or at most faintly yellow proximally and F5 is about 1.3× as wide as long, whereas in *A. papayae* F5 is at least 1.5× as wide as long. It differs from *A. texanus* on the narrower frontovertex, relatively longer clava and forewing being less extensively infuscate. In *A. texanus*, the frontovertex is about 1.5× as long as wide, the clava is about as long as the funicle and the forewing is infuscate below the apex submarginal vein, whereas in *A. papayae* the frontovertex is about 2× as long as wide, the clava is longer than the funicle and the forewing is infuscate only below the stigmal vein.

ACKNOWLEDGMENTS

We thank Juan A. Villaneuva, Hector Gonzalez, and Douglass Miller for assistance during fieldwork in Mexico. Michael Gates, Stuart McKamey, and David Smith kindly read the manuscript and made valuable comments. Dale E. Meyerdirk (APHIS, NBCI) was instrumental in supporting both the field work and taxonomic research.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 186–194

A GREGARIOUS, MYCOPHAGOUS, MYRMECOPHILOUS MOTH, *AMYDRIA ANCEPS* WALSINGHAM (LEPIDOPTERA: ACROLOPHIDAE), LIVING IN *ATTA MEXICANA* (F. SMITH) (HYMENOPTERA: FORMICIDAE) SPENT FUNGAL CULTURE ACCUMULATIONS

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Abstract.—The lepidopteran *Amydria anceps* Walsingham (Acrolophidae) is reported for the first time as a myrmecophile. Its gregarious larvae feed on the exhausted fungal substrate accumulations outside mature colonies of the Mexican leaf-cutting ant, *Atta mexicana* (Smith), a fungus-growing ant in Mexico. This constitutes the second report of an acrolophid myrmecophile. Morphology of the principal life stages of *A. anceps* are described, as well as its general natural history. No interactions were observed between *Amydria* larvae and *A. mexicana,* although the larvae of *A. anceps* are attacked by ichneumonid and tachinid parasitoids. Chalcids (primary or secondary parasitoids) also are associated with *A. anceps* larvae. Thus, there are potentially five trophic levels in this system: fresh plant material—*Atta* fungal symbiont—*Amydria anceps*—ichneumonid and tachinid parasitoids—chalcid hyperparasitoids.

Key Words: Acrolophidae, *Amydria, Atta,* biology, Formicidae, leaf-cutting ant, Mexico, mycophagous, myrmecophile

The attine leaf-cutting, fungus-growing ants, *Atta* and *Acromyrmex* spp., utilize large amounts of plant biomass for the subterranean cultivation of the fungal symbionts (Basidiomycetes: Agaricales: Lepiotaceae) they use as food (Waller and Moser 1990, Mueller et al. 1998). The fungal strains cultivated by *Atta* and *Acromyrmex* have been identified as species of the mushroom genus *Leucoagaricus,* principally *Leucoagaricus gongylophorus* (Möller), as well as similar species as *L. weberi* Muchovej, Della Lucia and Muchovej (Bononi et al. 1981, Fisher et al. 1994, Pagnocca et al. 2001). After overgrowth by the fungus and subsequent harvesting of fungal biomass by the ants, the manured, compostlike substrate consists mainly of fungal and plant cell walls and is disposed of by the ants. The different species of attine fungus-growing ants show at least two strategies for disposal of the exhausted fungal substrate: some species (most *Atta* species, such as *Atta texana* (Buckley) and *A. cephalotes* L.) create special subterranean galleries where the used up fungal substrate is stored (Waller and Moser 1990); other species take this substrate to the outside and dump it in "garbage piles" at variable distances from the nest. Species such as *Atta mexicana* (Smith), *Trachymyrmex turrifex* (Wheeler) (S. Sanchez-Pena, personal observation), and *A. colombica* Guérin (Anderson and Ratnieks 2000, Hart and Ratnieks 2001, U.

Fig. 1. A mature colony of *Atta mexicana* in the urban area of Monterrey, Mexico. The substrate accumulations on the street by the curb (a) consist of the spent fungal material (dumps) characteristic of this leaf-cutter ant.

G. Mueller, personal observation) frequently deposit the piles adjacent to the nest. The *Atta* substrate dumps, whether subterranean or exposed, constitute an accumulation of organic matter that attracts an abundant and diverse community of invertebrates (Waller and Moser 1990) and microorganisms (Rogers et al. 1995, Hart and Ratnieks 2001, Sanchez-Pena, unpublished observations).

Atta mexicana (Smith), the Mexican leaf-cutting ant, is a widespread fungus-grower in Mexico and parts of Central America. This species eliminates the exhausted, compostlike, fungal substrate by dumping it on a garbage heap outside the nest (Fig. 1). The exhausted fungal substrate is made up of particles or granules up to a few millimeters in diameter. In both *Atta colombica* and *A. mexicana*, these external dumps can be more than two feet tall and have a volume of several gallons.

In May–September 2000, samples of associated biota found on *A. mexicana* dumps were collected at several localities in Mexico. During June and September 2000, gregarious larvae of *Amydria anceps* Walsingham were discovered living in these external dumps in Monterrey, Santiago, and Guadalupe, in the State of Nuevo Leon, as well as in Queretaro, in the State of Queretaro. Queretaro is approximately 800 km from the other localities. Beutelspacher (1977) previously had reared *Amydria anceps* (which he redescribed as a new species, *Acrolophus socialis*) without noting its association with leaf cutting ants. Larvae of this species were reported by Beutelspacher as living in tubes within a compact mass or "colony," resembling a termite nest. Beutelspacher's specimens were collected at the Estación de Biologia Chamela, Jalisco, Mexico.

Walter et al. (1938) reported another, but not congeneric acrolophid, "*Amydria*" *confusella* Dietz, from the subterranean chambers where the Texas leaf-cutting ant, *Atta texana* (Buckley), accumulates the spent fungal substrate. This appears be the only previous record of an acrolophid myrmecophile. Walter et al. (1938) collected larvae and adults from these subterranean waste chambers. The utilization of the subterranean chambers of *A. texana* (some of which are more than 2 m below ground surface) probably requires adaptations, behaviors, and cues different from those required to exploit the exposed heaps of *A. mexicana.* The present deposition of Walter's specimens is unknown and, consequently, the identification of the moth could not be verified. Larvae of both *Amydria* and *Ptilopsaltis,* the allied genus which includes *confusella,* are known to be scavengers on plant debris as well as guanophiles in caves (Davis 2000, Davis et al. 1986, Davis and Robinson 1998).

Amydria anceps Walsingham

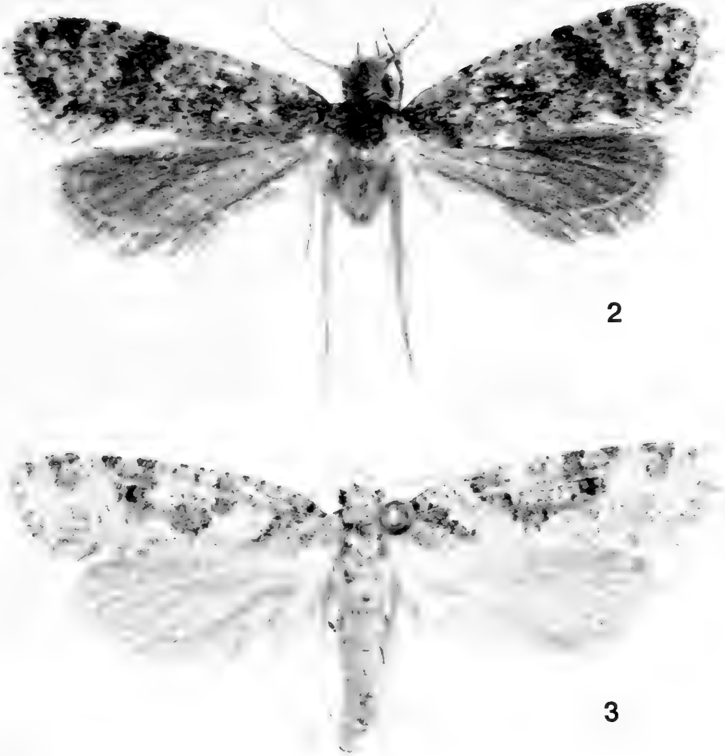
Amydria anceps Walsingham *Amydria anceps* Walsingham 1914: 363.—Davis 1984: 20; 2000: 481.

Acrolophus socialis Beutelspacher 1977: 145.—Davis 1984: 20 (synonym of *Amydria anceps*).

Adult (Figs. 2–3).—*Head:* Pale buff with darker brown scales concentrated near vertex and lateral over occipital tufts, to almost entirely dark brown. Vertex and occipital areas rough with semi-erect scales; frons usually less rough; scales slender with mostly bidentate, sometimes tridentate apices. Antenna filiform, ~0.4 length of forewing; scape smooth, buff to dark brown; flagellum buff to brown, with a single annulus of slender scales per segment. Haustellum and maxillary palpus vestigial, normally not visible on uncleared head. Labial palpus slightly upcurved, with a strong ventral scale brush, especially prominent on segment II; palpus buff, variably marked with dark brown, especially laterally; 2–3 dark bristles arising laterally from III, and up to 7 bristles from II; segment III elongate, slender, smooth, sometimes with a dark median ring of dark brown scales. *Thorax:* Light brown dorsally and ventrally, heavily irrorated with dark brown dorsally. Forewing length: ♂, 4.5–11.0 mm; ♀, 6.5–13.0 mm. Forewing light brown, variably irrorated with dark brown scales until often appearing generally dark brown; a more or less distinct pattern of dark brown markings along costa, with largest forming an irregular, broadly U-shaped band from basal third of costa to apical third; base of wing with an oblique, dark basal band; another large band extending ⅓–½ across distal ⅕ of wing; fringe light brown, irrorated with dark brown. Hindwing uniformly light grayish brown to dark brown; ♂ frenulum a simple, stout spine; ♀ usually with 4 smaller spines. Foreleg without epiphysis; light brown, heavily irrorated with dark brown over coxa and femur; tibia mostly dark brown with two light brown rings at middle and apex; tarsomeres dark brown, with basal and apical light brown rings; midleg similar to foreleg in color; spurs light brown; hindleg uniformly light brown except for suffusion of darker scales dorsally. *Abdomen:* Varying from uniformly light brown in paler specimens to dark brown dorsally and light brown ventrally in darker forms.

Male genitalia (Figs. 4–8): Uncus deeply bifid. Tegumen an elongate narrow dorsal ring. Vinculum short, broadly U-shaped, with a slight median indentation (Fig. 4). Gnathos fused apically into a narrow U-shaped sclerite. Valva simple, nearly as long as genital capsule, slender, tapering to even more slender cucullus (Fig. 6). Aedoeagus ~0.8 the length of valva, moderately broad and flat to apex; apical third laterally separated into a larger, more membranous dorsal half and a sclerotized, acute ventral half (Fig. 8); cornuti absent.

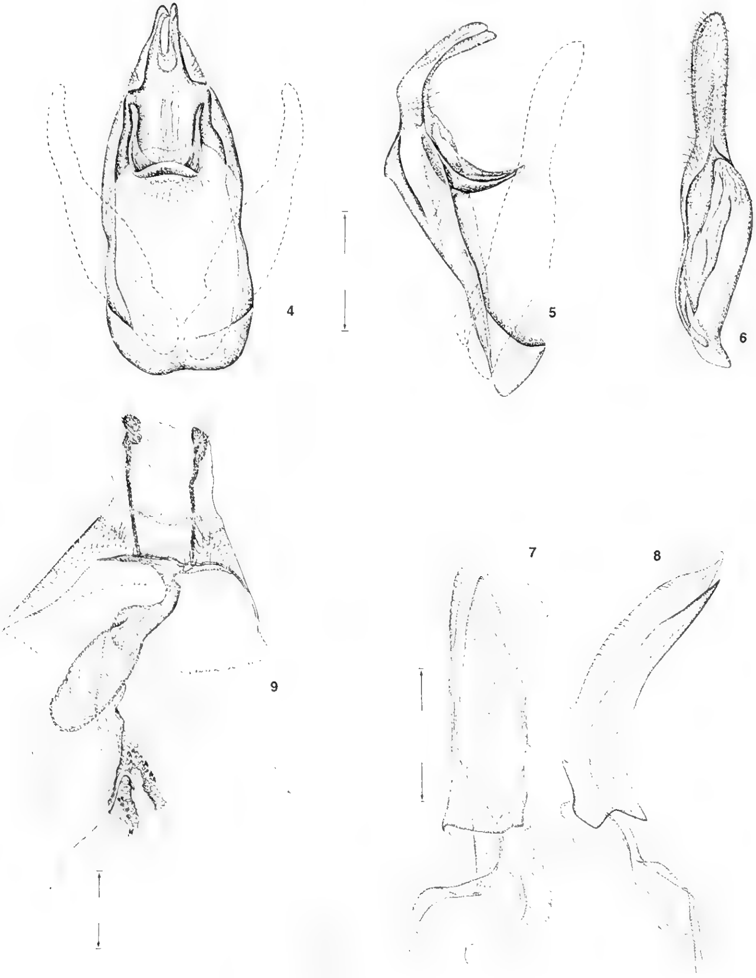
Female genitalia (Fig. 9): Posterior apophysis short, approximately as long as the eighth abdominal segment. Lamella antevaginalis ~ smoothly curved. Ductus bursae thickened, short, less than half the length of posterior apophysis, gradually enlarging to mostly membranous corpus bur-



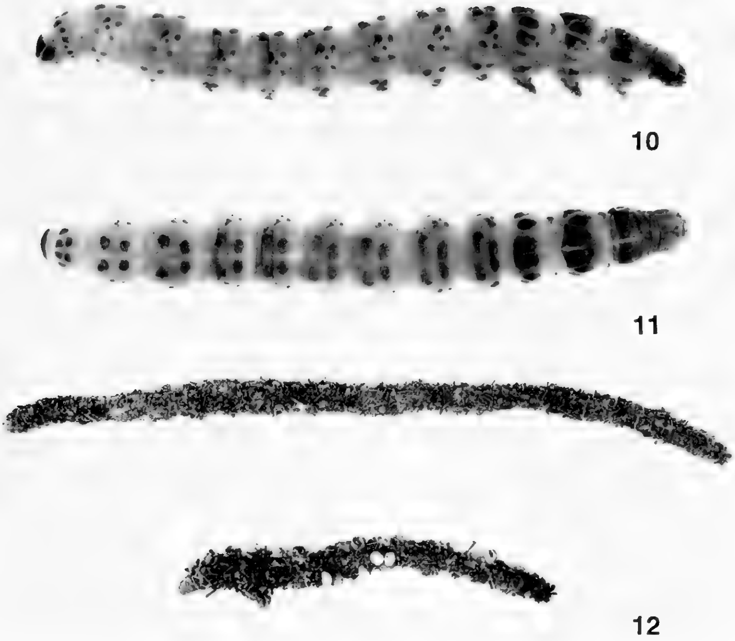
Figs. 2–3. Adults of *Amydria anceps.* 2, Male, forewing length 5.5 mm. 3, Female, forewing length 12 mm.

sae which extends about 3× length of apophysis; a small accessory bursa branching off caudal end of corpus bursae at common juncture with ductus bursae; basal, ventral half of accessory bursae wall with an elongate-oval ring of thickened tissue; corpus bursae with an elongate, dense, coarse patch of small, irregularly shaped, short spicules extending a short distance along caudal half of corpus anterior to junction of accessory bursa; anterior margin of spinule patch deeply excavated. Ductus seminalis joined to corpus bursae from caudal end of cornutal excavation.

Egg.—Upright, cylindrical, with 18 longitudinal ridges evenly dispersed and converging toward either pole; length 0.46 mm, diameter 0.3 mm (Beutelspacher 1977).



Figs. 4–9. Genitalia of *Amydria anceps*. 4, Male, ventral view (0.5 mm). 5, Lateral view of fig. 4. 6, Valva, mesal view. 7, Male aedoeagus, ventral view. 8, Lateral view of fig. 7. 9, Female, ventral view (0.5 mm). Scale lengths indicated in parentheses.

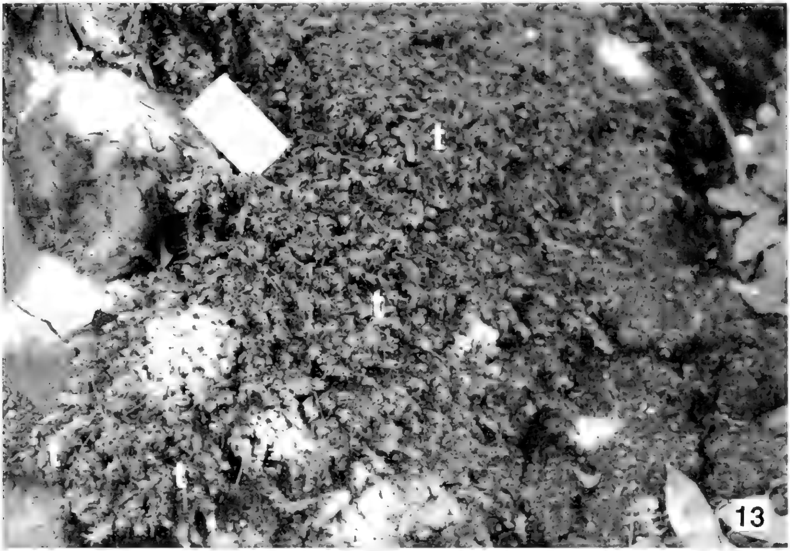


Figs. 10–12. Larva and larval tubes of *Amydria anceps*. 10, Larva, lateral view; length 21 mm; maximum diameter 2 mm. 11, Dorsal view of fig. 10. 12, Larval tubes; longest tube 15 cm in length and 5 mm in diameter.

Larva (Figs. 10–11).—Length of largest larva 22 mm; maximum diameter 2 mm. Head width 1.5 mm; dark reddish brown, with a prominent lateral dark brown to black streak through stemmatal area; streak becoming slightly broader toward rear margin of head. Six stemmata present; 3–5 aligned in a contiguous, vertical, anterior series. Integument cream to buff with dark reddish-brown plates and pinacula. Prespiracular pinaculum of prothorax partially fused to pronotum and bearing all three L setae together with spiracle. Thoracic legs well developed; coxal plates well separated. Prolegs on A3–6 and A10; crochets 25–28 in number, arranged in a uniserial ellipse on A3–6; anal proleg with 17–18 crochets arranged in a slightly curved line; all prolegs with 2–3 scattered rows of spines immediately anterior to crochets.

Larval case (Figs. 12–13).—An elongate silken tube, up to 15 cm in length, 5 mm in diameter, densely covered with small plant fragments.

Pupa (Fig. 14).—Length of largest pupa 10.2 mm. Head smooth. Abdomen with dorsum of A2–6 with an anterior row of numerous minute spines and a smooth posterior ridge which continue nearly ⅔ around each segment; A7–8 with anterior row of dorsal spines more reduced and continuing around each segment as a ventral ridge;



Figs. 13–14. Larval tubes and pupae of *Amydria anceps*. 13, Dump mound of *Atta mexicana* colonized by *Amydria* larva; tubes (t) with active larvae are visible on dump's surface. Erosion has removed some of the substrate that normally completely covers the tubes. White 35 mm film container included for scale. 14, Five pupal exuviae (arrows) after adult emergence, on dump surface, protruding nearly perpendicular 7–10 mm from substrate. The exuviae remain attached to the buried larval tubes, which open to the surface.

posterior ridge also reduced on 7–8 and completely encircling each segment. Cremaster of A10 consisting of a large, prominent pair of stout dorsal spines and a much shorter pair of stout ventral spines.

Material examined.—MEXICO: Chiapas: El Chorreadero, Chiapa de Corzo: 1 ♀, 11 Aug 1967, O. S. Flint Jr. (USNM). Guerrero: Amula, 6,000 ft: 1 ♂ (holotype), 18 Sep, H. H. Smith (BMNH). Tonalapa: 1 ♀ (paratype), Jun, H. H. Smith (USNM). Morelos: Cuernavaca: 1 ♂, 22 May 1949, J. McKelvey (USNM); 1 ♀, Nov 14, R. Müller (USNM). Nuevo Leon: Anegada Arroyo, 16 mi S. Linares, 1,250 ft: 2 ♂, 2 ♀, D. R. Davis & W. D. Duckworth, 9 Jul 1963, slides USNM 32413 (USNM). Monterrey: 4 ♂, 14 ♀, 4 larvae, pupal exuviae, S. R. Sanchez-Pena, reared from *Atta* mound, slide USNM 32394 (USNM, UTA); 1 ♂, 3 ♀, 20 Jun, 2000, S. R. Sanchez-Pena, reared from *Atta* mound, slide USNM 32340 (USNM, UTA). Puebla: Tehuacán: 1 ♀, Sep 1937, C. Hoffmann, (USNM); 1 ♀, 12 Sep, R. Müller (USNM). Sinaloa: Venadio: 3 ♀, B. Clark (USNM). Tamaulipas: 4 mi S. Ciudad Victoria: 1 ♀, 5 Aug 1963, D. R. Davis & W. D. Duckworth (USNM).

Distribution.—Known only from subtropical and semiarid areas of northern Mexico, from Nuevo Leon south to Chiapas. Beutelspacher (1977) also reported this species from Estación de Biologia Chamela, Jalisco, Mexico. *Atta mexicana* is known to occur at every locality reported for *Amydria anceps.*

Biology.—The larvae were found to burrow into the fungal substrate heap and to spin a tough, leathery tube covered with substrate particles. They live within these tubes through the larval cycle, probably protruding only the head outside the tube to eat while immersed in the substrate. Empty tubes (Fig. 13) become very visible after heavy rains that wash away loose particles. Immediately prior to adult emergence, the moth pupae force their way ¾ their length out of the open upper end of the tubes at the dump surface. Pupae are exposed for only a brief period after the rains (perhaps one day). Following a mass emergence, pupal exuviae may be observed in large numbers projecting perpendicularly from the surface of the dump area (Fig. 14). Adult emergence apparently is triggered by rain. Two emergence events were observed during the summer of 2000, within two days after heavy precipitation.

Larvae inside cases were collected in the field and reared to adults. Larvae were incubated at room temperature in plastic containers, using the spent fungal substrate as food. Adult moths emerged in these containers. Hymenopteran (Ichneumonoidea and Chalcididae) and dipteran (Tachinidae: *Pseudochaeta* sp.) parasites also emerged from some of these field-collected larvae during rearing. In the field, ichneumonid and chalcid parasitoids have been observed engaged in host searching behavior over *Amydria* larval cases, on dumps heavily colonized by *Amydria* larvae. The chalcids could be either primary parasitoids or hyperparasitoids. The trophic levels of this system are thus potentially five: plant material → symbiotic fungus → *Amydria* → *ichneumonids* and tachinids → chalcids.

Amydria larvae are the largest colonizers of the upper layers of the fungal dumps examined. Further research is warranted to determine the actual nutritional needs of larvae, and their level of dietary specialization on fungi. No antagonistic interaction was observed between moth larvae and *Atta mexicana.* The workers do not dig or tunnel into the dump material to any significant extent. The predaceous ponerine ant, *Pachycondyla villosa* (Fabricius), which was very common at the collection localities, was observed digging a few millimeters into the *Atta* dumps in what appeared to be attempts to reach *Amydria* larvae.

ACKNOWLEDGMENTS

We are indebted to Vichai Malikul and George Venable, Department of Systematic Biology, Entomology Section, Smithsonian Institution, and John Chung for the illustrations. John Steiner of the Smithsonian Photographic Services assisted with the photographs. Norman Woodley, Systematic Entomology Laboratory, U.S. Department of Agriculture, identified the tachinid parasitoid. Specimens examined are deposited

in the following institutions: The Natural History Museum, London, England (BMNH); National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM); and the University of Texas, Austin, TX, USA (UTA).

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PROC. ENTOMOL. SOC. WASH.
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POLLEN PROVISION RECORDS FOR THREE SOLITARY BEE SPECIES OF *MEGACHILE* LATREILLE AND *HERIADES* SPINOLA (HYMENOPTERA: MEGACHILIDAE) IN SOUTHWESTERN MONTANA

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Abstract.—We identified the pollen included in nest provisions by three species of solitary bees at four sites in the vicinity of Bozeman, Montana. *Megachile relativa* Cresson and *Heriades carinata* Cresson were studied in trap nests in natural populations, whereas *Megachile rotundata* (F.) were from a managed, introduced population adjacent to an alfalfa field being used for seed production. Over 90% of 186 cells examined in the three species contained more than a single type of pollen (and up to seven different types). The most intensively studied species, *M. relativa*, provisioned with pollen from eight families of dicot plants (particularly Asteraceae and Fabaceae), as well as two unidentified monocots that were also common in provisions of *H. carinata* and *M. rotundata*. Results include new pollen records for all three species.

Key Words: *Megachile*, *Heriades*, trap nests, pollen provisions, alfalfa leafcutting bee

Pollen collected by adult female bees provides the major source of protein and other nutrients for their larvae, and the types of pollen collected can correlate with growth and survival during development (Guirguis and Brindley 1974, Schmidt et al. 1987, Horne 1995, Michener 2000). The types of pollen collected also affect the efficiency of bees as pollinators of cross-pollinated plants, a subject of particular interest to those managing bees for fruit or seed production (Free 1993). Knowledge of the types of pollen collected cannot always be determined from flower visitation records alone because bees may visit flowers solely to obtain nectar. For example, Hurd (1979) cited 16 families of plants whose flowers are visited by *Megachile relativa* Cresson and 8 families visited by *Megachile rotundata* (F.). However, after identifying pollen from nest cells, Strickler et al. (1996) identified two plant families used by *M. relativa*, and Stubbs et al. (1994) found four families used by *M. rotundata*. Although these discrepancies could be due to differences in pollen availability among sites, they may also reflect differences between nectar and pollen preferences. Thus, in order to determine the types of pollen collected by bees during actual pollen-collecting trips, it may be necessary to examine either the pollen present in nest provisions or that found on the scopae of foraging bees (or on bees in museum collections). Here, we report the pollen identified from nest cells of three megachilid bees, *M. relativa* and *M. rotundata*, and *Heriades carinata* Cresson, at four sites in the vicinity of Bozeman, Montana.

MATERIALS AND METHODS

We identified pollen that we removed from the nest cells provisioned by bees during the summers of 1999 and 2000. *Megachile rotundata* nested within 0.5 × 9.5 cm deep tunnels in commercial polystyrene "bee boards" manufactured by Beaver Plastics (Edmonton, Alberta) for use in commercial seed alfalfa production (Richards 1984). The shelter containing the boards was located between two plots of alfalfa (*Medicago sativa* (L.)) being grown for seed on the Montana State University Post Farm, 3 km west of Bozeman, Gallatin County, Montana. Bees nesting in these boards were purchased as overwintering prepupae from Mennie Bee Farms Inc. (Parkside, Saskatchewan). All *M. rotundata* cells were provisioned by bees during July and August 2000 at a time when alfalfa was in bloom. The *M. relativa* and *H. carinata* were from native populations that nested in two types of trap nests. The first type consisted of pine boards into which we drilled 15 cm long holes and inserted paper straws with internal diameters of 3.2, 3.7, 4.6, 5.9, 7.5, 8.0, and 9.0 mm. *Megachile relativa* nested in 4.6–9.0 mm tubes, and *H. carinata* in 3.7 mm tubes. The second trap nest type, used only by *M. relativa,* consisted of pine boards with 15 cm long grooves (6.3 and 9.5 mm diameter) routed in the sides, which were then fitted with removable plexiglass sheets (3 mm thick) to provide a transparent surface for viewing nest contents and removing pollen. Nest boards of both types were mounted on fence posts (at heights of 1.5–2.0 m) adjacent to trees and with the nest holes facing southeast.

We placed the trap nests at three sites: 1) western Bozeman (WB), located on the western end of Bozeman on the Montana State University Horticultural Farm (nests placed within an abandoned ornamental tree farm surrounded by agricultural test plots and weedy fields); 2) southeastern Bozeman (SEB), located in a residential area 3.0 km from WB (nests placed within area that contained ornamental flowering plants and which was 150 m from a weedy industrial storage yard and 300 m from a wooded stream); and 3) Rocky Creek Farm (RCF), just east of Bozeman and 5.6 km east of WB (nests placed along the weedy border of a cultivated field and shaded by lilac, *Syringa vulgaris* (L.)) which was not in bloom while the bees nested.

We used two methods to obtain pollen samples from 186 nest cells, including 145 from 44 *M. relativa* nests (from WB and SEB), 26 from 19 *M. rotundata* nests (all from the Post Farm), and 15 from 11 *H. carinata* nests (5 from WB, 10 from RCF). The first method was to insert the wooden end of a cotton swab stick into the nest and twist it in the provision of the outermost cell while the female was away from the nest. The second method was to open nests in the lab, taking pollen either from uneaten provisions, or from frass left by the developing larvae (Strickler et al. 1996). From mid-May through August 1999, we also collected flowers within 200 m of the nests at approximately three-week intervals. We used this pollen to create a reference collection following the methods described by Moore et al. (1991) and Sawyer (1988) with slight adaptations described below.

We placed pollen extracted from each cell or plant into an Eppendorf tube with 2 ml of distilled water and one drop of safranin. After 24 h, we centrifuged the samples at 3,000 rpm for 5 min, poured the dye off, and resuspended the pellet in water for a second rinse. After a second centrifugation, we poured off the supernatant and resuspended the pellet in two drops of water. We then placed the sample on a slide where it was allowed to dry before mounting it in Euparal and sealing the slide with clear nail polish. To identify pollen, we first examined the entire slide under a Nikon phase contrast light microscope (40×). We then examined each type of pollen at high power (100×) for identification. By using pollen identification keys (Kapp 1969) and comparing pollen from nests with pollen in reference samples, we identified most dicot pollen grains to family and many to genus. We made no exact counts of each type of pollen in samples, but we did record general estimates of the proportions of different pollen types, which were sometimes unevenly distributed on slides due to clumping. However, we roughly estimated the relative frequencies of different pollen types on each slide, as 1%, 5%, or greater values to the nearest 10%. Rare pollen types represented by only several grains on a slide containing thousands of pollen grains were excluded from counts to reduce the possibility of recording pollen incidentally picked up by females on flowers or other sources.

We did not compare the frequency distributions of pollen types provisioned by different bee species because samples came from different sites. However, we did compare pollen types in different types of *M. relativa* samples: 1) WB vs. SEB samples and 2) samples from uneaten provisions vs. those from frass. We first determined if there was a significant (Pearson's) correlation between sample types in the number of cells containing each type of pollen (a significant correlation indicating similarity of the two samples). Where the correlation was not significant, we used 2 × 2 chi-square contingency table analyses (each with d.f. = 1) to test the null hypothesis that the proportions of cells with and without a particular type of pollen (e.g., thistle) were the same in the two sets of samples (a significant difference indicating that a particular type of pollen was over- or under-represented in a set of samples).

RESULTS AND DISCUSSION

Overall, the three species provisioned with pollen from nine families of dicot plants and two types of monocots (Fig. 1). Using reference samples, we distinguished at least three types of Asteraceae: 1) *Cirsium* spp. (thistle); 2) *Taraxacum* spp. (dandelion); and 3) unknown Asteraceae. Similarly, Fabaceae could be divided into 1) *Lotus* sp. (probably birdsfoot trefoil, *Lotus corniculatus* L.); 2) *Medicago* sp. (all which was probably alfalfa, *Medicago sativa* L.); and 3) unknown Fabaceae. Dicot pollen grains that could not be identified were grouped in an "unknown" category. We found two types of monocot pollen (based on pollen grain size), hereafter referred to as the "small" and "large" monocots. Both the small and large monocot pollen grains were of a general type (i.e., prolate and with a single sulcus), indicating that they were clearly neither grass (Poaceae) nor cattail (Typhaceae) pollen (Kapp 1969).

Pollen provisioned by *Megachile relativa.* Fifteen of 16 types of pollen distinguished occurred in *M. relativa* nests (Fig. 1). The 145 cells sampled contained a mean (± SE) of 3.1 ± 0.1 types of pollen (range 1–7), but there was considerable variation in the number of pollen types per cell. At one extreme, there were nine cells in which we were able to find just a single pollen type among thousands of grains present in each sample. In a few cases, entire nests contained relatively few pollen types. One nest, for example, averaged just 1.3 ± 0.2 pollen types per cell (range 1–2) and two of its six cells each contained a single type (one with *Taraxacum,* the other with the large monocot). The other extreme was one particularly diverse nest with eight cells that averaged 4.8 ± 0.5 pollen types per cell (range 3–7) and contained a total of 8 different pollen types. Note that we cannot be sure that all cells in this nest were provisioned by the same female, because nest supersedure is common in trap nesters (Krombein 1967).

The *M. relativa* pollen samples came either from frass (N = 116) or uneaten provisions (N = 29). Thus, we were concerned that using different types of samples might bias results if maceration or digestion of some pollen types reduced their detection in frass. However, similarity in the prevalence of different pollen types in samples from larval frass and uneaten provisions of

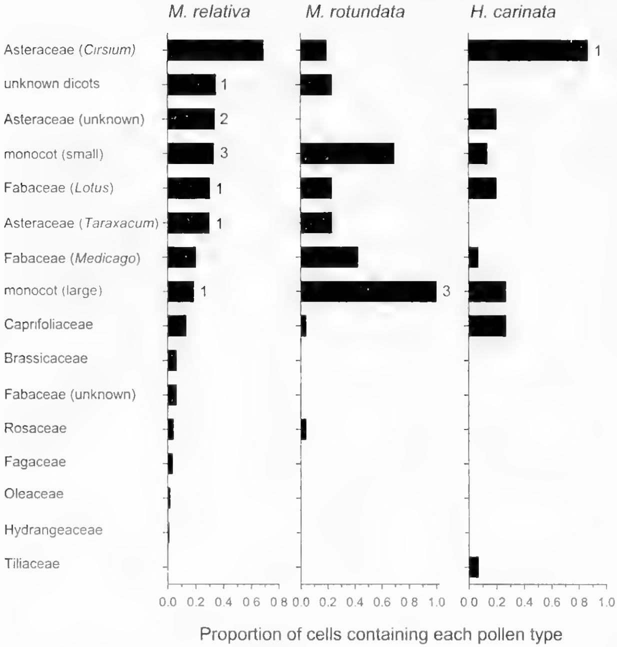

Fig. 1. Pollen records for three species of Megachilidae. Pollen types are ranked from top to bottom based on their occurrence in *Megachile relativa* records. Numbers by bars indicate the number of cells that in which the pollen type made up 100% of the provision.

M. relativa (r = 0.73, N = 15, *P* = 0.002) indicates that timing of sampling (i.e., pre- vs. post-ingestion) did not markedly affect our results. Therefore, we combined data from provision and frass samples.

The three types of Asteraceae were among the five most prevalent types in *M. relativa* cells. Strickler et al. (1996), who collected pollen samples from *M. relativa* cells in northern Michigan, found Asteraceae from a diversity of genera, including *Cirsium,* to be the most prevalent pollen types; they also found pollen of Hypericaceae, Onagraceae, and Rosaceae. Along with Asteraceae and Rosaceae, we found five additional dicot families (Caprifoliaceae, Fabaceae, Fagaceae, Hydrangeaceae, Oleaceae), as well as the two types of non-grass monocots. Along with numerous records of visitations of *M. relativa* to dicot flowers, Hurd (1979) reported *M. relativa* visits to only one monocot family (Iridaceae). We found no Iridaceae near our field sites, so the identity of the monocot pollen in our records remains a mystery. Medler and Koerber (1958) listed flowers in 23 species in 7 families visited by *M. relativa* in Wisconsin, although some of these may represent nectar-collecting rather than pollen-foraging trips.

We found considerable variation in the prevalence of different pollen types. Fagaceae and Hydrangeaceae pollen were found in small amounts in just a few cells. In addition, for some pollen types that were found in a large proportion of the cells, there may be a few cells in which its presence in the provision was incidental (perhaps because the provisioning female used the pollen in previous cells). For example, among the 100 cells in which we identified *Cirsium* pollen (many at proportions ≥ 50%), were 7 cells in which we estimated that it made up about 5% of the pollen. Other pollen types found in only a few nests, were present in significant proportions in at least one cell. Although Oleaceae pollen was found in just two cells, it made up a minimum of 25% of the provision mass in one of these. Rosaceae pollen, though present in just six cells made up about 50% of the pollen in three cells (and approximately 90% in one of these). Both Brassicaceae and the unknown Fabaceae, present in nine cells each, were found once as approximately half of a provision mass. Caprifoliaceae pollen was found in 19 nests, but as approximately 25–50% of the provision in each. Thus, very few of the pollen types that we found can be excluded as purely incidental inclusions in *M. relativa* provisions.

The types of pollen collected in 1999 (N = 48) and 2000 (N = 97) were similar (r = 0.72, N = 15, P = 0.002), but when comparing WB (N = 101) and SEB (N = 44), we found no correlation between the number of cells containing particular pollen types (r = 0.20, N = 15, P = 0.48). This difference resulted from a higher proportion of the WB cells containing the unknown dicots (0.52 vs. 0.14; $\chi^2 = 18.3$, $P < 0.001$), the small monocot (0.45 vs. 0.2; $\chi^2 = 19.6$, $P < 0.001$), *Lotus* (0.40 vs. 0.09; $\chi^2 = 13.5$, $P < 0.001$), *Taraxacum* (0.41 vs. 0.07; $\chi^2 = 16.5$, $P < 0.001$), and the large monocot (0.25 vs. 0.05; $\chi^2 = 8.3$, $P = 0.04$). In contrast, the WB cells contained a lower proportion of the unknown Asteraceae (0.11 vs. 0.69; $\chi^2 = 78.0$, $P < 0.001$), *Medicago* (0.07 vs. 0.48; $\chi^2 = 32.7$, $P < 0.001$), and Caprifoliaceae (0.0 vs. 0.43; $\chi^2 = 50.2$, $P < 0.001$). The discrepancies in pollen prevalence between the WB and SEB samples may simply be due to differences in pollen availability between the two sites. WB is adjacent to agricultural land, whereas SEB is in a neighborhood with ornamental plants. The number of pollen types per cell at WB (mean = 3.06 ± 0.12) did not differ from the number per cell at SEB (mean = 3.02 ± 0.17; $t = 0.17$, 143 d.f.; $P = 0.87$).

Pollen provisioned by *Megachile rotundata*. In 26 *M. rotundata* cells, we identified pollen from six dicots (Asteraceae, Caprifoliaceae, Fabaceae, and Rosaceae), in addition to the two groups of monocot pollen and one unknown pollen type (Fig. 1). The *M. rotundata* nests were only several meters from two large plots of flowering alfalfa, and females were commonly seen foraging on alfalfa (Ruth P. O'Neill, personal communication). However, we found alfalfa pollen in a smaller proportion of cells (0.42) than we did the large (1.00) and small (0.69) monocot pollen; all 26 cells examined contained at least one type of monocot pollen. The cells contained a mean of 3.1 ± 0.4 types of pollen (range 1–7) and three contained only the large monocot pollen. Although Caprifoliaceae and Rosaceae pollen were each found in just one cell, the former made up 25% of the provision in the cell, whereas the latter made up approximately half of the provision. Each of the remaining pollen types made up ≥ 25% of the pollen grains in at least one cell (and often in greater proportions in numerous cells).

Although our data are based on a small sample, the results indicate a relatively wide range of pollen types provisioned by *M. rotundata*. Our records (Asteraceae, Caprifoliaceae, Fabaceae, Rosaceae, and the two monocots) partially overlap with those observed in a lowbush blueberry agroecosystem, where *M. rotundata* provisioned not only with blueberry (Ericaceae, *Vaccinium* spp.), but also Asteraceae, Rosaceae, and Salicaceae (Stubbs et al. 1994). The mix of pollen used by *M. rotundata* nesting near blueberry and alfalfa indicates that, even when presented with an overwhelming predominance of a single pollen type, this bee includes large proportions of other pollen in its diet. Whether this mix represents a strategy of diet diversification or simply reflects some interaction between the relative availability of and preferences for different flowers remains to be determined. Although Horne (1995) demonstrated that *M. rotundata* forages for pollen on a wide variety of Fabaceae, she found that pollen preference did not correlate with success in offspring production on different pollen types. In controlled preference tests with over 200 species of 52 families, *M. rotundata* was attracted to 21 species in 7 families, with high preference for Fabaceae (including *Medicago*), Lythraceae, Crassulaceae, and Labiatae (Small et al. 1997). Several species of monocot (Liliaceae, *Allium*) were also visited, although they showed relatively low attractiveness. However, flower visitation preferences records may not necessarily coincide with pollen preferences of *M. rotundata*.

Pollen provisioned by *Heriades carinata*. *Heriades carinata* provisions included pollen from eight of the categories we distinguished, including Asteraceae, Caprifoliaceae, Fabaceae, Tiliaceae, and both types of monocot pollen (Fig. 1). Cells contained a mean of 2.1 ± 0.2 types of pollen (range 1–3). *Cirsium* was the most common pollen, occurring in 13 of 15 cells and as 100% of the pollen in one cell. Along with a larger amount of *Cirsium* pollen, one cell contained pollen of Tiliaceae (approximately 10% of the pollen) which was not found in nests of the other two bee species. Each of the other seven pollen types made up ≥ 25% of the pollen in at least one cell (and often in greater proportions in some cells). Analysis of pollen from nest cells in Michigan revealed "almost entirely" staghorn sumac (Anacardiaceae, *Rhus typhina* L.) pollen (Matthews 1965); Hurd (1979) cites 11 families of dicots visited by *H. carinata*.

SUMMARY AND CONCLUSIONS

The types of pollen used by *M. relativa*, *M. rotundata*, and *H. carinata* overlapped, which is to be expected because all three species used a variety of pollen types and had a similar local flora available. Among the 15 pollen types found in *M. relativa* nests, 9 were also found in *M. rotundata* nests and 7 in *H. carinata* nests. The larger number of pollen types found in *M. relativa* nests is likely related to the larger number of cells sampled and greater number of sites at which it was studied. For all three species, the known range of pollen in provisions is much less than the known range of flowers visited (Matthews 1965, Hurd 1979, Small et al. 1997).

It is difficult to know for particular cells whether pollen types present in low proportions represent 1) a small number of pollen-collecting trips to a particular plant species, 2) trips to flowers containing few pollen grains, or 3) incidental inclusion of a pollen type picked up during a nectar-foraging trip. Further, the proportion that represents an incidental inclusion could vary among flower types. Due to variation in flower morphology and pollen placement, some pollen types could be picked up incidentally in large quantities during nectar visits, whereas others may be transferred to the foraging bee in small numbers. Some of the pollen we identified, such as Fagaceae and Hydrangeaceae in *M. relativa* cells, may well have represented incidental inclusions of pollen picked up by nectar-foraging females. Alternatively, some of these records may represent opportunistic pollen foraging on primarily nectar-gathering trips or exploratory visits to flowers by females seeking new pollen sources. Overall, we feel that it is safe to conclude that all three species foraged for pollen on variety of plant species. A relatively wide diet breadth is especially evident for *M. relativa*, given that six of the 15 pollen types each occurred in at least one cell as pure samples, whereas two others (*Cirsium* and Rosaceae) were found as nearly pure samples in individual cells. The same can be said for the other two species where several pollen types clearly made up at least 50% of the pollen in individual cells: 1) *Cirsium, Medicago,* the large monocot, Rosaceae, and the unknown family in *M. rotundata* cells and 2) *Cirsium, Lotus, Medicago,* the large monocot, and Caprifoliaceae in *H. carinata* cells. Nevertheless, because of uncertainties related to possible incidental inclusion of pollen, it is premature to use our records to precisely define the host ranges of these bee species, even at our sites. In addition, a complete analysis of the importance of each pollen type to the nutrition in developing bees will require estimates of individual pollen grain volume of different host species.

A potential pollinator must visit the flowers of the crop species with a degree of constancy adequate to effect high levels of pollen transfer. Even in agricultural systems, when the flowers of fruit or seed crops such as blueberry (Stubbs et al. 1994) or alfalfa predominate in close proximity to nests, *M. rotundata* may direct a high proportion of its pollen foraging trips to non-crop plant species. Horne (1995) found that *M. rotundata* exhibited only moderate preference for alfalfa relative to birdsfoot trefoil (*Lotus caniculata* L.) and crown vetch (*Coronilla varia* L.). Pollen records for *M. rotundata* suggest that control of alternative pollen sources could increase pollination efficiency in alfalfa seed crops, perhaps reducing the number of bees needed for commercial purposes. However, the types of pollen gathered by bees must be of nutritional quality adequate to sustain populations of the pollinator. Horne (1995) showed that pollen preference did not always correlate with reproductive success for *M. rotundata* given access to 11 species of plants. Thus, its moderate success on alfalfa relative to sainfoin and red clover suggests that increasing pollen source diversity could increase bee populations in agroecosystems, a goal potentially in conflict with that of increasing pollination efficiency on alfalfa. In addition, control of alternative pollen sources may negatively impact native pollinators, as well as parasitoids and predators, that depend on the flowers.

ACKNOWLEDGMENTS

We thank William Kemp (USDA-ARS Bee Biology and Systematics Laboratory, Logan, UT) for providing trap nesting materials, Ruth O'Neill for providing the cells from her *Megachile rotundata* nests, and Pete Fay and Michael Ivie for use of their properties for trap-nesting sites. We also thank Sue Blodgett, Gregory Johnson, and William Kemp for providing advice at various stages during the research, and Jordi Bosch, Jim Cane, Bill Kemp, Ruth O'Neill, and Norm Weeden for comments on the manuscript. This research was done in partial fulfillment of requirements for an M.S. in Entomology by Peter D. Jensen.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 203–208

NEW SYNONYMS AND STAGE DESCRIPTION FOR THREE SPECIES OF LEPTOHYPHIDAE (EPHEMEROPTERA)

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Abstract.—*Vacupernius paraguttatus* (Allen) and *Allenhyphes michaeli* (Allen) are **new junior subjective synonyms** of *V. packeri* (Allen) and *A. vescus* (Allen), respectively. Larval characters such as abdominal maculation are shown to be variable and unreliable in separating these species. Maxillary palp segmentation is difficult to detect among immature larvae of both species and must be used with caution when identifying immature leptohyphid larvae to species. The adult stage of *Homoleptohyphes mirus* (Allen) is described for the first time based upon reared and field-associated specimens from southern Arizona.

Key Words: Ephemeroptera, Leptohyphidae, *Allenhyphes, Vacupernius, Homoleptohyphes,* taxonomy

The mayfly family Leptohyphidae (Ephemeroptera) is a New World family of mayflies distributed in North, Central, and South America, and the Carribean. Although the family is common and widely distributed, the species-level taxonomy of this family suffers from many problems that include a lack of larval and adult associations, larval characters that are variable within and among populations and discrepancies in original descriptions and figures of species (Baumgardner and McCafferty 2000). Allen (1978) provided keys and descriptions for species of *Leptohyphes.* Recent publications by Lugo-Ortiz and McCafferty (1995), Wang et al. (1998), Baumgardner and McCafferty (2000) and Wiersema and McCafferty (2000) provided new or revised descriptions of taxa, synonyms, and distributional data. Despite these recent advances, many species-level problems remain in Leptohyphidae.

As part of an ongoing revision and cladistic analysis of the family Leptohyphidae in North and Central America, two new junior subjective synonyms are presented for the family. *Vacupernius paraguttatus* and *Allenhyphes michaeli* are shown to be synonyms of *V. packeri* and *A. vescus*, respectively. In addition, the adult stage of *Homoleptohyphes mirus* is described for the first time based upon reared and field-associated specimens from Sonoita Creek, Santa Cruz County, in southern Arizona, near the type locality of the species.

Depositions (and their acronyms) of materials used in this study include: The California Academy of Science, San Francisco (CAS); Texas A&M University, College Station (TAMU); Florida A&M University, Tallahassee (FAMU); Southwest Texas State University, San Marcos (SWTS); and Wilbur R. Enns Entomology Museum, University of Missouri, Columbia (UMC).

Vacupernius packeri (Allen)
(Figs. 1, 2)

Leptohyphes packeri Allen 1967: 350.
Leptohyphes phalarobranchus Kilgore and Allen 1973: 328; Allen 1978: 552 (syn.).

Leptohyphes paraguttatus Allen 1978: 552. **New synonym.**

Vacupernius paraguttatus: Wiersema and McCafferty 2000.

Vacupernius packeri: Wiersema and McCafferty 2000.

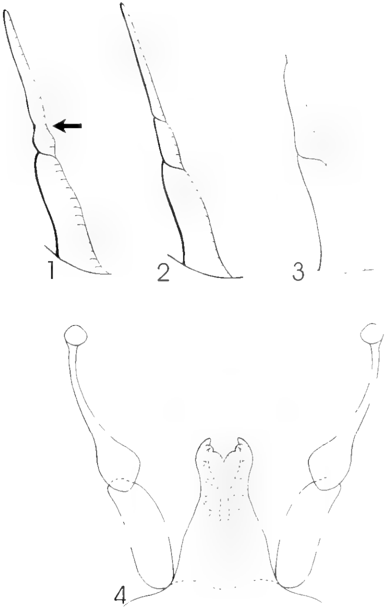
Vacupernius packeri was described by Allen (1967) from a series of larvae collected in Honduras, and has been shown to be widely distributed throughout the southwestern United States and Central America (Allen 1978, Henry 1986, Allen and Murvosh 1987, Lugo-Ortiz and McCafferty 1995). Henry (1986) associated the adult stage through rearing. In the larval stage, this species was distinguished from all other described species of *Leptohyphes* sensu lato by distinctive maculations on the operculate gills (see Allen 1967; fig. 14) and vertex of the head; the presence of a 3-segmented maxillary palp; and the absence of what Allen referred to as the basal spine on the operculate gill, which is actually a colorless outgrowth of the outer ventral lamellae of gill 2 (Baumgardner and McCafferty 2000).

Vacupernius paraguttatus, also described by Allen (1978), was based upon a single, immature larval specimen from the Hill Country of central Texas. This species was distinguished from other species of *Leptohyphes* sensu lato based primarily upon abdominal maculations on terga 2–4 that formed a "V"-shaped pattern. Pale body and the presence of a 2-segmented maxillary palp were also considered important characters separating this species from others within the genus.

Critical examinations of series of *V. packeri* larval specimens showed that a few of these specimens have the distinctive "V"-shaped maculation that was believed by Allen (1978) to be diagnostic of *V. paraguttatus.* Unfortunately, the holotype of *V. paraguttatus* has become badly faded and no longer has the distinctive "V"-shaped pattern on the abdomen. However, this "V"-shaped pattern has been observed on some immature larvae of *V. packeri.* This abdominal mark has only been observed on immature specimens of *V. packeri,* indicating developmentally influenced color pattern change. Abdominal larval markings similar to this have been found to be highly variable in other leptohyphid mayflies, such as *L. zalope* Traver, some of which display distinctive but variable abdominal markings (Baumgardner and McCafferty 2000). The distinctive maculations on the operculate gills of *V. packeri* are also absent in immature larvae, but begin to become visible in mature larvae. A few larvae of *V. packeri* were found to have both the abdominal "V"-shaped pattern and operculate gill maculation, providing the most compelling evidence to support the synonymy.

Although Allen (1978) indicated that *V. paraguttatus* had a 2-segmented maxillary palp, careful re-examination of the slide-mounted mouthparts of the holotype showed the maxillary palp to be 3-segmented, but the intersegmental suture between the second and third segment is difficult to detect (Fig. 1). Examination of immature specimens of *V. packeri* also showed that they have a maxillary palp that appears to be 2-segmented. However, under high magnification a very faint suture is visible on the middle of the apical maxillary palp segment, as it is in the holotype of *V. paraguttatus.* For mature larvae, this intersegmental suture is distinct. Other larval specimens having both the distinctive "V" maculation of *V. paraguttatus* and the operculate gill markings of *V. packeri* were observed to have this weak suture between the second and third maxillary palp segments. In mature specimens of *V. packeri* this suture is readily visible and distinct (Fig. 2).

The above observations clearly support the synonymy of *V. paraguttatus* with *V. packeri.* Also of importance is the wide variation that occurs in immature specimens of this species, such as abdominal maculation and maxillary palp segmentation, characters which have historically been used to sepa-



Figs. 1–4. 1, *Leptohyphes paraguttatus*, holotype larva, maxillary palp (arrow indicates location of weak suture line). 2, *Vacupernius packeri*, larva, maxillary palp (mature larvae). 3, *Allenhyphes vescus*, larva, maxillary palp. 4, *Homoleptohyphes mirus*, male adult, genitalia.

rate numerous species of leptohyphid mayflies. This indicates that these characters should be used with caution when determining species limits within the family Leptohyphidae.

Type material examined.—*Leptohyphes paraguttatus* Allen: HOLOTYPE larva: Geronimo Cr., Guadalupe Co., Tex., 18-v-73, Michael Peters; three associated slides (CAS #13603).

Other material examined.—(All larvae, unless otherwise indicated.) UNITED STATES: ARIZONA: Yavapai Co., Wet Beaver Ck. at Wet Beaver Ck. Campground, 24-25-v-1999, D.E. Baumgardner, (TAMU). TEXAS: Bandera Co., Winans Creek, Hwy. 16 crossing, 12-iv-1992, Moulton & Stewart, 6 ♂, 2 ♀, (TAMU). Comal Co., Sattler, Río Raft Co., Guadalupe River at 5.5 mi. below Canyon Dam below 4th crossing., 26-x-1996, N. Wiersema, (TAMU). Comal Co., Guadalupe River at Hwy. 311, 20-vi-1993, J. L. Cook, (TAMU). Milam Co., Rockdale, San Gabriel River at Hwy. 487 crossing, 16-xi-1996, N.A. Wiersema, (TAMU). Hays Co., San Marcos R. at Co. Rd. 101 (Caners Crossing), 1 mi. below conf. with Blanco R., in San Marcos City Limits, at Hays/Caldwell Co. Line, 21-ii-1997, DE Baumgardner and DE Bowles, (TAMU). Medina Co., Seco Creek, 6 mi. S. of D'Hanis, 13-v-1993, L. Gilpin, V. Castillo, (SWTS, TAMU); Same but, 27-vi-1993, (SWTS, TAMU); Same but, 25-iv-1993, (SWTS). Milam Co., Rockdale, San Gabriel R. at 487 crossing, 16-xi-1996, N. Wiersema. Williamson Co., Georgetown, San Gabriel Park, below little dam and bridge, 07-x-1996, N. Wiersema, (TAMU). BELIZE: STANN CK. DISTRICT, North Stann Creek, 2.7 mi. SE Middlesex on Hummingbird Hwy., 11-i-1996, R. W. Sites, (UM). MEXICO: NUEVO LEÓN, Cabazones R. at Hwy. 85, 15 mi. N. Linares, 16-v-1995, D. E. Baumgardner and B. C. Henry, (TAMU).

Allenhyphes vescus (Allen)
(Fig. 3)

Leptohyphes vescus Allen 1978: 555.

Leptohyphes michaeli Allen 1978: 549. **New synonym.**

Allenhyphes michaeli: Wiersema and McCafferty 2000.

Allenhyphes vescus: Wiersema and McCafferty 2000.

Allenhyphes vescus was described by Allen (1978) from the Hill Country of Texas based on a larva. Henry (1986) described the adults through rearing. The thin, delicate body and 2-segmented maxillary palp were considered diagnostic for the larval stage. Although not mentioned by Allen

(1978), the maxillary palp also has a diagnostic terminal seta.

In the same publication that Allen (1978) described *A. vescus* he also described *A. michaeli,* based on a single larva from the Hill Country of Central Texas. *Allenhyphes michaeli* was distinguished from other larvae then placed in *Leptohyphes* sensu lato by having a dark, median longitudinal line on abdominal terga 1–6, and a 1-segmented maxillary palp with a distinct apical seta.

A careful study of numerous specimens of *Allenhyphes vescus* from the Hill Country of Texas has clearly shown much variability in the median longitudinal line character. Specimens both with and without the median longitudinal line on abdominal terga 1–6 were observed. Moreover, this abdominal feature gradually disappears as the larvae develop and no mature larvae of *A. vescus* were found to have the longitudinal line on abdominal terga 1–6.

Although Allen considered *A. michaeli* to have a 1-segmented maxillary palp, a careful re-examination of the holotype maxillae under high magnification indicated that a small intersegmental suture is present, and the palp is actually 2-segmented, as in *A. vescus.*

In summary, larvae of *Allenhyphes vescus* have 2-segmented maxillary palps with an apical seta. The morphological details of the palp can most easily be observed under high (400×) magnification (Fig. 3). Although both species were described in the same publication, *A. vescus* was chosen to be the senior name as the prerogative of the first revisor.

Allenhyphes vescus is known from throughout much of central Texas and is often associated with streams in the Balconian ecoregion. It is also known from Nuevo Leon and Tamaulipas, Mexico.

Type material examined.—*Leptohyphes vescus* Allen: HOLOTYPE larva: Río Sabinal at Utopia, Uvalde Co., Texas., 2-viii-68, R. K. Allen; 2 slides (CAS #13607). *Leptohyphes michaeli* Allen: HOLOTYPE larva: North Fork Guadalupe Riv., 4 mi W. Hunt, Kerr Co., Tex., 27-vii-73, Michael Peters; 3 slides (CAS #13602).

Other material examined.—UNITED STATES: TEXAS: Kimble Co., Llano R. @ Texas Tech Field Station, 07-xi-1998, DE Baumgardner, 1 male (reared), (TAMU). Val Verde Co., Dolan Falls Preserve, Devils River; The Nature Conservancy, 08-xi-1998, DE Baumgardner, 1 male (TAMU). Comal Co., Honey Ck. in Honey Ck. St. Natural Area in Guadalupe R. State Pk, 08-iii-1997, DE Baumgardner & DE Bowles, 1 male (reared), larvae (TAMU). Williamson Co., Georgetown, San Gabriel Park, riffles below the little dam on the San Gabriel River, 2-x-1996, N. Wiersema, larvae (TAMU). Val Verde Co., Devils River, Dolan Falls, 19-x-1993, C. R. Nelson & S. M. Stringer, larvae (TAMU). MEXICO: TAMAULIPAS, spring (at local park) (at Hidalgo Ave?) near town of Jaumave, off Hwy. 101; 16-v-1995, 2 males, BC Henry & DE Baumgardner. TAMAULIPAS, R. Guayaalejo (Tamasi) off Hwy 247 nr. San Ignacio, 26-v-1993, B. Henry, larvae.

Homoleptohyphes mirus (Allen)
(Fig. 4)

Leptohyphes mirus Allen 1967: 353.
Homoleptohyphes mirus: Wiersema and McCafferty 2000.

Male adult.—Body length: 3.0–4.5 mm. Forewing length 4.5–5.0 mm. Hindwing absent. Cerci length 8.0–10.0 mm. Overall coloration dark reddish brown with pale lateral markings. Head dark brown, with black over shading. Compound eyes large; width of one eye greater than distance between eyes. Antenna brown at base, pale apically. Pro- and mesonotum reddish brown with pale lateral markings. Metanotum shiny reddish brown to dark brown. Forefemur pale with dark brown stippled longitudinal bands; apical segments pale. Meso- and metafemora pale with dark brown to black longitudinal bands; apical segments pale with brown stippling. Foreclaws similar and blunt. Forewings translucent with darkened subcostal vein. Abdomen pale to dark reddish brown, similar in color to thorax; cerci pale with grey over shading. Genitalia as in Fig. 4; penes with shallow emargination and scattered small spines; subgenital plate with shallow emargination, covered with minute spines (Fig. 4).

Female adult.—Body length: 3.0–4.0 mm. Forewing length 4.5–5.0 mm. Hindwing absent. Cerci missing. Body coloration and markings similar to male. Compound eyes small and widely separated.

Comments.—In both the larval and adult stages, *H. mirus* is most similar to *H. dimorphus* (Allen), because male larvae and adults have large compound eyes. These are the only two known species of Leptohyphidae in North or Central America that have this feature. In the larval stage, *H. mirus* can be differentiated from *H. dimorphus* by the presence of short spines on the forefemur of *H. mirus.* In contrast, *H. dimorphus* has long setae on the forefemur. Differentiating adults of *H. mirus* from *H. dimorphus* can be difficult without associated larvae. Adults of *H. mirus* apparently can be separated from those of *H. dimorphus* by the mostly solid dark red-brown coloration of the abdominal sternites, with limited black overshadowed stippling. In *H. dimorphus,* coloration of the abdominal sterna is pale yellow to reddish brown, overshadowed by extensive, fine black stippling.

Homoleptohyphes mirus is known only from the southwestern United States (far west Texas and southern Arizona) and northwestern Mexico, from the states of Sonora, Chihuahua and Sinaloa. Larvae can be found in small, apparently permanent, spring-fed desert streams. Upon reexamination, the specimen identified by Allen (1978) as *L. ferruginus* Allen and Brusca (now a synonym of *L. zalope*) from the Río Sonora, Sonora, Mexico is clearly that of *H. mirus* and not *L. zalope.*

Type material examined.—*Leptohyphes mirus* Allen: HOLOTYPE: Río Blanco, Arizona, 3-iv-37, J. G. Needham, 1 male larva (FAMU). ALLOTYPE: Río Blanco, Arizona, 3-iv-37, J. G. Needham, 1 female larva (FAMU). PARATOPOTYPES: Río Blanco, Arizona, 3-iv-37, J. G. Needham, 2 larvae (CAS), 4 larvae (FAMU).

Other material examined.—UNITED STATES: ARIZONA: Santa Cruz Co., Sonoita Cr., nr. Patagonia, 15-iii-1997, J. Slusark and K. Byrnes, 38L, 4 males (TAMU); Santa Cruz Co., Sonita Cr. at Blue Haven Rd., ca. 1 mi. SW Patagonia (31°30′57″N; 110°47′35″W), 06-vi-2000, DE Baumgardner, 52 larvae 3 males (reared) and 2 females (reared) (TAMU). TEXAS, Brewster Co., Calamity Cr. at TX Hwy 118, ca. 22 mi. S. Alpine, 24-viii-1996, DE Baumgardner & DE Bowles, 2 larvae (TAMU); Jeff Davis Co., H.C. Espy Ranch, Farm Rd. 1832, 14-v-1973, RG McClure, 20 larvae (TAMU). MEXICO: CHIHUAHUA, Río San Pedro at Meoqui on Hwy. 45, 14-viii-77, R. K. Allen, 6 larvae (CAS); CHIHUAHUA, Río Satevo at Gral. Tris on Hwy. 16, 13-viii-77, RK Allen, 9 larvae (CAS); CHIHUAHUA, Río Papagochic, 4 mi. E. Ciudad Guerrero on Hwy 16, 13-viii-77, R. K. Allen, 2 larvae (CAS); SINALOA, Río Baluarce at Rosarito, 13-i-83, Allen, Murvosh, 1 larva (CAS); SINALOA, stream 1 mi. N. El Viola, 18-I-83, Allen and Murvosh 6 larvae (CAS); SONORA, Río Sonora 2 mi. SE Rte. 21 between Uras & Mazocahui, 14-i-83, Allen & Murvosh, 1 larva (1 slide) (CAS) (record previously published as *L. ferruginus* by Allen 1978); SONORA, Río Bavispe, 3 mi. SW Colonia Moralia at dam, 2-i-1983, Allen, Murvosh, 12 larvae (CAS); SONORA, Río Altas at Tubutama, 13-I-83, Allen and Murvosh, 5 larvae (CAS).

ACKNOWLEDGMENTS

I thank Vince Lee (California Academy of Sciences) and Janice Peters (Florida A&M University) for providing *Leptohyphes* type specimens, Nick Wiersema (Austin, TX), Jerry Cook (Sam Houston State University) and Robert Sites (University of Missouri, Columbia) for providing additional specimens of Leptohyphidae, and

Abigail Fuller for assistance with figures. Special thanks are due to Joe Slusark (United States Geological Survey) for providing additional specimens of *Leptohyphes mirus* from Arizona and David Bowles (Texas Parks and Wildlife) for his field assistance on several collecting trips. Reviews by Steven Burian (Southern Connecticut State University), Jan Peters (Florida A&M University) and two anonymous reviewers greatly improved the final manuscript. Partial funding was provided by the Entomology Graduate Student Organization of Texas A&M University.

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 209–224

BIODIVERSITY AND BIOGEOGRAPHY OF MEXICAN BUTTERFLIES (LEPIDOPTERA: PAPILIONOIDEA AND HESPERIOIDEA)

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Abstract.—We present a brief history of the scientific study of butterflies in Mexico, which began in the 18th century, and provide an overview of the holdings of Mexican butterfly specimens in institutional collections worldwide. The current status of a massive database on Mexican butterflies, at present containing over 450,000 distributional records, is detailed. Around 1800 species of butterflies have been reported from Mexico, which equals roughly 10% of the world butterfly fauna, placing Mexico among the ten most butterfly-rich countries in the world. About 14.8% of Mexico's butterfly species are endemic, and six genera appear to be endemic to Mexico. For the first time, we present a list of all endemic Mexican butterfly taxa: 88 species and 150 additional subspecies of Papilionoidea, and 171 species and 14 additional subspecies of Hesperiidae. Patterns of species richness and endemism are not alike: the richest areas are in the southeastern part of Mexico, mostly in the tropical evergreen forests, whereas endemism is greater in the arid north, and the humid montane forest in the central and southern parts of the country. The twenty richest sites for butterfly diversity in Mexico are identified, and comparisons are made between these sites and regions.

Key Words: Rhopalocera, Papilionidae, Pieridae, Nymphalidae, Lycaenidae, Hesperiidae, endemism, species richness, biogeographical patterns, diversity

Scientific study of Mexican butterflies began with the Royal Scientific Expeditions to New Spain in the late 18th and early 19th centuries (Llorente et al. 1994). Since then, most lepidopterological research has been aimed at efforts to document the biodiversity of the country (Llorente and Luis 1993). Despite these efforts, the knowledge gathered in the last two centuries on the biodiversity and biogeography of Mexican butterflies remains incomplete. Considering the vast biodiversity that exists in Mexico, the continued existence of completely unexplored regions is not surprising, and the scarcity of institutional collections continues to be a hindrance to efforts at furthering our knowledge (Llorente et al. 1996).

Worldwide, about 18,000 species of butterflies are known, which represent about 13% of the approximately 150,000 species of Lepidoptera [Shields (1989) estimates 17,280 butterfly species, Heppner (1991) estimates 19,238 butterfly species, Robbins and Opler (1997) estimate 17,500 total butterfly species]. Data from Shields (1989) and Heppner (1991) estimate that 1,800 species of butterflies inhabit Mexico, representing around 10% of the world total

Table 1. Richness of Mexican butterfly species, by family, compared to major biogrographical regions. Numbers are taken from Shields (1989) and Heppner (1991). N = Nearctic; M = Mexico; NL = Neotropical; P = Palaearctic; E = Ethiopian; O = Oriental; A = Australia/Oceania. About 13.1% of the species of Lepidoptera are butterflies.

Family	N	M	NL	P	E	O	A	Total
Hesperiidae	290	800	2,016	155	437	569	191	3,658
Papilionidae	33	56	120	84	87	178	70	572
Pieridae	64	90	323	167	174	307	187	1,222
Lycaenidae	164	430	2,611	407	1,413	1,540	429	6,564
Nymphalidae	214	440	2,857	1,083	1,156	1,563	349	7,222
Total	765	1,816	7,927	1,896	3,267	4,157	1,226	19,238

(see Table 1). This richness may be due to two facts: 1) Mexico is located in an area of tectonic convergence (termed the Mexican Transition Zone by Halffter (1976), also see Llorente (1996)), where the Nearctic and Neotropical regions overlap; together these regions contain 40% of the world's butterflies; and 2) Mexico has an extratropical-intertropical situation, with various mountain ranges, which generate a wide variety of climates (ranging from arid to humid), as well as many vegetation types ranging from xerophilous scrubs to tropical forests and various types of temperate forests (Morrone et al. 1999).

The Hesperioidea is the largest group of butterflies; a single family (Hesperiidae) is included, with about 3,600 species. According to Heppner (1991), the Papilionoidea include four families, which are, from largest to smallest: Nymphalidae, Lycaenidae, Pieridae, and Papilionidae (see Table 1) [following Weintraub and Miller (1987), we do not consider the Hedylidae to be butterflies]. Considering all biogeographical regions, the Neotropical Region is the richest in butterfly species, with the exception of the Papilionidae, which are more diverse in the Oriental Region (Heppner 1991). Mexico harbors more than twice the number of species than the entire Nearctic Region north of Mexico. This figure is considerably larger than that of the Australian Region and similar to the number of species in the Palaearctic Region. Several groups have diversified extensively in Mexico, and there are also a number of paleoendemic and relictual groups, such as *Baronia* Salvin, 1893; *Eucheira* Westwood, 1834; *Prestonia* Schaus, 1920; *Chlosyne* Butler, 1870; *Cyllopsis* R. Felder, 1869; *Paramacera* Butler, 1868; *Lamphiotes* Callaghan, 1982; *Zobera* H. A. Freeman, 1970; *Piruna* Evans, 1955; *Paratrytone* Godman, 1900; and all megathymine genera (especially *Agathymus* H. A. Freeman, 1959 and *Stallingsia* H. A. Freeman, 1959).

MATERIALS AND METHODS

Collections of Mexican butterflies.—The number of butterfly specimens in nine of the largest American collections exceeds 72,000 (see Table 2). Two of the three most important collections in Mexico are housed at UNAM, the collection of the Departamento de Zoología of the Instituto de Biología (IBUNAM), and the collection at the MZFC, which has specialized in the fauna of the Mexican humid montane forests (Navarro and Llorente 1996). Together, both collections contain over 100,000 mounted specimens and another 250,000 specimens papered in envelopes (Table 2). The third most important collection in Mexico is private and is the product of research conducted by members of the de la Maza family, which, according to G. Lamas (personal communication) [information obtained orally], is composed of approximately 35,000 specimens. Three other important private collections that have been assembled during the last three decades are those

Table 2. Numbers of Mexican butterfly records from major institutional collections. All numbers are from the database of butterfly localities maintained by the "Alfonso L. Herrera" Museum of Zoology, at UNAM in Mexico City.

Collection	# of Records
Allyn Museum of Entomology, Sarasota, FL	9,035
American Museum of Natural History, New York, NY	11,530
California Academy of Sciences, San Francisco, CA	5,330
Carnegie Museum of Natural History, Pittsburgh, PA	14,278
Los Angeles County Museum of Natural History, CA	9,484
San Diego Natural History Museum, CA	8,322
University of California, Berkeley, CA	2,394
National Museum of Natural History, Washington, DC	7,804
Nevada State Museum, Las Vegas, NV	3,850
The Natural History Museum, London	15,000
Museo de Zoología "Alfonso L. Herrera," UNAM	300,000
Instituto de Biología, UNAM, Mexico City	55,000
Colegio de la Frontera Sur (Chetumal, QROO)	30,000
TOTAL	472,027

of Díaz Francés, Jesús Saldaña, and González Cota. These collections include a wide variety of material from all the southern Mexican states, and contain many species endemic to Mexico. Fortunately, the two former collections were recently acquired by IBUNAM, and the latter, by the MZFC, sponsored by the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), thus ensuring their preservation in academic institutions.

Mexican butterfly database.—Over the past 15 years, one of the primary objectives of the Lepidoptera collection at the MZFC has been the computerization of Mexican butterfly records into a database. This database contains three groups of primary data, including data from specimen labels of Papilionoidea housed in Mexican institutions, the same data from Papilionoidea housed in major institutions in the U.S.A. and England, and data of Papilionoidea and Hesperioidea from over 1,000 literature sources (Table 3). Data from specimens of Mexican Hesperioidea housed in institutional collections are being added to the database. The database is currently supported by the "Sistema de Información Biótica," a program developed by CONABIO to manage nomenclatural, geographic, bibliographic and curatorial information on all of Mexico's biota.

At present, the butterfly database contains over 450,000 records, of which almost 85,000 are from natural history museums outside of Mexico, mainly in the U.S.A. and England. About 55,000 of these records are from IBUNAM, a minimum of 10,000 are from literature reports, and the remaining records are from faunal studies or specific collecting efforts aimed at determining the distributions of certain taxa (Luis et al. 2000).

The records in this database have enabled us to examine the distributions of many of the species that make up the Mexican fauna (Llorente et al. 1997). One of the best studied butterfly faunas in Mexico is that of the western state of Michoacán. Through studies made during the last 10 years, over 100,000 records have been obtained from Michoacán, from 144 localities (Luis et al., in preparation). In contrast, despite its long history of butterfly collecting tracing back to the 18th century, the state of Veracruz is represented by 50,000 records from 562 localities. To supplement this database of locality information, three additional compilations have been or are being prepared: a catalogue of taxonomic names of Mexican

Table 3. Numbers of localities from which butterflies have been recorded in each Mexican state. All numbers are from the database of butterfly localities maintained by the "Alfonso L. Herrera" Zoology Museum, at UNAM in Mexico City.

State	Localities
VERACRUZ	562
BAJA CALIFORNIA SUR	547
BAJA CALIFORNIA	520
CHIAPAS	472
OAXACA	409
GUERRERO	228
SAN LUIS POTOSÍ	215
SINALOA	198
SONORA	196
JALISCO	178
DURANGO	157
MICHOACÁN	144
TAMAULIPAS	139
NAYARIT	139
CHIHUAHUA	137
NUEVO LEÓN	125
HIDALGO	117
PUEBLA	96
COLIMA	96
MORELOS	91
YUCATÁN	72
QUINTANA ROO	65
ESTADO DE MÉXICO	63
DISTRITO FEDERAL	56
CAMPECHE	40
TABASCO	38
COAHUILA	35
QUERÉTARO	19
ZACATECAS	19
AGUASCALIENTES	17
GUANAJUATO	15
TLAXCALA	4
TOTAL LOCALITIES	5,209

butterflies, one of geographical localities of Mexican butterflies (Luis et al. 1996), and one containing literature citations that deal with Mexican Papilionoidea (Luis et al. 2000).

GEOGRAPHICAL DISTRIBUTION OF MEXICAN BUTTERFLY RECORDS

Although Mexico is a large Latin American nation, thought by some to be relatively well known and explored, this is not true for insects (Burke and Fryxell 1995). According to the data from nearly 500,000 specimens held in nearly a dozen museums in the U.S.A., The Natural History Museum, London, Mexican collections, and reports from the literature, the number of Mexican localities that have been explored for butterflies since the beginning of the former century is just over 5,000. Such a representation is poor for a county like Mexico which contains a vast megadiversity of organisms (Llorente and Luis 1993).

Published distributional records on Mexican butterflies are varied in their scope. Reports range from occasional collections made during a few hours (e.g., Comstock 1959; Díaz 1975; Guzmán 1975; González 1977, 1978), to comprehensive faunistic studies (e.g., Luis and Llorente 1990; Luis et al. 1991, 1996; Vargas et al. 1994, 1999), with many reports that fall somewhere in between (e.g., Clench 1968, Freeman 1969, de la Maza 1976, Routeledge 1977, Brown et al. 1992, Balcazar 1993). For the Papilionidae and Pieridae (Llorente et al. 1997), it has been observed that the best studied sites are near, or geographically associated with, classic historical collecting sites such as the regions of Jalapa and Los Tuxtlas in Veracruz, the Sierra de Juárez in Oaxaca, and the Sierra Madre del Sur in Guerrero (Sierra de Atoyac de Álvarez, Chilpancingo and Omiltemi).

Our state of knowledge of the geographical distribution of butterflies within Mexico's political boundaries remains poor; of the 31 states comprising the Republic, six states contain 52.56% of the recorded 5,209 collecting localities (Veracruz, Baja California Sur, Baja California, Chiapas, Oaxaca and Guerrero). States with fewer than twenty recorded collecting localities and no published faunal studies include Tlaxcala, Aguascalientes, Zacatecas and Querétaro (Table 3). However, given that a substantial number of Mexican species of papilionoids are known to have wide distributions, and several highly localized endemic species are known, it seems valid to assume that the primary general distributional patterns displayed by Mexican butterflies have been

Table 4. Numbers of butterfly species known from various Mexican states. BC = Baja California; BCS = Baja Calfornia Sur; DGO = Durango; COL = Colima; JAL = Jalisco; GRO = Guerrero; VER = Veracruz; OAX = Oaxaca; CHIS = Chiapas; QROO = Quintana Roo.

Family	BC	BCS	DGO	COL	JAL	GRO	VER	OAX	CHIS	QROO
Papilionidae	8	6	12	28	28	32	40	51	42	24
Pieridae	26	27	29	36	44	44	57	64	70	27
Nymphalidae	34	23	61	135	176	209	300	371	379	116
Lycaenidae	53	30	45	125	151	192	279	285	333	64
Hesperiidae	39	35	104	221	258	300	435	416	462	118
Total	159	121	251	545	657	777	1,111	1,187	1,276	349

identified. Nevertheless, a large number of faunal studies remain to be conducted in order to understand at a finer level the distribution of species and groups which are endemic to Mexico (Llorente et al. 1994, 1997; Soberón et al. 2000; Oñate et al. 2000).

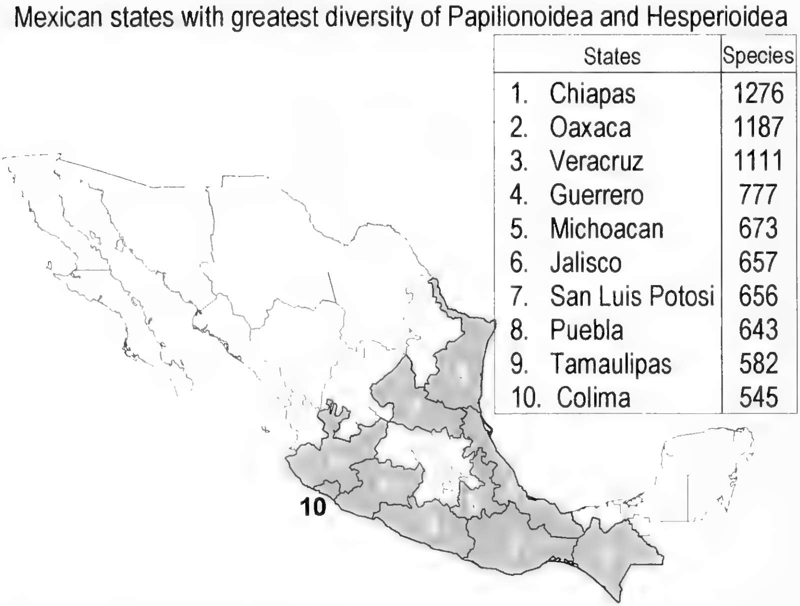
According to the literature, museum collections, and recent faunal studies, less than one third of the Mexican states have a butterfly species checklist (Vargas et al. 1996, Warren et al. 1998). Additionally, most of the existing state checklists are based on one or two faunal studies centered in the most diverse parts of those states (leaving large parts of those states un-collected). Exceptions to this are the states of Baja California and Baja California Sur, where no rigorous faunal studies have been made but for which Brown et al. (1992) compiled in book-form numerous data from the literature, museum collections and field work conducted at several localities. Table 4 provides numbers of butterfly species from states for which we have species checklists, and Map 1 shows Mexico's ten richest states, in numbers of Papilionoidea and Hesperioidea species.

PATTERNS OF SPECIES RICHNESS

The nine richest regions in Mexico, in terms of butterfly diversity, are shown on Map 2. Each of these regions includes from three to more than 30 individual collecting localities that can arguably be classified as single biotic units. In general, these regions contain various altitudinal, climatic, and vegetational gradients, such as the Sierra de Atoyac de Álvarez in Guerrero (with 339 Papilionoidea species), and the Sierra de Juárez in Oaxaca (with 450 Papilionoidea species), which ranges from 100 to 3,100 m. and includes many forest types. Sadly, in recent years, we have observed a profound alteration of these habitats, due to human activities, which has resulted in widespread ecological fragmentation and destruction.

Several measurements should be considered when trying to determine the most diverse of these areas; namely the size of the area, variations in elevation, environmental heterogeneity, and the biogeographical history of the region. Luis et al. (1991) shows that the Sierra de Juárez in Oaxaca is the region showing the widest altitudinal range (100–3,100 m), contrasted with the following regions: a) Los Tuxtlas, Veracruz (with 516 Papilionoidea species), with elevational extremes from sea level to 900 m, but with over 30 sampled localities and various vegetation types (Raguso and Llorente 1997), b) Chajul, Chiapas (with 396 Papilionoidea species), composed of a single forest type at 300 m. elevation (de la Maza and de la Maza 1985a, b), and c) Presidio, Veracruz (with 392 Papilionoidea species). Most of the records from the Presidio area are historical (up to 150 years old); forests in this area have been altered considerably, and only a few sites remain that still host native vegetation.

The four richest single Mexican localities for butterflies are located on the Atlantic



States	Species
1. Chiapas	1276
2. Oaxaca	1187
3. Veracruz	1111
4. Guerrero	777
5. Michoacan	673
6. Jalisco	657
7. San Luis Potosi	656
8. Puebla	643
9. Tamaulipas	582
10. Colima	545

Map 1. Numbers of Papilionoidea and Hesperioidea species known from Mexico's ten richest states.

slope, which is the most diverse region in Mexico for several groups of organisms (Escalante et al. 1998, Flores 1998). Mexico's richest sites on the Pacific slope include humid areas with great physiographical heterogeneity (Map 3). Along Mexico's Pacific slope there are only three localities that have more than 200 species. These are: Mismaloya and La Calera in Jalisco, and Río Santiago in Guerrero, all with tropical semi-deciduous forests that contain elements from the montane cloud forest (Monteagudo et al. 2001). While Mismaloya does not appear on Map 3 (see Map 2), Warren and Llorente (1999) reported 315 butterfly species from that site (including Papilionoidea and Hesperioidea).

Patterns of Endemism

The patterns of species richness and endemism among Mexican butterflies differ. The tropical evergreen forests of southeastern Mexico comprise the richest region in Mexico, in terms of total numbers of species. Over 50% of the species of Papilionoidea that occur in Mexico (over 700 species, excluding Hesperioidea) are known to occur in these forests (Salinas 1999). Despite this great diversity, only about 2% of the butterfly species associated with the tropical evergreen forests are endemic to Mexico; most species in these forests range south into parts of Central and South America. According to Rzedowski (1978), tropical evergreen forests formerly occupied 12.8% of Mexico; the current remaining forest fragments cover at most between 10 and 15% of their original area (Granillo 1985, Toledo 1988).

Mexico's endemic fauna, in contrast, is associated both with the arid communities of northwestern Mexico, and with the humid

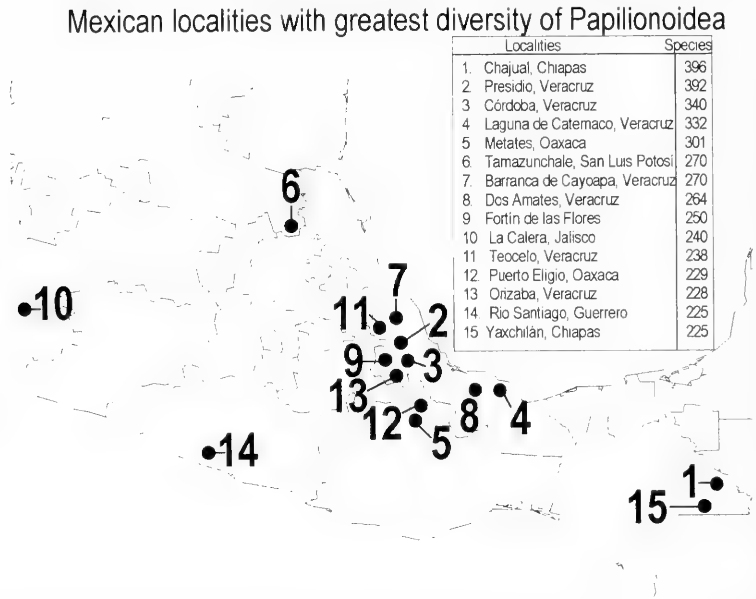
Mexican regions with greatest diversity of Papilionoidea

Regions	Species
1. Orizaba-Córdoba-Fortín de las Flores	537
2. Región de los Tuxtlas	516
3. Jalapa-Coatepec-Teocelo	486
4. Sierra de Juárez	450
5. Sierra de Atoyac	339
6. Sierra de Manantlán	315
7. Mismaloya-Bahía de Banderas	281
8. Acahuizotla	262
9. Sierra de San Juan	237

Map 2. Numbers of Papilionoidea species known from Mexico's most diverse regions. Each region includes from three to more than 30 separate collecting sites

montane forests (especially the montane cloud forests) of central and southern Mexico. The insular distribution of the montane cloud forests along various mountain chains in Mexico has resulted in the speciation of many taxa, a phenomenon evident in many plant and animal groups (Halffter 1987). According to Llorente (1984), there are two altitudinal barriers in Mexico which limit dispersion and generally prohibit continuous distributions of taxa: one around 600 m, and the other around 2,000 m. Each of these altitudinal barriers present dramatically different climatic and vegetational conditions. Throughout Mesoamerica, the lower altitudinal zone is composed of the tropical evergreen and semi-deciduous forests on the Atlantic slope, with tropical deciduous and semi-deciduous forests on the Pacific slope. The middle elevational zone (roughly 600–2,000), is significantly cooler than the lower zone and is occupied by various humid forest types. The highest elevational zone is seasonally cold, often arid, and is dominated by fir, pine and oak forests.

The insularity of the humid montane forests in Mexico has made them spots of high endemicity for several groups of butterflies at the specific and subspecific levels. The assemblages of subspecies scattered in a number of these submontane islands sometimes group together with tropical Mesoamerican species, whereas in other cases they are more closely related with montane Central American species. In Mexico, there are six discernible biogeographical "islands": a) the highlands of Chiapas [and Guatemala]; b) the highlands of the Los Tuxtlas region in Veracruz; c) the Sierra de Juárez-Sierra Madre Oriental mountain chains in



Localities	Species
1. Chajual, Chiapas	396
2 Presidio, Veracruz	392
3 Córdoba, Veracruz	340
4 Laguna de Catemaco, Veracruz	332
5 Metates, Oaxaca	301
6. Tamazunchale, San Luis Potosí	270
7. Barranca de Cayoapa, Veracruz	270
8. Dos Amates, Veracruz	264
9 Fortín de las Flores	250
10 La Calera, Jalisco	240
11 Teocelo, Veracruz	238
12. Puerto Eligio, Oaxaca	229
13 Orizaba, Veracruz	228
14. Rio Santiago, Guerrero	225
15 Yaxchilán, Chiapas	225

Map 3. Numbers of Papilionoidea species known from the twenty richest localities in Mexico.

Veracruz and Oaxaca; d) the Sierra Madre del Sur mountain chain in Guerrero and Oaxaca; e) the Pacific slope of the Nueva Galicia region from Colima to southern Sinaloa; and f) in lesser degree, the Transmexican Volcanic Belt. Some of these "islands" may be further subdivided into two or three portions, such as the highlands of Chiapas and Guatemala (Llorente and Escalante 1992).

We know of 88 species and 150 additional subspecies of Papilionoidea that are endemic to Mexico, with three endemic genera (*Baronia*, *Prestonia* and *Eucheira*). These endemic species and subspecies include 11.7% of Mexican butterfly taxa. Papilionoid genera which have diversified extensively in Mexico include *Chlosyne*, *Cyllopsis*, and *Calephelis* Grote and Robinson, 1869. Currently, 171 species and 14 subspecies of Hesperioidea are known to be endemic to Mexico, with three endemic genera (*Zobera*, *Aegiale* and *Turnerina*). These endemic hesperioids include 9.1% of Mexican butterfly taxa. Hesperioid genera that have diversified extensively in Mexico include *Piruna*, *Paratrytone* and *Agathymus*. The number of endemic species of Hesperioidea exceeds that of all four papilionoid families combined. Considering all 423 taxa considered to be endemic in this work (including species and subspecies), 43.7% are hesperioids (Appendix). Thus, overall, 14.8% of Mexican butterfly species are endemic, and over 60% of these endemic taxa are distributed in the Mexican Pacific region. The Pacific region is environmentally discontinuous with other Mesoamerican and Central American faunal elements, and possesses two well delimited biogeographical islands: the Sierra Madre del Sur in Guerrero and Oaxaca, and the

Pacific slope of the Nueva Galicia region from Colima to southern Sinaloa. The Tehuantepec Isthmus and the Balsas River Basin, respectively, play the role of physiographic and climatic barriers to these islands (Llorente 1984).

CONCLUSIONS

We summarize our biogeographical knowledge of Mexican butterflies, acquired through the past 200 years, as follows:

1) Mexico possesses 10% of the butterfly species of the world and 14.8% of these species are endemic, making Mexico one of ten countries with the greatest butterfly diversity.
2) Mexico and the areas adjacent to its borders possess relictual, palaeo- and neoendemic butterfly groups of great scientific interest, mostly in the northwestern arid zones, and in the montane communities to the south.
3) Patterns of species richness and endemism are not alike: the richest areas are in the southeast, mostly in the tropical evergreen forests, whereas endemic taxa are mostly distributed in the arid north, and in the humid montane forests in the central and southern portions of the country.
4) Areas richest in species numbers and endemic taxa are those exhibiting physiographic, climatic and vegetational heterogeneity, in a mosaic of preserved and partially altered environments, (such as the Los Tuxtlas region in Veracruz, Chajul in Chiapas, and the Sierra de Juárez in Oaxaca, each one possessing over one third of Mexico's butterfly species). In contrast, whole states or physiographic provinces with less environmental heterogeneity, such as the Peninsula of Baja California (which claims less than 9% of the butterfly fauna of Mexico), possess fewer total and endemic taxa.
5) Mexico's complex biogeographical history has resulted in several intercontinental, insular, distributional patterns that are evident among Mexican butterflies; these are the product of a heterogeneous and disjunct distribution of arid, humid and montane environments.
6) There are a number of relictual taxa that occur in unique biogeographical areas in Mexico.

ACKNOWLEDGMENTS

We thank Drs. Robert K. Robbins (Smithsonian Institution, Washington, D.C.) and Gerardo Lamas Müller (Universidad Nacional Mayor de San Marcos, Lima, Peru) for their comments on and contributions to this paper, as well as for access to the collections and libraries under their supervision. Additionally, we thank Paul A. Opler for comments on this paper. Thanks also to CONACyT for sponsoring project 32002, and to DGAPA-UNAM IN 209900 for funding. Special thanks is extended to the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) for funding research visits by three of the authors to institutional collections in the United States and to The Natural History Museum in London, England.

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APPENDIX

Species and Subspecies of Endemic Mexican Butterflies

= Taxon that has been reported from the USA by stray specimens or in error.
^ = Taxon reported from Belize or Guatemala by rare strays.
a = Taxon originally described from Arizona but now extinct in the USA.
?? = Questionable taxonomic status, further study required (this symbol is after names).

Taxa listed in **bold** are endemic to Mexico at the species level. We note that some taxa listed as endemic herein may be found to have distributions that extend outside of Mexico with future fieldwork. However, taxonomic revisions and new species discoveries also will increase the number of endemic species in the future.

Endemic genera include: *Baronia* (Papilionidae), *Prestonia*, *Eucheira* (Pieridae), *Zobera*, *Aegiale*, and *Turnerina* (Hesperiidae).

We list subspecies (geographical races) to aid in the identification of patterns of endemism. Distributions of many Theclinae and Hesperiidae are less well known, and most modern publications on these groups have not recognized subspecies extensively.

PAPILIONIDAE

Baroniinae

Baronia brevicornis brevicornis Salvin, 1893
Baronia brevicornis rufodiscalis J. Maza & J. White, 1987

Papilioninae

Battus philenor orsua (Godman & Salvin, 1889)
^*Battus philenor acauda* (Oberthür, 1880)
Battus laodamas iopas (Godman & Salvin, 1897)
Battus eracon (Godman & Salvin, 1897)
****Parides alopius*** (Godman & Salvin, 1890)
Parides erithalion trichopus (Rothschild & Jordan, 1906)
Parides panares panares (Gray, [1853])
Protographium agesilaus fortis (Rothschild & Jordan, 1906)
Protographium epidaus tepicus (Rothschild & Jordan, 1906)

Protographium epidaus fenochionis (Salvin & Godman, 1868)
Protographium thyastes occidentalis (R. G. Maza, 1982)
Mimoides ilus occiduus (Vázquez, 1956)
Mimoides thymbraeus aconophos (Gray, [1853])
Heraclides erostratus erostratinus (Vázquez, 1947)
Heraclides erostratus vazquezae (Beutelspacher, 1986)
^_Heraclides rogeri rogeri_ (Boisduval, 1836)
Heraclides torquatus mazai (Beutelspacher, 1974)
Heraclides astyalus bajaensis (J. W. Brown & Faulkner, 1992)
___Pterourus esperanza___ (Beutelspacher, 1975)
Pterourus glaucus alexiares (Hopffer, 1865)
Pterourus glaucus garcia (Rothschild & Jordan, 1906)
Pterourus palamedes leontis (Rothschild & Jordan, 1906)
*_Pterourus abderus abderus_ (Hopffer, 1856)
Pterourus abderus baroni (Rothschild & Jordan, 1906)
___Pterourus garamas___ (Geyer, [1829])
Pterourus menatius morelius (Rothschild & Jordan, 1906)

Pieridae

Dismorphiinae

___Enantia mazai mazai___ Llorente, 1984
___Enantia mazai diazi___ Llorente, 1984
Lieinix lala turrenti J. Maza & R. G. Maza, 1984
___Lieinix neblina___ J. Maza & R. G. Maza, 1984
Lieinix nemesis nayaritensis Llorente, 1984
Dismorphia amphione lupita Lamas, 1979
Dismorphia amphione isolda Llorente, 1984
Dismorphia crisia alvarezi J. Maza & R. G. Maza, 1984
Dismorphia eunoe eunoe (Doubleday, 1844)
Dismorphia eunoe popoluca Llorente & Luis, 1988
Dismorphia eunoe chamula Llorente & Luis, 1988

Coliadinae

*_Phoebis agarithe fisheri_ (H. Edwards, 1883)
___Prestonia clarki___ Schaus, 1920
Eurema agave millerorum Llorente & Luis, 1987

Pierinae

Anthocharis cethura bajacalifornia J. Emmel, T. Emmel & Mattoon, 1998
___Anthocharis limonea___ (Butler, 1871)
*___Euchloe guaymasensis___ Opler, 1987
Hesperocharis crocea jaliscana (Schaus, 1898)
Hesperocharis graphites avivolans (Butler, 1865)
___Eucheira socialis socialis___ Westwood, 1834
___Eucheira socialis westwoodi___ Beutelspacher, 1984
Catasticta flisa oaxaca Beutelspacher, 1986
___Catasticta___ undescribed species
*_Catasticta nimbice nimbice_ (Boisduval, 1836)
Catasticta teutila flavifaciata Beutelspacher, 1986
Catasticta teutila teutila (Doubleday, 1847)
Pereute charops charops (Boisduval, 1836)
Pereute charops leonilae Llorente, 1986
Pereute charops sphocra Draudt, 1931
Melete polyhymnia serrana R. G. Maza, 1984
Perrhybris pamela chajulensis J. Maza & R. G. Maza, 1989
Perrhybris pamela mapa J. Maza & R. G. Maza, 1989
Ascia monuste raza Klots, 1930
*___Ganyra howarthi___ (Dixey, 1915)

Nymphalidae

Heliconiinae

Actinote stratonice oaxaca (L. Miller & J. Miller, 1979)
Actinote guatemalena guerrerensis J. Maza, 1982
Actinote guatemalena veraecrucis Jordan, 1913
Eueides isabella nigricornis R. G. Maza, 1989
Heliconius erato cruentus Lamas, 1998
Speyeria nokomis wenona dos Passos & Grey, 1945 «
Speyeria nokomis melaena Mooser & García, 1979 «
[a]_Speyeria nokomis coerulescens_ (Holland, 1900)

Nymphalinae

___Nymphalis cyanomelas___ (Doubleday, [1848])
___Polygonia g-argenteum___ (Doubleday, 1848)
___Polygonia haroldii___ (Dewitz, 1877)
Anartia amathea colima Lamas, 1995
___Chlosyne kendallorum___ Opler, 1999
*___Chlosyne ehrenbergii___ (Geyer, [1833])
Chlosyne definita anastasia (Hemming, 1934)
Chlosyne definita schausi (Godman, 1901)
Chlosyne endeis endeis (Godman & Salvin, 1894)
Chlosyne gaudialis wellingi L. Miller & Rotger, 1979
*___Chlosyne eumeda___ (Godman & Salvin, 1894)
___Chlosyne marina___ (Geyer, 1837)
*___Chlosyne melitaeoides___ (R. Felder 1867)
Chlosyne janais gloriosa Bauer, 1960
Chlosyne janais marianna Röber, [1914]
Chlosyne rosita mazarum L. Miller & Rotger, 1979
Chlosyne rosita riobalsensis Bauer, 1961
Thessalia cyneas cynisca (Godman & Salvin, 1882)
Thessalia leanira austrina Austin & M. J. Smith, 1998
Thessalia theona brocki Austin & M. J. Smith, 1998
Thessalia theona mullinsi Austin & M. J. Smith, 1998
___Texola anomalus___ (Godman & Salvin, 1897)
___Texola coracara___ (Dyar, 1912)
Texola elada elada (Hewitson, 1868)
___Phyciodes pallescens___ (R. Felder, 1869)
Phyciodes mylitta mexicanus Hall, 1928
___Anthanassa alexon___ (Godman & Salvin, 1889)
Anthanassa ptolyca amator (Hall, 1929)
Anthanassa sitalces cortes (Hall, 1917) «
Anthanassa otanes cyno (Godman & Salvin, 1889)
Anthanassa otanes oaxaca Beutelspacher, 1990
___Castilia chinantlensis___ (R. R. Maza, 1978)

Limenitidinae

Myscelia cyananthe diaziana R. G. Maza & J. Maza, 1985

**Myscelia cyananthe skinneri* Mengel, 1894
Myscelia cyananthe streckeri Skinner, 1889
Myscelia cyaniris alvaradia R. G. Maza & Díaz, 1982
Catonephele cortesi R. G. Maza, 1982
Eunica malvina almae Vargas, Llorente & Luis, 1998
Hamadryas amphinome mazai Jenkins, 1983
**Hamadryas atlantis lelaps* Godman & Salvin, 1883
**Hamadryas glauconome grisea* Jenkins, 1983
**Hamadryas guatemalena marmarice* (Frühstorfer, 1916)
^***Hamadryas honorina*** (Frühstorfer, 1916)
Pyrrhogyra edocla paradisea R. G. Maza & J. Maza, 1985
Temenis laothoe quilapayunia R. G. Maza & Turrent, 1985
Epiphile adrasta escalantei Descimon & Mast, 1979
Bolboneura sylphis beatrix R. G. Maza, 1985
Bolboneura sylphis lacandona R. G. Maza & J Maza, 1985
Bolboneura sylphis veracruzana Draudt, 1931
Diaethria astala asteroidea R. G. Maza & R. R. Maza, 1985
Diaethria asteria (Godman & Salvin, 1894)
Diaethria salvadorensis mixteca J. Maza, 1977
Callicore astarte casta (Salvin, 1869)
Callicore texa grijalva R. G. Maza & J. Maza, 1983
Callicore texa loxicha R. G. Maza & J. Maza, 1983
Callicore tolima tehuana R. G. Maza & J. Maza, 1983
Adelpha milleri Beutelspacher, 1976
Adelpha boeotia oberthurii (Boisduval, 1870)
Adelpha diazi Beutelspacher, 1975
Adelpha diocles creton Godman, 1901
Adelpha leucerioides leucerioides Beutelspacher, 1975
Basilarchia archippus hoffmanni (Chermock, 1947)

Charaxinae

Archaeoprepona amphimachus baroni J. Maza, 1982
Archaeoprepona demophon occidentalis Stoffel & Descimon, 1974
Archaeoprepona demophoon mexicana Llorente, Descimon & Johnson, 1993
Archaeoprepona phaedra aelia (Godman & Salvin, 1889)
Prepona deiphile brooksiana Godman & Salvin, 1889
Prepona deiphile diaziana L. Miller & J. Miller, 1976
Prepona deiphile escalantiana Stoffel & Mast, 1973
Prepona deiphile ibarra Beutelspacher, 1982
Prepona deiphile lambertoana Llorente, Luis & González, 1992
Hypna clytemnestra mexicana Hall, 1917
Consul electra undescribed subspecies
Fountainea eurypyle glanzi (Rotger, Escalante & Coronado, 1965)
Fountainea halice martinezi (J. Maza & Díaz, 1978)
Fountainea halice maya (Witt, 1980)
Fountainea halice tehuana (Hall, 1917)
Fountainea nobilis rayoensis (J. Maza & Díaz, 1978)
Memphis schausiana (Godman & Salvin, 1894)
Memphis wellingi L. Miller & J. Miller, 1976

Morphiinae

Morpho achilles guerrerensis Le Moult & Réal, 1962
Morpho achilles montezuma Guenée, 1859
Iphimedeia telemachus oaxacensis Le Moult & Réal, 1962

Satyrinae

Cissia cleophes (Godman & Salvin, 1889) «
Cyllopsis caballeroi Beutelspacher, 1982
Cyllopsis clinas (Godman & Salvin, 1889)
Cyllopsis diazi L. Miller, 1974
Cyllopsis dospassosi L. Miller, 1969
Cyllopsis hedemanni tamaulipensis L. Miller, 1974
Cyllopsis henshawi hoffmanni L. Miller, 1974 «
Cyllopsis jacquelinae L. Miller, 1974
Cyllopsis nayarit Chermock, 1947 «
Cyllopsis parvimaculata L. Miller, 1974
Cyllopsis perplexa L. Miller, 1974
Cyllopsis pertepida pertepida (Dyar, 1912)
Cyllopsis pertepida intermedia L. Miller, 1974
Cyllopsis pseudopephredo Chermock, 1947
Cyllopsis suivalens suivalens (Dyar, 1914)
Cyllopsis whiteorum L. Miller & J. Maza, 1984
Cyllopsis windi L. Miller, 1974 «
Euptychia fetna Butler, 1870
Euptychia rubrofasciata L. Miller & J. Miller, 1988
"Megisto" pellonia (Godman, 1901)
Megisto rubricata pseudocleophes L. Miller, 1976
Paramacera chinanteca L. Miller, 1972
Paramacera copiosa L. Miller, 1972
Paramacera xicaque rubrosuffusa L. Miller, 1972
Paramacera xicaque xicaque (Reakirt, [1867])
Splendeuptychia kendalli L. Miller, 1976
Taygetis mermeria griseomarginata L. Miller 1978
Taygetis uncinata Weymer, 1907
Taygetis weymeri Draudt, 1912
Pedaliodes undescribed species

Ithomiinae

Melinaea ethra flavicans Hoffmann, 1924
Oleria zea diazi J. Maza & Lamas, 1978
Callithomia hezia wellingi Fox, 1968
Episcada salvinia portilla J. Maza & Lamas, 1978
Pteronymia artena praedicta J. Maza & Lamas, 1982
Pteronymia rufocincta (Salvin, 1869)
Pteronymia simplex timagenes Godman & Salvin, 1889
Greta annette moschion (Godman, 1901)

LYCAENIDAE

Theclinae

Habrodais poodiae J. W. Brown & Faulkner, 1982

Eumaeinae

Micandra tongida Clench, 1971
Laothus erybathis (Hewitson, 1867)
Callophrys dospassosi Clench, 1981
Callophrys estela Clench, 1981

Symbiopsis undescribed species
Ministrymon undescribed species
Erora undescribed species
Thecla semones (Godman & Salvin, 1887)
Ipidecla miadora Dyar, 1916

Polyommatinae

Everes undescribed species
Euphilotes bernardino garthi Mattoni, 1989
Lycaeides melissa mexicana (Clench, 1965)

Riodininae

Euselasia cataleuca (R. Felder, 1869)
Euselasia hypophaea mexicana Lathy, 1926
Euselasia undescribed species
Mesosemia gemina J. Maza & R. G. Maza, 1980
Napaea danforthi A. Warren & Opler, 1999
Rhetus arcius beutelspacheri Llorente, 1987
Calephelis acapulcoensis McAlpine, 1971 «
Calephelis azteca McAlpine, 1971 «
*Calephelis dreisbachi*** McAlpine, 1971 «
Calephelis huasteca McAlpine, 1971 «
Calephelis nemesis bajaensis McAlpine, 1971 «
Calephelis matheri McAlpine, 1971 «
Calephelis mexicana McAlpine, 1971 «
Calephelis montezuma McAlpine, 1971 «
Calephelis perditalis donahuei McAlpine, 1971 «
Calephelis sinaloensis sinaloensis McAlpine, 1971 «
Calephelis sinaloensis nuevoleon McAlpine, 1971 «
Calephelis yautepequensis R. G. Maza & Turrent, 1971
Caria melino Dyar, 1912
Caria stillaticia Dyar, 1912
Exoplisia undescribed species
Melanis cephise huasteca J. White & A. White, 1989
Melanis cephise acroleuca (R. Felder, 1869)
Emesis poeas Godman & Salvin, 1901
Emesis zela zela Butler, 1870
Apodemia hepburni remota Austin, 1991
Apodemia mormo dialeuca Opler & Powell, 1962
Apodemia mormo maxima A. G. Weeks, 1891
Apodemia murphyi Austin, 1988
Apodemia palmerii australis Austin, 1988
[3]***Apodemia phyciodoides*** Barnes & Benjamin, 1924
Apodemia hypoglauca wellingi Ferris, 1985
Adelotypa eudocia (Godman & Salvin, 1897)
Theope villai Beutelspacher, 1981

HESPERIIDAE

Pyrrhopyginae

Chalypyge chalybea chalybea (Scudder, 1872) «
Jonaspyge tzotzili H. A. Freeman, 1969
Melanopyge mulleri (Bell, 1934)
Apyrrothrix araxes araxes (Hewitson, 1867)
Mysoria wilsoni H. A. Freeman, 1969

Pyrginae

Entheus crux Steinhauser, 1989
Epargyreus brodkorbi H. A. Freeman, 1966 (must also occur in GUAT)
Epargyreus deleoni H. A. Freeman, 1977
Typhedanus salas H. A. Freeman, 1977
Typhedanus undescribed species
Zestusa elwesi (Godman & Salvin, 1893)
Zestusa undescribed species
Codatractus cyledis (Dyar, 1912)
Codatractus uvydixa (Dyar, 1914)
Codatractus yucatanus H. A. Freeman, 1977
Ridens mercedes Steinhauser, 1983
Urbanus undescribed species #1
Urbanus dorantes calafia (R. C. Williams, 1926)
Urbanus undescribed species #2
Urbanus viridis H. A. Freeman, 1970
[4]***Autochton pseudocellus*** (Coolidge & Clemence, [1910])
Autochton siermadror Burns, 1984
Thorybes undescribed species
Cephise mexicanus Austin & Mielke, 2000
Cogia aventinus (Godman & Salvin, 1894)
Cogia hippalus peninsularis L. Miller & MacNeill, 1969
Telemiades choricus (Schaus, 1902)
Mimia chiapaensis H. A. Freeman, 1969
Polyctor undescribed species
Myrinia raymundo H. A. Freeman, 1979
Bolla cybele Evans, 1953
Bolla fenestra Steinhauser, 1991
Bolla guerra Evans, 1953
Bolla litus (Dyar, 1912)
Bolla oriza Evans, 1953
Bolla solitaria Steinhauser, 1991
Staphylus undescribed species
Staphylus tepeca (Bell, 1942)
Staphylus tierra Evans, 1953
Zera eboneus (Bell, 1947)
Quadrus francesius H. A. Freeman, 1969
Pythonides mundo H. A. Freeman, 1979
Pythonides rosa Steinhauser, 1989
Zobera albopunctata H. A. Freeman, 1970
Zobera marginata H. A. Freeman, 1979
Zobera oaxaquena Steinhauser, 1991
*Antigonus emorsa*** (R. Felder, 1869)
Antigonus funebris (R. Felder, 1869)
Systasea microsticta Dyar, 1923
Doberes hewitsonius (Reakirt, [1867])
Doberes sobrinus Godman & Salvin, 1895
Anastrus luctuosus Godman & Salvin, 1894
Camptopleura oaxaca H A. Freeman, 1969
Chiomara georgina pelagica (Weeks, 1891)
Erynnis brizo mulleri (Draudt, 1923)
Erynnis mercurius (Dyar, 1926)
Erynnis meridianus fieldi Burns, 1964
Erynnis tristis pattersoni Burns, 1964
Heliopyrgus sublinea Schaus, 1902

Celotes undescribed species

Heteropterinae

Piruna ceracates (Hewitson, 1874)
Piruna cyclosticta (Dyar, 1920)
Piruna dampfi (Bell, 1942)
Piruna gyrans (Plotz, 1884)
Piruna jonka Stainhauser, 1991
Piruna kemneri H. A. Freeman, 1990
Piruna maculata H. A. Freeman, 1970
Piruna microsticta (Godman, 1900)
Piruna millerorum Steinhauser, 1991
Piruna mullinsi H. A. Freeman, 1991
Piruna purepecha A. Warren & Gonzalez, 1998
Piruna roeveri (L. Miller & J. Miller, 1972)
Piruna undescribed species #1
Piruna sina H. A. Freeman, 1970
Piruna undescribed species #2
Dalla bubobon (Dyar, 1921)
Dalla dividuum (Dyar, 1913)
Dalla faula (Godman, 1900)
Dalla kemneri Steinhauser, 1991
Dalla undescribed species
Dalla mentor Evans, 1955
Dalla nubes Steinhauser, 1991
Dalla steinhauseri H. A. Freeman, 1991

Hesperiinae

Synapte silna Evans, 1955
****Synapte syraces*** (Godman, 1901)
Zariaspes mythecus Godman, 1900
Anthoptus macalpinei H. A. Freeman, 1969
Pheraeus covadonga covadonga H. A. Freeman, 1969
Pheraeus covadonga loxicha Steinhauser, 1991
Virga clenchi L. Miller, 1970
Monca jera Godman, 1900
Remella undescribed species
Cobalopsis zetus (Bell, 1942)
Turesis tabascoensis H. A. Freeman, 1979
Thoon wellingi H. A. Freeman, 1969
Enosis matheri H. A. Freeman, 1969
Ebusus ebusus nigrior L. Miller, 1985
Carystoides escalantei H. A. Freeman, 1969
Carystoides abrahami H. A. Freeman, 1969
Carystoides floresi H. A. Freeman, 1969
Carystoides mexicana H. A. Freeman, 1969
Cynea nigricola H. A. Freeman, 1969
Decinea rindgei H. A. Freeman, 1968
Decinea mustea H. A. Freeman, 1979
Oeonus pyste Godman, 1900
Oarisma era Dyar, 1927
Adopaeodes bistriata Godman, 1900
Stinga undescribed species
Hesperia uncas gilberti MacNeill, 1964
Polites norae MacNeill, 1993
Polites pupillus (Plotz, 1883)
Polites puxillius (Mabille, 1891)
Polites sabuleti margaretae L. Miller & MacNeill, 1969
Ochlodes samenta Dyar, 1914
Poanes monticola (Godman, 1900)
"Poanes" benito H. A. Freeman, 1979
Paratrytone aphractoia Dyar, 1914
Paratrytone decepta L. Miller & J. Miller, 1972
Paratrytone kemneri Steinhauser, 1996
Paratrytone undescribed species #1
Paratrytone raspa (Evans, 1955)
Paratrytone undescribed species #2
Paratrytone omiltemensis Steinhauser, 1996
Paratrytone undescribed species #3
Paratrytone pilza Evans, 1955
Paratrytone polyclea Godman, 1900
Paratrytone rhexenor Godman, 1900
Paratrytone undescribed species #4
Quasimellana siblinga Burns, 1994
Quasimellana agnesae (Bell, 1959)
Quasimellana mulleri (Bell, 1942)
"Mellana" gala (Godman, 1900)
Librita heras (Godman, 1900)
Euphyes chamuli H. A. Freeman, 1969 (must also occur in GUAT)
Euphyes canda Steinhauser & Warren, [2002]
Atrytonopsis frappenda (Dyar, 1920)
Atrytonopsis zweifeli H. A. Freeman, 1969
Atrytonopsis undescribed species
Amblyscirtes anubis (Godman, 1900)
Amblyscirtes brocki H. A. Freeman, 1992
Amblyscirtes fimbriata pallida H. A. Freeman, 1993
Amblyscirtes fluonia Godman, 1900
Amblyscirtes folia Godman, 1900
Amblyscirtes novimmaculatus A. Warren, 1998
Amblyscirtes raphaeli H. A. Freeman, 1973
Lerodea similea Bell, 1942 «
Vacerra undescribed species #1
Vacerra gayra (Dyar, 1918)
Vacerra undescribed species #2
Vacerra undescribed species #3
Niconiades comitana H. A. Freeman, 1969
Halotus jonaveriorum Burns, 1992
Aides undescribed species

Megathyminae

Stallingsia smithi (H. H. Druce, 1896)
Stallingsia undescribed species
Stallingsia jacki D. Stallings, Turner, & V. Stallings, 1963
Megathymus beulahae beulahae D. Stallings & Turner, 1958
Megathymus beulahae gayleae D. Stallings, Turner & V. Stallings, 1963
Aegiale hesperiaris (Walker, 1856) (may represent a species complex)
Turnerina mejicanus (Bell, 1938)
Turnerina hazelae (D. Stallings & Turner, 1958)
Agathymus belli (H. A. Freeman, 1955)
Agathymus comstocki (Harbison, 1957)
Agathymus dawsoni Harbison, 1963
Agathymus undescribed species #1

Agathymus undescribed species #2
Agathymus undescribed species #3
Agathymus undescribed species #4
Agathymus escalantei D. Stallings, Turner & V. Stallings, 1966
Agathymus remingtoni (D. Stallings & Turner, 1958)
Agathymus fieldi H. A. Freeman, 1960
Agathymus hoffmanni (H. A. Freeman, 1952)
Agathymus juliae (D. Stallings & Turner, 1958)
Agathymus undescribed species #5
Agathymus undescribed species #6
Agathymus undescribed species #7
Agathymus undescribed species #8
Agathymus micheneri D. Stallings, Turner & V. Stallings, 1961
Agathymus undescribed species #9
Agathymus undescribed species #10
Agathymus undescribed species #11
Agathymus undescribed species #12
Agathymus undescribed species #13
Agathymus rethon (Dyar, 1913)
Agathymus ricei D. Stallings, Turner & V. Stallings, 1966

PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 225–237

HALYOMORPHA HALYS (STÅL) (HETEROPTERA: PENTATOMIDAE): A POLYPHAGOUS PLANT PEST FROM ASIA NEWLY DETECTED IN NORTH AMERICA

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Abstract.—The Asian pentatomid *Halyomorpha halys* (Stål) (Heteroptera) is reported for the first time in North America based on collection of specimens or confirmed sightings in five counties in eastern Pennsylvania. Known in the Asian literature as the yellow-brown or brown marmorated stink bug, *H. halys* is considered a significant horticultural pest in Japan; it has a broad host range that includes plants of economic importance such as pea, soybean, apple, peach, cherry, and various other fruit and ornamental trees. In Japan's northern regions it is regarded as a nuisance pest late in the season when adults aggregate and seek overwintering sites in and around houses and commercial establishments. Descriptions and photographs of the adult and immature stages are provided to help distinguish it from other North American pentatomids. Habits, seasonal history, and host plants, based on the Asian literature and our own observations, are summarized. Photographs of leaf-feeding damage are also provided. *Halyomorpha halys* may have been accidentally introduced with international commerce, i.e., via bulk freight containers from either Japan, Korea, or China.

Key Words: Heteroptera, Pentatomidae, *Halyomorpha halys,* North America, adventive species, Pennsylvania

In late September of 2001, two specimens of a pentatomid stink bug, collected in Allentown, Pennsylvania (Lehigh County), were submitted to the Cornell University Insect Diagnostic Lab by Karen M. Bernhard (KMB), an extension entomologist with the Lehigh County Cooperative Extension office. They proved to be *Halyomorpha halys* (Stål), an Asian species not known previously to occur in North America. Numerous log records of homeowners' inquiries of stink bugs being found in and around homes in the greater Allentown region over the past several years (compiled by KMB) indicate that populations of this exotic stink bug are well established in Lehigh County and to a lesser degree in surrounding counties in eastern Pennsylvania. Further surveys are needed to determine the full geographic range of this introduced plant pest in the eastern United States.

The earliest confirmed U.S. sighting of *H. halys* is from Adams Island (Allentown) in the fall of 1996. We are also aware of stink bug sightings in Allentown in September of 1998 and January of 1999. Since these initial sightings, homeowners of the region have made numerous telephone calls complaining of this bug to the extension office of Lehigh County. After ERH identified the two specimens on October 1, 2001, he joined KMB on October 3 in Allentown to make further observations and to collect additional specimens. On that unseasonably warm day, adults of *H. halys* were extremely numerous on the foundations, outer wall surfaces, eaves, and window and door frames of homes, and sidewalks.

In this paper, we provide the first North American records for *H. halys*; review the literature on seasonal history, habits, economic damage, and host plants; provide notes on our own rearing data; and redescribe and give color photographs of the adult and immature stages that allow it to be distinguished from similar-appearing North American pentatomids.

SYSTEMATICS

Halyomorpha halys (Stål)
(Figs. 1–7)

Pentatoma Halys Stål 1855: 182.

Poecilometis mistus Uhler 1860: 223. Synonymized by Josifov and Kerzhner 1978: 172.

Dalpada brevis Walker 1867: 226. Synonymized by Josifov and Kerzhner 1978: 172.

Dalpada remota Walker 1867: 227. Synonymized by Josifov and Kerzhner 1978: 172.

Halyomorpha picus: auctorum (nec Fabricius 1794: 115).

Halyomorpha halys: Josifov and Kerzhner 1978: 172.

Note.—Josifov and Kerzhner (1978) determined that only one species of *Halyomorpha* is found in Japan, Korea, and eastern China. All citations pertaining to *Halyomorpha* species from these localities should be referred to *H. halys* (Rider et al. in press). There are currently 37 species of *Halyomorpha* recognized, of which 16 are African, 8 are Indian, and 13 are Asian. There is, however, considerable confusion surrounding several species; a generic revision is needed.

Diagnosis.—The only eastern North America pentatomids that resemble *Halyomorpha halys* in overall size (12–17 mm) and its dark "marbled" dorsal coloration are species of the genus *Brochymena* Amyot and Serville (tribe Halyini). Members of *Brochymena,* however, have the juga each with a tooth on the outer side subapically and the pronotum with the anterolateral margins coarsely dentate. By comparison, *H. halys* lacks teeth on the outer juga subapically and the anterolateral margins of the pronotum are not dentate, but entire.

Among members of the tribe Pentatomini *sensu* Rolston and McDonald (1979) (to which *H. halys* belongs; many Old World workers place *Halyomorpha* in the tribe Cappaeini which at present has no known representatives in the New World), only the taxa *Euschistus* Dallas, *Holcostethus* Fieber, and *Thyanta* Stål might be confused with *Halyomorpha. Euschistus* species are recognized by the conspicuous ostiole (of the metathoracic scent gland) usually with a distinct, well-developed auricle (similar to a small earlike or flaplike process or lobe). Also in *Euschistus,* the hind tibiae are distinctly sulcate dorsally throughout their lengths. In *Halyomorpha,* the metathoracic scent gland ostiole is without a developed auricle but has an elongate tapering channel extended beyond the middle of the supporting or evaporative plate, and the hind tibiae are without a dorsal sulcus.

Halyomorpha keys to *Thyanta* in McPherson (1982). *Thyanta* species, however, are generally smaller (7–11 mm) and the dorsal surface is chiefly or entirely green or pale tan (overwintering forms). In Slater and Baranowski (1978), *Halyomorpha* will trace to the genus *Holcostethus*. In *Holcostethus,* the metathoracic scent gland is produced into an elongate tapering channel as in *Halyomorpha.* In contrast, *Holcostethus* is smaller (7–9 mm); has the apices of the juga rounded, converging, and frequently contiguous in front of the tylus; and differs in general shape and coloration. Also in *Halyomorpha*, the connexiva are usually broadly exposed (hemelytra not covering them), revealing the distinctive alternating pattern of black and pale patches. The fourth antennal segment is annulated (pale white) at the base and apex, and the fifth segment is annulated at the base. The venter of the adult (thoracic sterna, abdomen, and leg bases) is distinctly pale luteous.

Redescription.—*Adult* (Fig. 1): Length 12–17 mm.; width across humeral angles 7–10 mm. Variable in color and size. Generally brownish cinereous, but also greyish ochraceous, ochraceous, testaceous, or castaneous, densely and darkly punctate. Head broadly rounded in front, surface densely punctured with black, lateral margins narrowly reflexed and slightly sinuate, tylus and juga nearly equal in length (tylus perhaps slightly longer); eye large, sessile; rostrum reaching second abdominal segment. Head, anterior and lateral areas of pronotum more or less heavily punctured with black, coarse punctures; basal angles of scutellum pale luteous or yellow, without punctures. Hemelytra mottled with brown, densely punctured, slightly tinged with reddish on apex of corium, apical membrane yellowish hyaline, with veins marked with dark brown. Body beneath and legs generally pale luteous; lateral areas of head, prosternum, and abdominal sterna more or less densely punctured; punctures black to somewhat metallic green. Legs pale reddish yellow; sparsely pubescent; distal half of femora and most of tibiae densely punctured with black.

Detailed line drawings of eggs and all nymphal instars of *H. halys* are available in Kobayashi (1956, 1967) and Hoffmann (1931). The following key to instars and nymphal measurements and descriptions are taken, in part, from Kobayashi (1956, 1967).

KEY TO INSTARS OF *HALYOMORPHA HALYS*

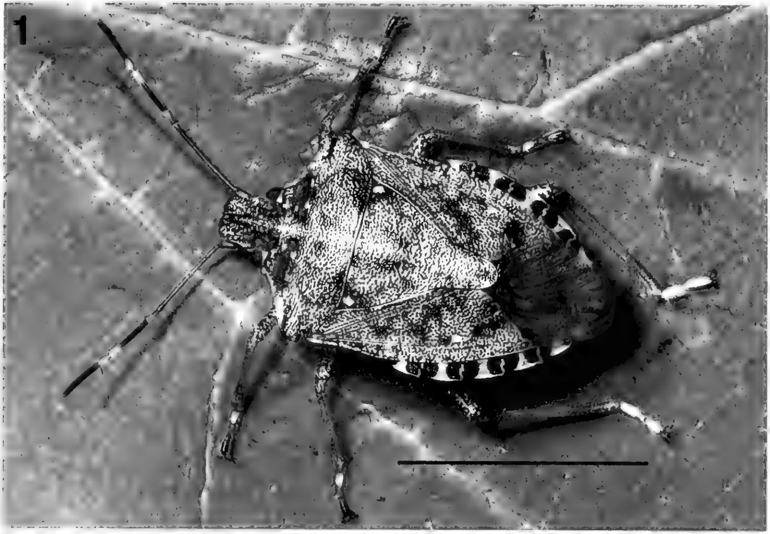
1. Anterior wing pads not developed (Figs. 3–5) 2
– Anterior wing pads well-developed (Figs. 6–7) 4
2. Middle of each tibia without a white band (Figs. 3–4) 3
– Middle of each tibia with a white band (Fig. 5) . . . . Third instar
3. Eyes not projecting (Fig. 3) . . . . First instar
– Eyes spherically projecting (Fig. 4) . . . . Second instar
4. Posterior wing pads not developed (Fig. 6) . . . . Fourth instar
– Posterior wing pads conspicuously developed (Fig. 7) . . . . Fifth instar

Egg and egg cluster (Fig. 2): Length approximately 1.6 mm, diameter 1.3 mm, elliptical, chorion whitish with fine reticulation with minute spines. Micropylar projections 30–32, capitate, white. Egg burster chitinized, blackish, T-shaped. Egg cluster consisting generally of 20–30 eggs, arranged more or less regularly.

First instar (Fig. 3): Length approximately 2.4 mm. Body elliptical, not depressed. Head roundish, triangular. Head, thorax, dorsal plates, connexiva, and legs black, except lateral portions of each thoracic tergum and each connexivum subhyaline or pale. Abdomen mostly yellowish red. Eye darkish red. Antenna reddish black.

Second instar (Fig. 4): Length approximately 3.7 mm. Body egg-shaped, more or less depressed. Head rectangular, with pair of hornlike projections in front of eyes. Head, thorax, dorsal plates, and connexiva mostly black, except lateral portions of each thoracic tergum and each connexivum subhyaline. Abdomen whitish with reddish spots and reddish junctions. Eye reddish black. Antenna reddish black except apical portion of third antennomere white. Legs blackish brown. Body above with large scattered punctures.

Third instar (Fig. 5): Length approximately 5.5 mm. Body pear-shaped, rather depressed. Head rectangular, with pair of hornlike projections in front of eyes. Head, thorax, dorsal plates, and connexiva mostly brownish black, except apical portion of median lobe near inner margins of lateral lobes, anterior portion of head in front of eyes, middle and some spots on thorax, lateral portions of anterior half of pronotum, middle of mesonotum and entire metano-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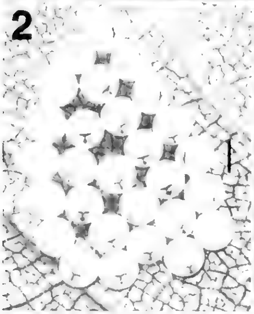
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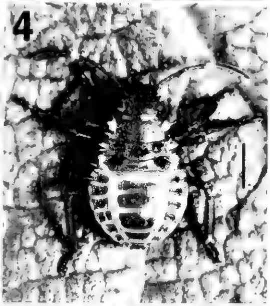
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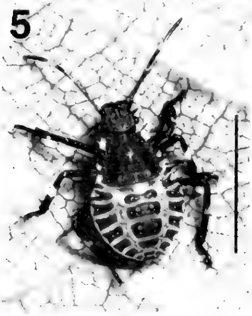
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tum, anterior portions of orifices of scent glands and middle portions of connexiva mostly yellowish brown. Abdomen whitish with reddish spots and junctions. Eye and antenna colored as in second instar. Legs blackish brown, except bases of femora and middle of tibiae white.

Fourth instar (Fig. 6): Length approximately 8.5 mm. Body as in previous instar, pear-shaped, rather depressed. Coloration of body almost same as third instar. Antenna reddish black, except apex of third antennomere and base of fourth antennomere yellowish white. Femora brown, scattered with black spots, except bases yellowish white. Tibiae and tarsi blackish brown except middle of each tibia yellowish white. Purplish black, shallow depression on inner surface of each connexivum at middle.

Fifth instar (Fig. 7): Length approximately 12 mm. Body as in previous instar, pear-shaped, rather depressed. Head, thorax, dorsal plates, and connexiva mostly brownish black with metallic luster, except some spots on head and thorax yellowish and some yellowish white spots on connexiva. Anterior half of anterolateral margins of pronotum, lateral margins of mesonotum and middle of lateral margins of connexiva all whitish subhyaline. Abdomen luteous-white, with dense covering of black, metallic punctures, reddish junctions, and reddish spots. Eye reddish black. Antenna black, except apex of third and base of fourth antennomeres whitish. Femora mottled blackish brown, bases whitish. Tibiae and tarsi mostly brown, except middle of tibiae white and apices of tarsi black.

Thoracic sterna, including leg bases (coxae, trochanters, and basal areas of femora) and abdominal venter of all instars, particularly the fifth (Fig. 8), whitish, sharply contrasting with darker lateral margins of thorax and abdomen.

Fig. 8. Fifth-instar nymph of *Halyomorpha halys*, ventral aspect. Scale line = 5 mm.

SUMMARY OF BIONOMICS AND HABITS

Aspects of the seasonal history, ecology, and developmental stages of *H. halys* (often cited as *H. picus*, *H. brevis*, or *H. mista* in the Asian literature) have been reported by Nozu and Sonoyama (1924), Suzuki (1924), Shizuoka Agricultural Experiment Station (1925), Takahashi (1930), Hoffmann (1931), Abe and Mori (1942), Fukuda and Kitajima (1956), Kobayashi (1956, 1967, 1981), Saito et al. (1964), Yanagi and Hagihara (1980), Fujiie (1984, 1985), Kawada and Kitamura (1983a, b), and Chu and Zhou (1997).

Overwintered adults emerge from their

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Figs. 1–7. *Halyomorpha halys*. 1, Adult. 2, Egg cluster. 3, First-instar nymphs. 4, Second-instar nymph. 5, Third-instar nymph. 6, Fourth-instar nymph. 7, Fifth-instar nymph. Scale line for Fig. 1 = 10 mm; for Figs. 2–4 = 1 mm; for Figs. 5–7 = 5 mm.

hibernation sites in early spring (probably by early to mid-April). Mating and egg laying do not commence until about two weeks after adults emerge from overwintering sites. Under laboratory conditions, adults require 14–15 days from imaginal ecdysis to become sexually mature (Kawada and Kitamura 1983b). Sexually mature females usually mate on multiple occasions, as many as five times per day (Kawada and Kitamura 1983b). A female, mated only once, can lay eggs for nearly half her life span, but fecundity decreases in proportion to her age. The period of laying fertile eggs and fecundity increase with multiple copulations. Females deposit eggs on the lower leaf surfaces of host plants from May to late August. Egg clusters commonly contain 20 to 30 eggs, which hatch 4–5 days after deposition. As with other pentatomids, *H. halys* has five nymphal instars (Kawada and Kitamura 1983b).

Emerging adults of the first generation are generally observed in early to mid-August. Adults are most numerous in early August in parts of Korea (Chung et al. 1995). In Tsukuba, Japan (Ibaraki Prefecture), first generation adults are not found until early to mid-September. Light trap records in Japan, from 1978 to 1986, indicate a single peak occurrence in most years from late July to early August (cited as *H. mista*) (Moriya et al. 1987). In the Allentown area (Lower Macungie Twp., The Rodale Working Tree Center), fifth-instar nymphs and teneral adults were common on foliage on August 23, 2002 (Gary Bernon, in litt.).

Only one generation is produced annually throughout most of the native range, but 1–2 generations have been reported (as *H. picus*) for central and southern Hebei Province, China (Zhang et al. 1993). Zhang et al. (1993) also noted that overwintered adults, with an average life span of 301 days, emerged from their overwintering sites from early April to mid-June. New generation adults seek overwintering sites from late August to late October. Hoffmann (1931) also reported multiple annual generations in south China, near Canton. He noted that the first generation is completed before the middle of June, and that there are at least four, and possibly six, annual generations. There, eggs have been observed at the end of September and nymphs as late as mid-October.

Duration of immature stages.—Nymphal development of *H. halys* apparently varies significantly depending on the location in Asia. For example, near Canton in south China, nymphs (cited as *H. picus*) developed to the adult stage in as little as 27 days (Hoffmann 1931). In another laboratory study (Kadosawa and Santa 1981), nymphal development ranged from 29 to 54 days on soybean seed. In two separate rearing trials conducted in 1963 in the mountainous areas of the Tohoku districts in Japan, Saito et al. (1964) found that when eggs of *H. halys* (also cited as *H. picus*) were laid in midsummer (July 11), presumably by overwintered females, adults appeared by August 19 (40 days for complete development from egg through five instars to adult). When eggs were laid in late summer (August 3), adults did not appear until October 3 (62 days for complete development). Developmental times from egg hatch through five instars in midsummer in the mountains of Japan's Tohoku districts were as follows: egg (6 d), instar I (5 d), instar II (6–7 d), instar III (7–9 d), instar IV (6–8 d), and instar V (7–10 d). For eggs deposited later in the summer (August 3), developmental times increased moderately, particularly for fourth and fifth instars: eggs (5 d), instar I (4 d), instar II (7–11 d), instar III (7–11 d), instar IV (15–19 d), and instar V (16–22 d) (Saito et al. 1964).

One of us (MEC) reared *H. halys* in captivity [at room temperature (20–22°C) and natural photoperiod (June–July)] to gain information on numbers of eggs in an egg cluster and on developmental times for the immature stages (beginning with 10 overwintered adults collected in Allentown on June 6, 2002). Egg clusters (n = 5; range of number of eggs/cluster = 25–28, mean

= 26.8) were placed individually in small plastic boxes and supplied with cut stems (in aquapics) of leaves and fruits of common chokecherry (*Prunus virginiana* L.) and changed every few days. Individuals from these five egg clusters were reared to adults. Our observations do not vary significantly from those reported in the Japanese literature, especially from localities in northern Japan. Developmental times were as follows: egg (5–9 d, mean = 7.2), instar I (4–6 d, mean = 5.4), instar II (5–9 d, mean = 7.2), instar III (5–8 d, mean = 6), instar IV (5–7 d, mean = 6.2), and instar V (9–11 d, mean = 10.25).

HOST PLANTS AND FEEDING DAMAGE

Halyomorpha halys is a polyphagous horticultural pest of some importance in Japan and elsewhere in its geographic range (Panizzi et al. 2000). In Japan, it severely injures various shade and fruit trees, vegetables, pulses, and leguminous crops (Kobayashi 1967). In southern China, adults and nymphs cause considerable damage to flowers, stems, and pods of various beans, and also feed on flowers of *Hibiscus rosa-sinensis* L., stems of *Celosia argentea* L., and fruits of *Solanum nigrum* L. and *Basella rubra* L. (Hoffmann 1931). Host plants of economic significance include *Citrus* (citrus), *Diospyros kaki* L. (persimmon), *Ficus* (fig), *Glycine max* Merrill (soybean), *Malus domestica* L. (apple), *Morus* (mulberry), *Paulownia* spp. (paulownia), *Prunus avium* L. (cherry), *P. mume* Siebold and Zuccarini (ume, Japanese apricot), *P. persica* Batsch (peach), *Pyrus pyrifolia* Nakai (pear), and reportedly some weeds (including *Arctium* spp.) (Shiraki 1952; JPPS 1966; Fujiie 1984; Yoshii and Yokoi 1984; Yuan 1984; Yasunaga et al. 1993; Chung et al. 1995; Funayama 1996, 2002; Watanabe 1996; Chu and Zhou 1997). Adults generally feed on fruit, whereas nymphs feed on leaves, stems, and fruits.

Halyomorpha halys is one of approximately 50 insects that are considered major pests of various leguminous crops, and particularly soybean, in Japan (Kadosawa and Santa 1981, Kobayashi 1981, Kobayashi et al. 1972, Kobayashi and Oku 1976), Korea (Son et al. 2000), and China (Hoffmann 1931). Adults and nymphs of *H. halys* can cause serious yield loss by sucking sap from soybean seeds (Kadosawa and Santa 1981). The most serious damage to tree fruit (persimmon, for example) is observed from late August to late October in Korea (Chung et al. 1995). In Japan, most adult feeding damage to 'Fuji' apples is from early to mid-August, with the fruit most susceptible to sucking (stylet) injury during the thickening period; the actual feeding injury appears as pitting and discoloration of the flesh (Funayama 1996). In non-astringent persimmon orchards in Korea, severe feeding symptoms by *H. halys* include physical changes of the fruit, such as concaving of the surface or its becoming dark blue in a "bull's-eye" configuration and the flesh becoming soft and "spongy" (Chung et al. 1995).

Paulownia, which includes six species of deciduous trees native to China, is also a host for *H. halys* and it too can be severely affected by this stink bug. Species of this plant genus (at least two species are naturalized in the United States) have been planted as superior trees for more than 2000 years in eastern Asia. *Paulownia* species are highly suitable and popular as intercropping species in modern agroforestry and are used commonly for urban shelterbelts due to their rapid growth and attractive high-canopy formation (Hiruki 1999). Paulownia witches' broom, one of the mycoplasma diseases, is vectored or disseminated primarily by *H. halys* (Jin et al. 1981, Zhu et al. 1982). Paulownia witches' broom can greatly reduce the growth and vigor of trees, their severe decline causing premature death (Shiozawa and Tsuchizaki 1992). In Japan, this disease represents a serious threat to the production of paulownia (*P. tomentosa* Steudel) timber, which is much used in the Orient for cabinet wood.

To determine host plant preferences and

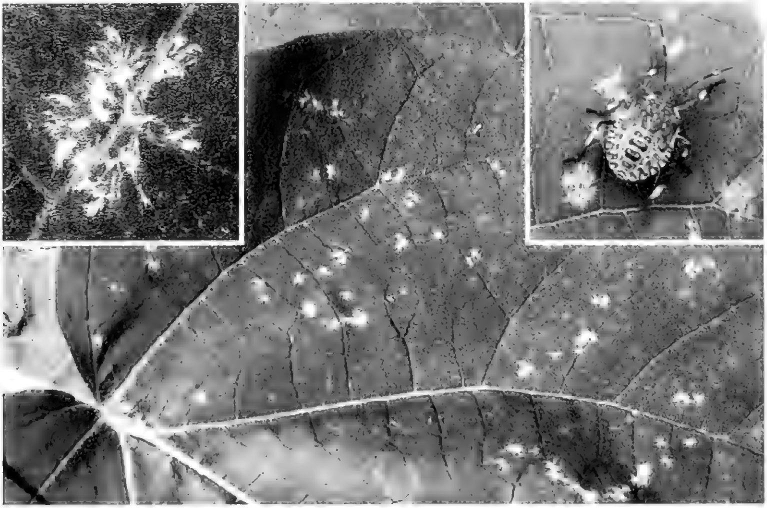

Fig. 9. Feeding damage to *Paulownia* leaf (*Paulownia tomentosa*) by *Halyomorpha halys*. Upper left insert: magnification of leaf damage at feeding site; upper right insert: fifth-instar nymph feeding.

feeding damage potential in North America, periodic surveys were conducted throughout the greater Allentown area in the spring and summer of 2002 by KMB and James F. Stimmel (Pennsylania Dept. of Agriculture, Harrisburg) (JFS, personal commumunciation). In late May and early June, adults (presumably overwintered) were beaten from the foliage of various trees and shrubs, including honeysuckle (*Lonicera* sp.), walnut (*Juglans* sp.), shadbush (*Amelanchier* sp.), butterfly-bush (*Buddleia* sp.), paulownia (*Paulownia tomentosa*), persimmon, and maples (*Acer* spp.). By early to mid-July, nymphs of several instars were beaten from some of the same foliage, as well as from basswood (*Tilia* sp.) and catalpa (*Catalpa* sp.) seedlings (KMB, personal communication). According to JFS (personal communication), fourth- and fifth-instar nymphs were abundant on persimmon and paulownia foliage at the Rodale Working Tree Center in the western part of Allentown. Nearby, at a private residence, a large population (perhaps hundreds) of nymphs, mostly fourth instars, were observed on a small and isolated group of butterfly-bushes (*Buddleia*). The nymphs fed on the leaves of *Buddleia* and *Paulownia*. Feeding damage on these hosts appeared as "stippled" areas, roughly circular and one-eighth inch in diameter. Under magnification, this "stippled" area is seen to consist of areas where the plant cells have been depleted in a "crow's-foot" pattern (see Fig. 9). As injury progresses, the previously "stippled" areas become brown and scablike.

STATUS AS A NUISANCE PEST

In Asia, *H. halys* overwinters as adults and aggregates, sometimes in large numbers, on the outside of buildings when it is seeking hibernation sites in the fall (Kobayashi and Kimura 1969). The invasion of homes, commercial establishments, and schools makes this stink bug a very serious nuisance pest in Japan (Inaoka et al. 1993, Watanabe et al. 1994a, b). The flight of *H.*

halys to wall surfaces of buildings starts at the end of September and peaks around the third week in October. Adult flight ceases by the end of November.

Similar aggregation and flight behavior have been observed in Pennsylvania for *H. halys* in residential areas in the fall of 2001. Wherever *H. halys* becomes established in the United States, it likely will become a serious household nuisance in a manner similar to the western conifer seed bug, *Leptoglossus occidentalis* Heidemann; the boxelder bug, *Boisea trivittata* (Say); and the multicolored Asian lady beetle, *Harmonia axyridis* (Pallas) (Mallis 1997).

DISTRIBUTION

Halyomorpha halys is reported from Japan (Honshu, Shikoku, Kyushu), Korea, China (Anhui, Hebei, Heilongjiang, Henan, Jiangsu, Jilin, Liaoning, Neu Monggol, Shaanxi, Shanxi, Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan, Xizang, and Yunnan), and Taiwan (Kobayashi 1967; Rider et al. in press).

Pennsylvania (Fig. 10), with 5 confirmed counties (Bucks, Lehigh, Monroe, Northampton, and Pike) to date, is a new record for the United States and the Western Hemisphere. Confirmed sightings, based on credible descriptions provided by homeowners and, in some cases, specimens provided, validate the establishment of *H. halys* in numerous communities in and around the Allentown/Bethlehem area, and from surrounding counties. These include: *Pike Co.:* Peck's Pond. *Monroe Co.:* Saylorsburg, Swiftwater. *Northampton Co.:* Northampton, Easton. *Lehigh Co.:* Orefield, Allentown/Bethlehem (including the following areas: Adams Island, Butztown, Catasauqua, Coopersburg, Coplay, Center Valley, Cetronia, Dorneyville, East Texas, Emmaus, Freemansburg, Fountain Hill, Greenawalds, Hellertown, Lanark, Macungie, Neffs, Springhouse Farms, Stiles, Walnutport, West Catasauqua, Westgate Hills, Whitehall, and Zionsville). These records are not listed below under "Material examined," but are mapped in Fig. 10.

Material examined.—All in the Cornell University Insect Collection (CUIC), Ithaca, NY, except as noted. PENNSYLVANIA: *Bucks Co.:* Perkasie, 26 January 2002, R. Miller [1]. *Lehigh Co.:* Allentown, Albright Avenue (private residence), 21st Street (apartment complex), 3 October 2001, ERH and KMB [27, including 4, National Museum of Natural History (Washington, DC); 2, North Dakota State University (Fargo); 2, Florida State Collection of Arthropods (Gainesville)]; Girard Avenue (private residence), 3 October 2001, S. Yoder, coll. [4]; Muhlenberg College campus and Trexler Memorial Park, 6 June 2002, ERH [10].

INTERCEPTIONS AT PORTS-OF-ENTRY

North American interceptions of this exotic stink bug have been infrequent. For the period 1973–1987, only two interceptions of a species of *Halyomorpha* at U.S. ports-of-entry were recorded in the USDA's "List of Intercepted Plant Pests"; both were identified as *Halyomorpha picus* (probably *H. halys*). One was intercepted in an aircraft from Japan in 1983 and the other in baggage from Korea in 1984. For 1989 to 1998, the USDA-APHIS's Port Information Network (PIN) database lists eight interceptions of *Halyomorpha* from China, Korea, or Japan from aircraft, machinery and woodenware crating, machinery crating and miscellaneous cargo, and tractor soil (Peter Touhey, personal communication).

Established populations of *H. halys* that were found in eastern Pennsylvania might have originated from aggregations of overwintering adults that were accidentally introduced with international commerce, i.e., via bulk freight containers from Japan, Korea, or China.

ACKNOWLEDGMENTS

We thank Karen M. Bernhard (Lehigh County Cooperative Extension, Allentown, PA), James F. Stimmel (Pennsylvania De-

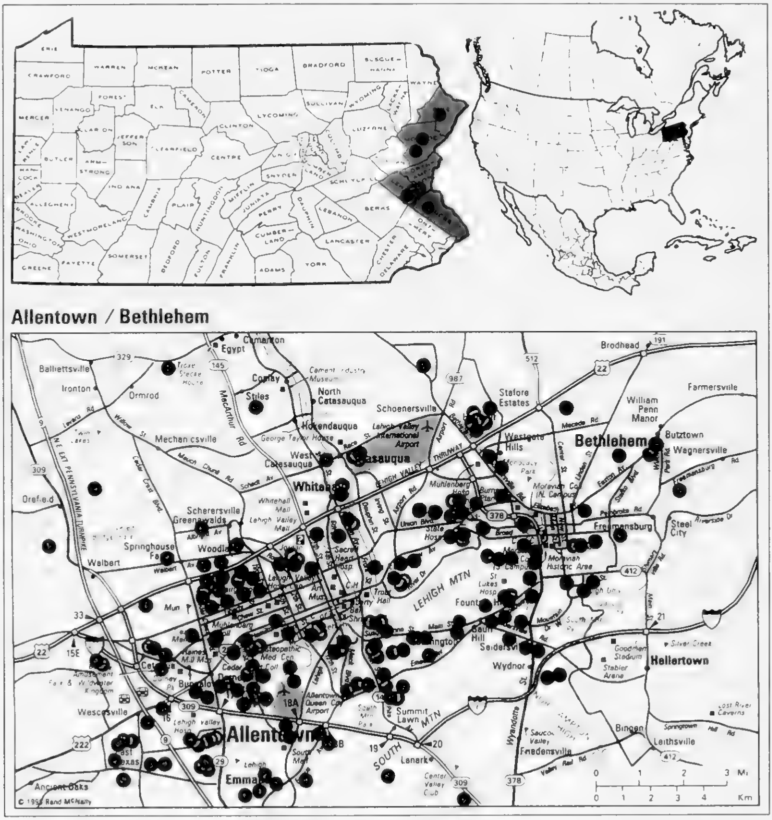

Fig. 10. County distribution of *Halyomorpha halys* in eastern Pennsylvania (upper left). Confirmed sightings of *H. halys* in the greater Allentown/Bethlehem area (bottom).

partment of Agriculture, Harrisburg), and Gary Bernon (USDA-APHIS, Otis ANGB, MA) for sharing with us their field observations on host plant records and feeding damage in the Allentown area; David A. Rider (North Dakota State University) for sharing information from his unpublished catalogue of world Pentatomidae on the synonymy of *H. halys*; Toshio Shono (Cornell University) for providing some English translation of Japanese; Robert A. Schall (USDA-APHIS-PPQ) for assisting in finding literature references on *H. halys*; Peter Touhey (Systematic Entomology Laboratory, USDA-ARS, Beltsville, MD) for sharing interception data; Kent Loeffler (Cornell University) for providing the photographs used in Figs. 1–8 and for facilitating the figure reproductions; and A. G. Wheeler, Jr. (Clemson University) and D. A. Rider for reviewing and giving critical comments on a draft of the manuscript. We are in-

debted to J. Stimmel for providing the digital images used in Fig. 9 and to him and K. Bernhard for also reviewing a draft of the paper.

This research was supported by the Cornell University Agricultural Experiment Station federal formula funds, Project No. NYC-139413 to ERH, received from Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

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Note added in proof.—In late August 2002, specimens of *H. halys* were retrieved from light traps in Phillipsburg (Warren Co.) and Little York (Hunterdon Co.), New Jersey that were operated by Rutgers University Cooperative Extension (Barry Emens, USDA-APHIS-PPQ, Trenton, NJ, personal communication). These collections represent a new state record for New Jersey.

While conducting a delimiting survey near Allentown, Pennsylvania, James Stimmel, Gary Bernon, and ERH collected *H. halys* at Stewartsville (Warren Co.), New Jersey on October 2, 2002, and at Mertztown (Berks Co.), Pennsylvania on October 3, 2002. Berks County is a new county record for Pennsylvania.

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NOTE

A New Species of the Asian Predaceous Midge Genus *Pseudostilobezza* Wirth and Ratanaworabhan (Diptera: Ceratopogonidae) from Hainan, China

Pseudostilobezza Wirth and Ratanaworabhan of the predaceous midge tribe Ceratopogonini was proposed for the type species from Vietnam, *P. macclurei* (Wirth and Ratanaworabhan 1973). The following new species from Hainan Island is only the second known species of the genus and the first record of the genus from China.

For an explanation of ceratopogonid terminology, see Tokunaga and Murachi (1959) and Das Gupta and Wirth (1968); for terms of the tribe Ceratopogonini, see Wirth and Grogan (1988).

Pseudostilobezzia wirthi Yu and Yan, new species
(Figs. 1–8)

Diagnosis.—The female is distinguished from that of the only other species in the genus, *P. macclurei*, by the presence of macrotrichia at apex of the wing, the costa produced beyond the end of R_{4+5}, and segment 3 of the palpus without a sensory pit.

Female.—Wing length, 1.32 mm, wing breadth, 0.44 mm. *Head:* Dark brown including antenna and palpus. Eyes separated by space equal to diameter of 1 facet, with interfacetal pubescence (Fig. 3). Antenna with lengths of flagellomeres in proportion of 34:19:18:17:20:20:22:23:34:32:34:34:38; antennal ratio 0.99 (Fig. 2). Palpal segments with lengths in proportion of 8:17:16:10:15; third segment with length to breadth ratio of 3.4, without sensory pit but with several elongate sensilla on mesal surface of distal portion (Fig. 4). Clypeus (Fig. 5) shield-shaped, with row of 4 dorsal setae and ventral row of 2 setae. Mandible with 7 well-developed teeth (Fig. 6). *Thorax:* Dark brown; scutum with sparse, fine, hair-like setae; scutellum with 4 bristles. Wing membrane (Fig. 1) covered with distinct microtrichia, macrotrichia present at wing tip. Costa produced beyond R_{4+5} and slightly curved; costal ratio 0.85. Two well-developed radial cells, second about 1.5× longer than first. Legs with femora and tibiae brownish; hind tibial comb with 7 spines; claws large and subequal on foreleg, small and equal on mid- and hind legs (Fig. 8); tarsal ratio of fore-, mid-, and hind legs 2.66, 4.06, 2.94. *Abdomen:* Brown. Spermathecae (Fig. 7) elongate, oval, unequal, largest measuring 0.083 mm × 0.038 mm, plus a small, round rudimentary third.

Male.—Unknown.

Holotype.—Female, Qionzhong, Hainan Province, China, 13-III-1995. Deposited in the Medical Entomology Collection Gallery, Beijing 100071, China.

Etymology.—Named for the late Dr. W. W. Wirth, in recognition of his important contributions to the study of world Ceratopogonidae.

Discussion.—This new species is very similar to *P. macclurei*; however, *P. macclurei* differs from *P. wirthi* by the lack of macrotrichia on the wing tip, the first radial cell much shorter than the second, the costa not produced beyond R_{4+5}, and palpal segment 3 with a small sensory pit.

Acknowledgments.—We are grateful to Art Borkent, Enderby, British Columbia, Canada, and William L. Grogan, Jr., Salisbury University, Salisbury, MD, U.S.A., for reviewing earlier drafts of the manuscript.

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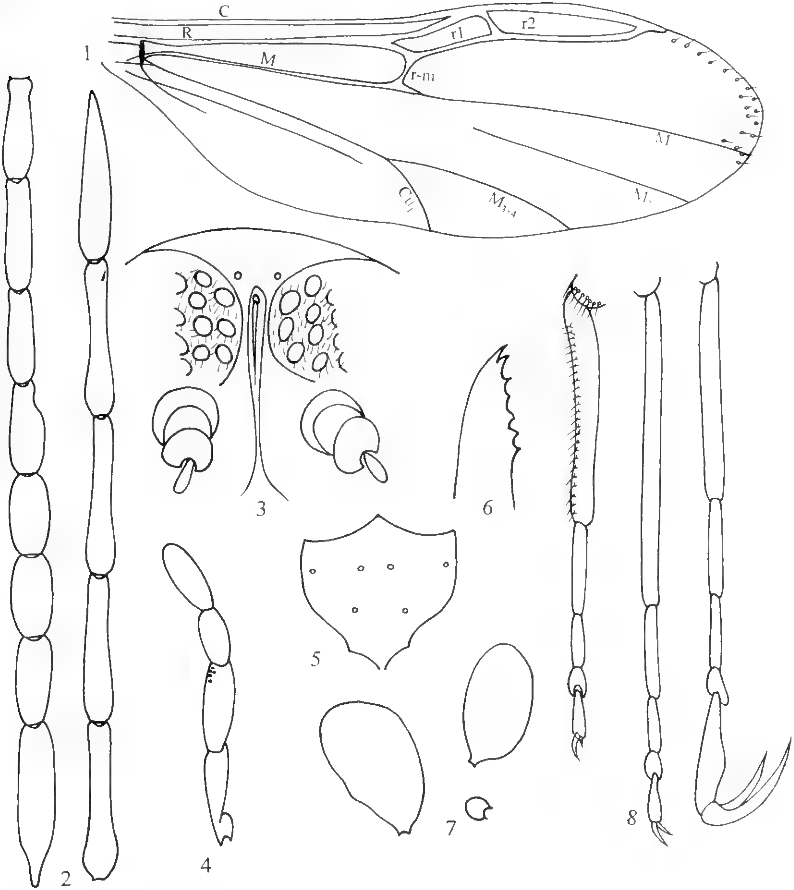

Figs. 1–8. *Pseudostilobezzia wirthi.* 1, Wing. 2, Antennal flagellum. 3, Interocular space. 4, Palpus. 5, Clypeus. 6, Mandible. 7, Spermathecae. 8, Tarsi and claws of fore-, mid-, and hind legs (right to left).

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PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 240–242

NOTE

First report of Epitraninae (Hymenoptera: Chalcididae) in the Nearctic

The subfamily Epitraninae contains the single genus *Epitranus* Walker, which includes 64 described species (Noyes 2001). Bouček (1988) summarized the world distribution of the genus as Africa, South Asia, and Australia, and considered the subfamily endemic to the Old World (Bouček 1992). He reported, however, that *Epitranus clavatus* Fabricius had been found in the New World on several occasions. It was described from Guyana (Fabricius 1804) and subsequently reported from St. Vincent (Walker 1834) and Brazil (Ashmead 1904) as *E. fulvescens* Walker, and from Hawaii as *E. lacteipennis* Cameron (1883), with both names subsequently synonymized under *E. clavatus* (Bouček 1982). This species also occurs in India, Malaysia, Taiwan, and Seychelles (Bouček 1982). Based on the distribution of known species of *Epitranus*, Bouček (1982) suggested that the presence of *Epitranus clavatus* in the New World was the result of multiple introductions from the Old World into ". . . parts of tropical America before effective quarantine measures were introduced." *Epitranus castaneus* Cresson (1865) was described from Cuba, but because no one has examined its type, Bouček (1982) suggested that it might also be a synonym of *E. clavatus*. Burks (1936) suggested that the genus *Epitranus* might eventually be found in Florida based on the proximity of *E. fulvescens* in St. Vincent and *E. castaneus* in Cuba.

In this note we report the first record of *Epitranus clavatus* (Fig. 1) as well as the subfamily Epitraninae (Chalcididae) in the Nearctic Region. A single female specimen was collected with the following information: USA, West Virginia, Hardy County, 3 miles NE Mathias, 38°55′N, 78°49′W, 17.V–3.VI-2002, ca. 2,200′ elevation, Malaise trap, D. R. Smith. The trap was set in disturbed areas within an eastern deciduous forest that is interspersed with relatively distantly-spaced "weekend" cabins.

Our identification of *Epitranus clavatus* was based on the key in Bouček (1982) and on voucher specimens in the National Collection of Natural History, Washington, D.C. identified by B. D. Burks. It is a member of the *clavatus*-group, including only one other taxon, *E. ramnathi* (Mani and Dubey). The species can be identified based upon the following set of characters: The marginal vein is distinct and the forewing pilosity is sparse and virtually absent beneath the vein; the propodeum is matte (not shiny) with granulate sculpture and has a distinct median cell delimited by two submedian carinae; the metafemur has fewer than 15 teeth and a distinct subbasal tooth (or angle); the tarsal sulcus of the metatibia is traversed for its entire length by an oblique carina; and the metasomal petiole is 3 (female) to 4 (male) times as long as broad.

Several factors are remarkable about this discovery. All known specimens of New World *E. clavatus* were collected before 1901 (Bouček 1992), thus the specimen discovered in West Virginia represents the first reported in over one hundred years from the New World—as well as the only specimen from the Nearctic. It is the only specimen from thousands of Chalcidoidea collected and examined from 20–21 Malaise traps run in the area each year for 3 years. Thus, the species does not appear to be common either locally or temporally. Finally, its discovery in a sparsely populated area, miles from any port of entry, suggests that the species is more widely distributed than this single record indicates.

Host records are known for only a few species of *Epitranus*; generally they are

Fig. 1. *Epitranus clavatus*, female, habitus

larval or pupal parasitoids of Pyralidae and Tineidae (Lepidoptera), some of which develop in stored products, and one species was reportedly reared from a *Camponotus* nest (Formicidae) (Bouček 1992). *Epitranus clavatus* has been reared from the pupa of a "case bearing cotton moth" (in India) and from *Tinea palaechrysis* Meyrick or *Crypsithyris* sp. in Malaysia (Bouček 1982). According to Don Davis (personal communication), both moth genera are closely related and have a wide range of hosts including stored cotton and fabrics. It is likely that *E. clavatus* is transported via its moth host in shipping bags, clothing, and carpeting all made from natural fibers.

We thank Don Davis, Department of Entomology, Smithsonian Institution, for information pertaining to the hosts of *Epitranus clavatus*; T. Henry and M. Gates, Systematic Entomology Laboratory, and Gary Gibson, Agriculture and Agri-Food Canada, for reviewing the manuscript; Cathy Apgar and Terry Nuhn, Systematic Entomology Laboratory, the former for producing the photograph (Fig. 1) and the latter for preparing the specimen; and the following individuals who allowed placement of traps on their property in Hardy County, West Virginia: R. Gordon, R. Gray, S. Henderson, T. and K. Henry, D. and J. Miller, G. Wood, and N. Booth.

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NOTE

Discovery of *Monodontomerus osmiae* Kamijo (Hymenoptera: Torymidae) in the New World

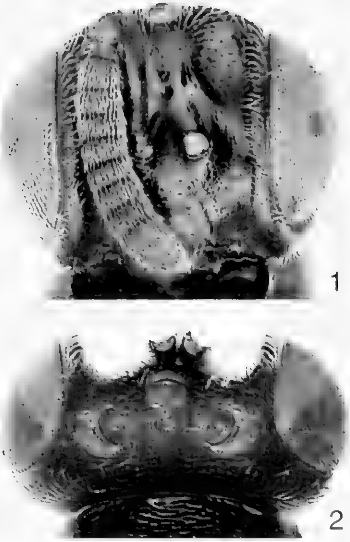
Monodontomerus osmiae Kamijo is a gregarious ectoparasitoid of megachilid bees. It was first discovered and named in Japan where it was reared from *Osmia taurus* Smith and *O. excavata* Alfken (Kamijo 1963). Subsequently it was reared from *O. cornifrons* Radoszkowski in Japan (Kamijo 1965). Since then it has been reported only from the "Russian Far East" (ex *Osmia taurus*) by Zerova and Romasenko (1986), who keyed and figured the species in a paper on the parasitoids of megachilid bees in the former USSR. Zerova and Seryogina (2002) reviewed the entire Old World fauna of *Monodontomerus* but added no additional information; they did include *M. osmiae* in a key to the known species of that region.

I recently discovered *Monodontomerus osmiae* attacking *Osmia* spp. nesting in straw bundles set out in my Silver Spring, Maryland, garden (39.076°N, 77.002°W). This is the first report of the parasitoid in the New World. A bundle of 88 paper nesting straws ($\frac{5}{16}'' \times 8''$) was placed in a 39 ounce coffee can and set out in the spring of 2001 under the protection of an overhang on the north side of my house. The straws and can were oriented horizontally and placed on a ledge about 5 feet above ground. In spring of 2001 many of the straws were used by several species of *Osmia* and *Megachile*. A few adult bees were collected to determine the genera involved, but no attempt was made to determine the species. These straws overwintered outside, and in April and May of 2002 the same set of straws were reused, this time entirely by *Osmia* (based on the entrance plugs all being made of mud).

In early to mid-June, 2002, large numbers of *Monodontomerus* were seen flying about the area and landing on the exposed outer edges of the straws. Adults were seen entering the interstices between straws, but no observations of oviposition were made. One collection of adult wasps was made in mid-June by aspirating specimens from the straw surfaces and by sweeping the air space near the nests and aspirating the resultant catches. These specimens were placed in alcohol but not identified until July 15. They consisted of two species: *M. osmiae* (20 females) and *M. obscurus* Westwood (21 females, 7 males). Another collection was made on 10 July. This consisted of 17 females and 1 male of *M. osmiae* and 116 females and 32 males of *M. obscurus*. These two random samples and the specimens collected represented only a small portion of the total specimens seen flying around the nest site. They were collected in an attempt to reduce parasitism rates on the nesting *Osmia* and to determine which of the common local species of *Monodontomerus* were attacking the bees.

When all specimens were identified in mid-July, and *M. osmiae* was detected, an attempt was made to collect additional parasitoids at the nest site, but the numbers of specimens had fallen off. On 21 July, 4 females and 7 males of the common species *M. aeneus* (Fonscolombe) were collected. On 30 July, 2 females of *M. osmiae* were collected as well as 5 females and 4 males of *M. aeneus*. On 1 August, the straws were placed in a plastic rearing box and brought indoors. Between 5–23 August, 33 females and 12 males of *M. aeneus* emerged. By 1 September emergence stopped and the straws were placed in the freezer. No specimens of *M. osmiae* were actually reared from the straws.

The New World species of *Monodontomerus* were revised by Grissell (2000), who



Figs. 1–2. *Monodontomerus osmiae*, male head. 1, Face. 2, Dorsum, antennae removed.

examined over 5,000 specimens, reared mostly from solitary bees. A large number of specimens were reared from areas in Maryland, and no *M. osmiae* were found up to that time. *Monodontomerus* species are generally difficult to identify, but *M. osmiae* is unusually distinct, especially in males, which have the face abnormally concave (Figs. 1– 2). Females of *M. osmiae*, unlike other *Monodontomerus*, have virtually no speculum (bare area) on the forewing, which makes it almost entirely setose. It would have been difficult to overlook such an anomalous species in either sex among all the specimens examined for the study. This suggests that *M. osmiae* may have moved into the area relatively recently.

Little is known of the biology of *Monodontomerus osmiae*. Iwata and Tachikawa (1966) reported a preponderance of females for rearings of this species from *Osmia taurus*. From 61 cocoons 87 males and 726 females emerged. The number of parasitoids per host (counted for 4 cocoons only) varied from 14 to 26. The gregarious nature of the parasitoid larvae and the highly female-skewed sex ratio make this parasitoid particularly effective at rapidly increasing its numbers at the expense of its host.

It is of more than passing interest that *M. osmiae* was reared in the Old World from *Osmia cornifrons* (the Japanese hornfaced bee), a bee that has been widely naturalized in the United States since the 1970's and is widely available commercially (MAAREC 2001). It would be instructive if keepers and retailers of solitary bees were to sample the parasitoids at their nest sites for the presence of *M. osmiae* and determine the extent of its distribution. Some attempt should also be made to determine if *M. osmiae* attacks indigenous solitary bees. If so, it would be a case of an introduced parasitoid being detrimental not only to its introduced beneficial host, but also to the native fauna of its adopted homeland.

I thank Mike Gates, Systematic Entomology Laboratory, and Gary Gibson, Agriculture and Agri-Food Canada, for reviewing the manuscript. I also thank Mike Gates for providing the illustrations.

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NEW PUBLICATION

"Holcocerini of Costa Rica (Lepidoptera: Gelechioidea: Coleophoridae: Blastobasinae)"

by David Adamski

Entomological Society of Washington Memoir No. 24, 147 pp.

See inside back cover for ordering information.

PROC. ENTOMOL. SOC. WASH.
105(1), 2003, pp. 246–248

NOTE

Expanding Ranges for Four Species of Invasive Sawflies (Hymenoptera: Tenthredinidae) in Eastern United States

Malaise trap collecting in the mid-Atlantic states has resulted in several significant southern range extensions in the eastern United States for four species of adventive sawflies. These collections indicate that these species continue to expand their ranges in North America since they were first discovered. All four species are apparently of European origin and follow a similar pattern of introduction. All were originally recorded from the northeastern United States or southeastern Canada, and three were independently introduced into British Columbia. Here I report the first records for three species south of the state of New York and one species new to Maryland. All four species are known now from as far south as about the latitude of Washington, DC. No specimens were found in 14 years (1986–1999) of extensive Malaise trap collecting approximately 100 miles south of Washington, DC, in Louisa and Essex counties Virginia.

Specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Hoplocampa testudinea (Klug) (Tenthredinidae: Nematinae) (European apple sawfly).—This pest of apple was first recorded from Long Island, NY, in 1939 and British Columbia in 1940 (Pyenson 1943). It has since been recorded from CT, MA, NH, NJ, VT, and RI (Smith 1979), and more recently from PA (anonymous 2002a) and the Kearnysville area of WV (anonymous 2002b). Some records may be based on larvae or the characteristic damage to apple fruits within which the larvae live and feed; young larvae leave a winding feeding scar on the surface and older larvae bore deeply into the core, usually causing mid-season fruit abortion (Weires 2001). Though the damage attributed to this sawfly is probably correct, I prefer to base records on adults even though they are short-lived and more difficult to find than the damage or larvae. The following, based on one female, is the first record for Maryland and the most southerly record known.

Records: MARYLAND: Montgomery Co., 4 mi SW of Ashton, 39°06′30″N, 77°01′30″W, Malaise trap, 18 April 2002, G. F. Hevel.

Allantus viennensis (Schrank) (Tenthredinidae: Allantinae).—This species feeds on *Rosa* spp., and occurs on cultivated roses. It was first reported from the area of Ithaca, NY (Smith 1975), and from the same locality by Smith (1979). The second collection is from my residence in Fairfax Co., VA, where I reared this species from larvae feeding on cultivated roses in 1982. It has subsequently been collected in a trap in back of the house as well as from other collection sites in northern Virginia and West Virginia, indicating that it is well established and generally distributed in this area. There are several generations a year; specimens have been taken from April through August.

Records: VIRGINIA: Clarke Co., University of Virgina Blandy Experimental Farm, 1 mi. S Boyce, 39°05′N, 78°10′W, Malaise trap, D. R. Smith (many specimens each year, 1990–1995); Fairfax Co., near Annandale, 38°50′N, 77°12′W, D. R. Smith (first reared in 1982 and subsequently taken from roses and in a Malaise trap for a number of years from 1983–1997); Loudoun Co., near junction of Goose Cr. and Sycolin Road, Malaise trap, C. J. Anderson (collected each year, 1998–2000); 12969 Taylorstown Road, Malaise trap, C. J. Anderson (2000). WEST VIRGINA: Hardy Co., 3 mi NE of Mathias, 38°55′N, 78°49′W (collected in 2000 and 2001).

Nesoselandria morio (Fabricius) (Tenthredinidae: Selandriinae).—This species, the larvae of which feed on mosses (Vikberg and Nuorteva 1997), was first recorded in North America from Ontario, Quebec, and British Columbia (Smith 1967), and subsequently recorded from NH (Smith 1969), and NY (Smith 1979). It also occurs in Maine (Franklin Co., 1967) and Michigan (Dickinson Co., 1982, 1983; Baraga Co., 1981). The earliest North American record I have seen is "Sclaterville Wild Flower Preserve, New York, May 27, 1938." Collections now establish this species in Maryland and Virginia. The trap in Fairfax Co., VA, has been run in the same place since 1981, but it wasn't until the nineteenth season that the species was collected.

Records: MARYLAND: Garrett Co., Finzel Swamp, 2 km S Finzel, 39°38′N, 79°00′W, V-21–30-1992, VI-30–VII-10-1993, Malaise trap, E. Barrows and D. R. Smith. VIRGINIA: Fairfax Co., near Annandale, 38°50′N, 77°12′W, VIII-5–11-2001, VI-16–22-2002, D. R. Smith.

Heptamelus ochroleucus (Stephens) (Tenthredinidae: Selandriinae).—Benson (1962) first recorded this species from British Columbia from specimens collected in 1953. Smith (1969) saw only the specimens Benson recorded, and Smith (1979) recorded it only from British Columbia. According to Benson (1952) larvae bore downwards in the stems of ferns of the genera *Athyrium, Polypodium,* and *Blechnum,* but the species appears to prefer *Athyrium* (Shaw and Bailey 1991). The first eastern North America record I have seen is from New York, Westchester Co., Armonk, Calder Center, V-30–VI-5-1974. I have collected specimens from Maryland and Virginia. Most records are April, May, and June, with a few from August and September.

Records: MARYLAND: Prince Georges' Co., Beltsville Agricultural Research Center, 39°02′N, 76°52′W, D. R. Smith (1992 and 1993). VIRGINIA: Fairfax Co., near Annandale, 38°50′N, 77°12′W (many specimens, first collected in 1984 and in most years to the present).

Acknowledgments.—I thank the following for allowing collections on their properties: M. Bowers, University of Virginia Blandy Experimental Farm, Clarke Co., Virginia; T. J. Henry, D. R. Miller, R. Gray, S. Henderson, and R. D. Gordon, Hardy Co., West Virginia; V. Power and T. Carlow, Loudoun Co. Virginia; J. and B. Kloke, Louisa and Essex counties, Virginia; and Maryland Nature Conservancy, Finzel Swamp, Garrett Co., Maryland.

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ENTOMOLOGICAL SOCIETY OF WASHINGTON
REGULAR MEETINGS, 2002–2003

October 3, 2002. Thomas J. Henry, Systematic Entomology Laboratory, USDA, Washington, DC. "Ecuadorian Bug-Collecting Adventures: From the Amazon to the Andes"

November 7, 2002. Michael Gates, Systematic Entomology Laboratory, USDA, Washington, DC. "Eurytomidae (Hymenoptera: Chalcidoidea): Morphology, Phylogeny, and the New Mexico Bootheel"

December 4, 2002. Daniel H. Janzen, University of Pennsylvania, Philadelphia. "How to Find All the Species of Caterpillars in a Large, Complex Tropical Habitat"

January 9, 2003. Gabriela Chavarria, National Wildlife Federation, Reston, VA. "Capitol Hill-Topping in D.C. and Conservation Policy"

February 6, 2003. Rob Raguso, University of South Carolina, Columbia. Sphingids and Fragrance (general topic).

March 6, 2003. Stuart H. McKamey, Systematic Entomology Laboratory, USDA, Washington, DC. "Hopp(er)ing through Mexico and Venezuela: Adventures in Leafhopper-Hunting"

April 3, 2003. David A. Nickle, Systematic Entomology Laboratory, USDA, Beltsville, MD. "Life in a Rainforest Canopy: An In-Depth Study of Amazonian Grasshoppers, Katydids, and Termites"

May 1, 2003. Barry Knisley, Randolph-Macon College, Ashland, VA. "Tiger Beetle Conservation: Case Studies with Impacts, Management and Natural History"

Meetings at 7:00 PM, Cathy Kerby Seminar Room (CE-340)
National Museum of Natural History
10th & Constitution Ave., NW, Washington, DC

Meetings Open to the Public
New Literature, Specimen Demonstrations, Ento-T-Shirts, etc. Welcome
Pre-Meeting Dinner: R. Reagan Building Food Court, 5:30 PM

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MEMBERSHIP LIST OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

The previous list was published in October 1999 with 429 members; the present list contains 418 members from every state in the union except Delaware, Indiana, Maine, Nevada, Oklahoma, Rhode Island, and South Dakota. The largest representation is in Maryland (48), followed by the District of Columbia (40), California (26), Florida (19), and Virginia (16). The figures from the Washington, D.C. area are slightly skewed since some members receive their *Proceedings* at office addresses. Five of the Canadian provinces are represented and 25 other countries, on six continents, are represented.

The format used in this list follows essentially that of the 1999 list. Names of Honorary Members are capitalized, those of Emeritus Members (25) are italicized, and Life Members (28) are distinguished by an asterisk following the date they joined the Society. Dates of election to Honorary or Emeritus status are entered in parentheses. In 1988 Dr. Louise M. Russell was elected Honorary Member. In 1993 Dr. Karl V. Krombein was elected Honorary Member. In 1998 Dr. Louise M. Russell was elected Honorary President and Dr. Ronald W. Hodges was elected Honorary Member. In 1999 Drs. Donald M. Anderson and William E. Bickley were elected Honorary Members.

I thank Dianne Mathis for her kind assistance in the preparation of this list. Any corrections to the list can be sent to the Corresponding Secretary at the address on the inside front cover of this issue. Corrections will be read at the next meeting of the Society, and will be published in the *Proceedings* by the Recording Secretary.

Holly B. Williams,
Corresponding Secretary

Abe, Masaki 1988 JAPAN
Abrahamson, W. G. 1997 Pennsylvania
Adams, J. R. 1963 Maryland
Adams, M. S. 1983 New York
Adamski, D. 1984 District of Columbia
Adler, P. H. 1986 South Carolina
Ahlstrom, K. R. 1992 North Carolina
Aitken, T. G. H. 1957 (1984) Connecticut
Alpert, G. D. 2002 Massachusetts
ANDERSON, D. M. 1954 (1999) Maryland
Anderson, L. D. 1944 (1989) California
Arce-Perez, R. 2001 MEXICO
Archangelsky, M. 1998 ARGENTINA
Arduser, M. S. 1999 Missouri
Armitage, B. J. 1983 Ohio
Arnaud, P. H., Jr. 1955 California
Ascher, J. S. 2000 New York
Athanas, M. M. 2001 Maryland

Baicher, V. V. 2001 Maryland
Baixeras, J. 2001 SPAIN
Baker, G. T. 1987 Mississippi
Ball, G. E. 1948 Alberta
Balogh, G. J. 1994 Michigan
Barber, K. N. 1985 Ontario
Barnes, J. K. 1978 New York
Barrows, E. M. 1976 District of Columbia
Baumann, R. W. 1972 Utah
Baumgardner, D. E. 1992 Texas
Becker, V. O. 1987* BRAZIL
Bell, R. T. 1955 Vermont
Bellinger, R. G. 1972 South Carolina
Berry, R. L. 1972 Ohio
Bezark, L. G. 1974 California
Bicha, W. 1981 Tennessee
BICKLEY, W. E. 1949* (1999) Maryland
Bilby, P. J. 1993 New Jersey
Bilyj, B. 1998 Ontario
Blank, S. M. 2002 GERMANY
Blom, P. E. 1986 Pennsylvania
Bilyj, B. J. 1998 Ontario
Bohart, R. M. 1944 California
Borkent, A. 1988 British Columbia

Bowles, D. E. 1993 Texas
Brailovsky, H. 1996 MEXICO
Branham, M. A. 1998 Ohio
Braswell, W. E. 2000 New Mexico
Broda, S. 1991 Maryland
Brodel, C. F 1991 Florida
Brou, V. A. 1985 Louisiana
Brown, B. V. 1993 California
Brown, J. W. 1997 District of Columbia
Brown, R. L. 1979 Mississippi
Bueno-Soria, J. 1977 MEXICO
Burger, J. F 1972. New Hampshire
Burns, J. M. 1975* District of Columbia
Burrows, W. L. 1983 West Virginia
Butler, L. 1966 West Virginia
Byers, G. W. 1984 Kansas

Calabrese, D. 1997 Maryland
Campbell, D. 2000 North Carolina
Carlson, R. W. 1970* Maryland
Carroll, J. F 1977 Maryland
Carroll, L. E. 1997 Maryland
Cave, R. D. 1977 HONDURAS
Chaboo, C. S. 2001 New York
Chavarria, G. 2000 Virginia
Choi, S.-W. 2002 SOUTH KOREA
Clark, W. E. 1975 Alabama
Codella, S. G. 2001 New Jersey
Cohen, E. A., Jr. 1999 Maryland
Connor, E. F 1990 California
Contreras-Ramos, A. 1986 MEXICO
Cook, J. L. 1996 Texas
Cooper, K. W. 1955 California
Coovert, G. A. 1996 Ohio
Coulson, J. R. 1961 Virginia
Courtney, G. W. 1985 Iowa
Covell, C. V., Jr. 1971 Kentucky
Cross, H. F 1954 Georgia
Currie, D. C. 1999 Ontario

Darling, D. C. 1981 Ontario
Darsie, R. F 1949 Florida
Davis, D. R. 1961 District of Columbia
Davis, L. R., Jr. 1992 Florida
Deans, A. R. Illinois
Debboun, M. 2002 Maryland
Deeming, J. C. 1974* WALES
Deitz, L. L. 1982 North Carolina
Dennis, S. 1976 Colorado
Dewalt, R. E. 1992 Illinois
Deyrup, M. A. 1979 Florida
Dodson, B. 1998 Virginia
Dorchin, N. 2000 ISRAEL
Dozier, H. L. 1952* South Carolina
Drummond, R. O. 1954 (1987) Texas
Duffield, R. M. 1996 District of Columbia
Durkin, P. 1999 District of Columbia

Eckerlin, R. P. 1990 Virginia
Enns, W. R. 1960 Missouri
Epstein, M. E. 1994 District of Columbia
Erwin, T. L. 1972 District of Columbia
Etnier, D. A. 1999 Tennessee
Evans, A. V. 2000 Virginia
Evans, H. E. 1948 Colorado
Evans, W. G. 1957 (1994) Alberta
Evenhuis, N. L. 1980 Hawaii

Fales, J. H. 1944 Maryland
Fee, F D. 1983 Pennsylvania
Ferguson, D. C. 1969 District of Columbia
Fisher, E. M. 1977 California
Fisk F. W. 1968 (1988) Florida
Flint, O. S., Jr. 1961 District of Columbia
Flowers, R. W. 1994 Florida
Floyd, M. A. 1991 Kentucky
Fluno, J. A. 1957 Florida
Flynn, D. 2002 North Carolina
Foote, B. A. 1958 Virginia
Foottit, R. G. 2002 Ontario
Foster, G. A. 1999 Maryland
Frank, J. H. 1994 Florida
Freidberg, A. 1979 ISRAEL
Freytag, P. H. 1979 Kentucky
Fullerton, S. M. 1999 Florida
Furth, D. G. 1994 District of Columbia

Gagné, R. J. 1966* Maryland
Gaimari, S. D. 1995 California
Gelhaus, J. K. 1989 Pennsylvania
Gimpel, W. F., Jr. 1995 Maryland
Glaser, J. D. 1988 Maryland
Goeden, R. D. 1982 California
Goldarazena, A. 2001 SPAIN
Gordon, R. D. 1968 North Dakota
Gordon, S.W. 1998 Maryland
Gorham, J. R. 1974 (1995) District of Columbia

Grace, J. K. 1987 Hawaii
Grissell, E. E. 1979 District of Columbia
Grogan, W. L. 1997 Maryland
Guang-Xue, Z 1999 P. R. OF CHINA
Guilbert, E. 2000 FRANCE

Haines, K. A. 1952 Virginia
Halbert, S. E. 1989 Florida
Hall, J. P. 2002 District of Columbia
Hamilton, S. W. — Tennessee
Hanks, L. M. 1993 Illinois
Hanson, P. 1985 COSTA RICA
Hansson, C. 1985 SWEDEN
Harbach, R. E. 1972 UNITED KINGDOM
Harlan, H. J. 1988 Maryland
Harman, D. M. 1966 Maryland
Harris, S. C. 1979 Pennsylvania
Harrison, B. A. 1976 North Carolina
Harrison, T. L. 1993 Illinois
Hastriter, M. W. 1998 Utah
Headrick, D. H. 1992 California
Henry, T. J. 1975 District of Columbia
Heppner, J. B. 1974 Florida
Heraty, J. M. 1986 California
Hespenheide, H. A., III 1981 California
Hevel, G. F. 1970 District of Columbia
Heydon, S. L. 1986 California
Heyn, M. W. 2002 Florida
Hight, S. 1990 Florida
Hilton, D. F. J. 1990* Quebec
HODGES, R. W. 1960* (1998) Oregon
Hoebeke, E. R. 1980 New York
Hoffman, K. M. 1986 California
Houghton, D. C. 2000 Minnesota
Howden, H. F. 1948 Ontario
Huang, Y.-M. 1968 District of Columbia
Husband, R. W. 1972 Michigan

Irwin, M. E. 1976 Illinois
Ivie, M. A. 1984 Montana

Jashenko, R. V. 1997 KAZAKSTAN
Jimenez, H. H. 1994 MEXICO
Jimenez-Guarda, P. 1999 CHILE
Johnson, E. L. 1995 Washington
Johnson, J. B. 1987 Idaho
Johnson, N. F. 1980 Ohio
Joseph, S. R. 1957 Maryland
Judd, D. 1994 Oregon

Kaster, C. H. 1979 Michigan
Keffer, S. L. 1993 Virginia
Keiper, J. B. 2000 Ohio
Keirans, J. E. 1984 Georgia
Kennedy, J. H. 1995 Texas
Kim, K. C. 1983 Pennsylvania
Kimsey, L. S. 1994 California
Kingsolver, J. 1963 (1992) Florida
Kirchner, R. F. 1981 West Virginia
Kitayama, C. 1974 California
Kittle, P. D. 1975 Alabama
Kjar, D. S. 2001 District of Columbia
Knutson, L. V. 1963* FRANCE
Kondratieff, B. C. 1992 Colorado
Korch, P. P. 1993 Pennsylvania
Korytowski, C. A. 2002 PANAMA
Kosztarab, M. 1978 (1994) Virginia
Kotrba, M. 1997 GERMANY
KROMBEIN, K. V. 1941* (1993) District of Columbia
Kruse, J. 2000 Alaska
Krysan, J. L. 1993 Kentucky

Labandeira, C. C. 1993 District of Columbia
Lago, P. K. 1984* Mississippi
Lakin, K. R. 1993 North Carolina
La Vigne, R. 1999 AUSTRALIA
Lee, S. SOUTH KOREA
Lein, J. C. 1967 TAIWAN
Levesque, C. 1985 Quebec
Lewis, J. A. 1994 District of Columbia
Lewis, P. A. 1974 Ohio
Lewis, R. E. 1958 Iowa
Lingafelter, S. W. 1997 District of Columbia
Lisowski, E. A. 1988 Washington
Little, R. G. 1993 California
Loechelt, H. K. 1988 Washington
Loeffler, C. C. 1992 Pennsylvania
Lopez-Martinez, V. 2002 MEXICO

MacDonald, J. F. 1984 Indiana
MacKay, W. P. 1982 Texas
Magner, J. M. 1953 Missouri
Maier, C. T. 1976 Connecticut
Main, A. J., Jr. 1965 New York
Manley, D. G. 1984 South Carolina
Manglitz, G. R. 1956 (1989) Nebraska

Mariluis, J. C. 2000 ARGENTINA
Marinoni, R. C. 2002 BRAZIL
Marsh, P. M. 1960 (1997) Kansas
Marshall, S. 1982 Ontario
Mason, H. C 1949 (1973) Maryland
Mathis, W. N. 1976* Virginia
Mawdsley, J. 2001 District of Columbia
May, E. 1990 Kansas
McCabe, T. L. 1977 New York
McGovran, E. R. 1937 (1973) Maryland
McKamey, S. H. 1989 District of Columbia
McPherson, J. E. 1985 Illinois
Mead, F. W. 1976 (1995) Florida
Menke, A. S. 1969 Arizona
Metzler, E. H. 1998 Ohio
Micheli, C. 2001 Maryland
Michener, C. D. 1994 Kansas
Miller, D. R. 1972 Maryland
Miller, G. L. 1981 Maryland
Miller, R. S. 1981 Montana
Miller, S. E. 1980* District of Columbia
Miller, T. D. 1988 Idaho
Mitchell, R. T. 1949 (1978) Maryland
Moore, T. E. 1950 Michigan
Morse, J. C. 1976 South Carolina
Morse, L. E. 1999 Virginia
Moulton, J. K. 1994 Arizona
Mudge, A. D. 2001 Oregon
Mullens, B. A. 1999 California
Muñoz-Quesada, F. 1996 Minnesota
Munro, J. B. 2000 California
Munson, S. C. 1938 (1975) District of Columbia
Murray, D. L. 2000 Oregon

Nakahara, S. 1968 Maryland
Neff, S. E. 1969 Pennsylvania
Nelson, C. H. 1969 Tennessee
Neunzig, H. H. 1956 North Carolina
Nguyen, T. C. 2000 New York
Normark, B. 2000 Massachusetts
Norrbom, A. L. 1989 District of Columbia
Novelo-Guiterrez, R. 1999 MEXICO
Nuhn, T. P. 1981 Virginia

O'Campo, F. C. 2001 Nebraska
Ochoa, R. 1999 Maryland
O'Neill, K. M. 2000 Montana
Opler, P. A. 2001 Colorado
Orr, R. L. 1990 Maryland
Oswald, J. D. 1987 Texas

Packauskas, R. J. 1993 Kansas
Painter, J. A. 2001 Virginia
Pakaluk, J. 1992* District of Columbia
Paras, F. 1999 Maryland
Parker, C. R. 1977 Tennessee
Parrish, D. W. 1963 (1987) Maryland
Paulo, O. 1998 BRAZIL
Pedrosa-Macedo, J.H. 1999 BRAZIL
Pennington, W. 2001 Tennessee
Perez, O. G. 2001 Florida
Perez-Gelabert, D. E. 2000 Maryland
Peters, J. G. 1999 Florida
Peterson, R. V. 1952 Utah
Pham, V. N. 2001 Maryland
Philip, M. 2001 North Carolina
Pinto, J. D. 1982 California
Pogue, M. 1996 District of Columbia
Poiner, G. 1999 Oregon
Polhemus, D. A. 1993 District of Columbia
Polhemus, J. T. 1964 Colorado
Polloni, J. 2001 Massachusetts
Porter, C. H. 1984 Georgia
Pratt, G. F. 2001 California
Pratt, H. D. 1943 Georgia
Price, R. D. 1963 Arkansas
Pujolluz, J. R. 1998 BRAZIL
Pulawski, W. J. 1975 California

Quio, G.-X. 1999 P. R. OF CHINA

Rabaglia, R. J. 2002. Maryland
Rainwater, C. F. 1954 (1975) Maryland
Rainwater, H. I. 1964 (1983) Maryland
Ramsdale, A. S. Wisconsin
Raspi, A. ITALY
Rawlins, J. F. 1974 Pennsylvania
Revol, L. M. 1999 FRANCE
Ribeiro-Costa, C. S. 1992 Puerto Rico
Richards, A. B. 1996 California
Richardson, H. H. 1939 (1976) New Jersey
Ridge-O'Connor, G. E. 2000 Connecticut
Riley, D. R. 1984 Texas
Robbins, R. G. 1979* Maryland
Robbins, R. K. 1986 District of Columbia
Robbins, T. O. 1989 Texas
Robinson, H. E. 1963 District of Columbia

Root, R. B. 1984 New York
Rothschild, M. J. 1989 Maryland
Roughley, R. E. 2001 Manitoba
Rozen, J. G., Jr. 1956 New York
Ruiter, D. 1976 Colorado
Rumph, J. A. 1996 Washington
RUSSELL, L. M. 1930 (1988) Maryland

Santana, F. J. 1966 Florida
Saugstad, E. S. 1979 West Virginia
Scarbrough, A. G. 1971 Maryland
Schaefer, C. W. 1985 Connecticut
Schang, M. M. 2000 ARGENTINA
Schauff, M. E. 1980 District of Columbia
Schick, K. 1994 California
Schiff, N. M. 1991* Mississippi
Schmidt, C. H. 1969 North Dakota
Schmude, K. L. 1990 Wisconsin
Schubert, R. D. 2001 Maryland
Schultz, T. R. 2000 District of Columbia
Scudder, G. G. E. 1984 British Columbia
Sedlacek, J. D. 1988 Kentucky
Setliff, G. P. 2002 Maryland
Shaffer, J. C. 1974 Virginia
Shands, W. A. 1940 (1991) South Carolina
Shaw, S. R. 1991 Wyoming
Shepard, W. D. 1992 California
Shorthouse, J. D. 1986 Ontario
Silva, M. O. 2002 BRAZIL
Silva, V.C. 1999 BRAZIL
Simmons, R. A. 2002 District of Columbia
Sites, R. W. 1989 Missouri
Skarlinsky, T. 2001. Florida
Skelley, P. E. 1992 Florida
Slater, J. A. 1949 Connecticut
Sloan, M. J. 1983 (1990) District of Columbia
Smiley, R. L. 1964 Maryland
Smith, C. F. 1967 (1987) North Carolina
Smith, D. R. 1965* District of Columbia
Snelling, R. R. 1972 California
Solis, M. A. 1985* District of Columbia
Spangler, P. J. 1958* District of Columbia
Spilman, R. E. 1950 (1977) Maryland
Spinelli, G. R. 1983 ARGENTINA
Staines, C. L. 1975 Maryland
Starr, C. K. 1987 TRINIDAD & TOBAGO
Steck, G. J. 1988 Florida
Steiner, W. E. 1979 Maryland
Steinly, B. A. 1983 Ohio
Stewart, R. D. 1985 Maryland
Stibick, J. N. L. 1992* Maryland
Stoetzel, M. B. 1971 Maryland
Strazanac, J. S. 2001 West Virginia
Strickman, D. 1988 Virginia
Sutherland, C. M. 1974 New Mexico
Sutherland, D. W. S. 1973* Maryland
Swann, J. 1999 Ontario

Tennessen, K. J. 1982 Alabama
Thomas, D. B. 1997 Texas
Thompson, F. C. 1968* District of Columbia
Thompson, J. V. 1953 (1985) New Jersey
Togashi, I. 1983* JAPAN
Torres-Miller, L. R. 1984 West Virginia
Triplehorn, C. A. 1972 Ohio
Turner, W. J. 1983 Washington

Ulrich, H. 1978* GERMANY

Valley, K. 1976 Pennsylvania
Vandenberg, N. — District of Columbia
Vazquez, A. W. 1957 Virginia
Vockeroth, J. R. 1995 Ontario
Voegtlin, D. 1981 Illinois

Wahl, D. B. 1987 Florida
Wallace, M. S. 2002 North Carolina
Wallenmaier, T. E. 1979 Michigan
Warren, A.D. 1999 Oregon
Webb, D. W. 1981 Illinois
Weber, N. A. 1941 (1981) Florida
Wenzel, R. L. 1984 Illinois
Wharton, R. A. 1981 Texas
Wheeler, T. A. 2001 Quebec
White, G. B. 1977* Maryland
Whitfield, J. B. 2002 Illinois
Whitsel, R. H. 1967 California
Whitworth, T. 1999 Washington
Williams, G. L. 1984 Maryland
Williams, H. B. 1977* District of Columbia
Wilson, D. 1999 Mississippi
Wilson, N. 1957 Iowa
Wilterding, J. 1999 Michigan
Wojtowicz, J. A. 1981 Tennessee
Wood, D. M. 1987 Ontario

Wood, T. K. 1974 Delaware
Woodley, N. E. 1984* District of Columbia
Woolley, J. B. 1986 Texas

Yasunaga, T. 1998 JAPAN
Young, D. K. 1981 Wisconsin

Zack, R. 1982 Washington
Zimmerman, E. C. 1965 AUSTRALIA
Zolnerowich, G. 1987 Kansas
Zuccaro, A. E., Jr. 1986 Mississippi
Zungoli, P. 1978 South Carolina
Zuparko, R. L. 1993 California
Zyla, J. D. 2000 Maryland

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(ISSN 0013-8797)

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of WASHINGTON

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QUARTERLY

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THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Organized March 12, 1884

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STATEMENT OF OWNERSHIP

Title of Publication: Proceedings of the Entomological Society of Washington.

Frequency of Issue: Quarterly (January, April, July, October).

Location of Office of Publication, Business Office of Publisher and Owner: The Entomological Society of Washington, % Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168.

Editor: David R. Smith, Systematic Entomology Laboratory, ARS, USDA, % Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168.

Books for Review: David R. Smith, Systematic Entomology Laboratory, ARS, USDA, % Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168.

Managing Editor and Known Bondholders or other Security Holders: none.

This issue was mailed 31 March 2003

Periodicals Postage Paid at Washington, D.C. and additional mailing office.

PRINTED BY ALLEN PRESS, INC., LAWRENCE, KANSAS 66044, USA

PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 257–264

PLAGIOGNATHUS REINHARDI JOHNSTON (HEMIPTERA: MIRIDAE): DISTRIBUTION, HABITS, AND SEASONALITY OF A HAWTHORN (*CRATAEGUS*) SPECIALIST

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Abstract.—The phyline plant bug *Plagiognathus reinhardi* Johnston, described from Texas in 1935, has been known only from the type locality (College Station). Recent fieldwork produced the first records of this species for the southeastern United States. This mirid developed on glandular hawthorns (*Crataegus* sp.[p.]; Rosaceae) of series *Lachrimatae*, mainly in the fall-line sandhills from southern North Carolina through South Carolina and Georgia to eastern Alabama but also in disturbed sandhills in the panhandle and northern peninsula of Florida. Overwintered eggs hatched near vegetative budbreak of host hawthorns: late February to early March in Florida and mid-March in South Carolina. Early instars were found on the expanding leaves, whereas late instars were associated mainly with flower buds and inflorescences. Adults appeared by mid- or late March in Florida and mid-April in South Carolina. Adults of this univoltine mirid were present for about four to six weeks, the females persisting longer than the males.

Key Words: Insecta, Miridae, insect distribution, seasonal history, *Crataegus*, fall-line sandhills

Johnston (1935) described the phyline plant bug *Plagiognathus reinhardi* from College Station, Texas. The type series consisted of 80 males and females collected on hawthorn, *Crataegus* sp. (Rosaceae), from March 29 to April 21, 1933. No further records of this distinctive dark red or reddish-brown mirid have been published since the original description (Henry and Wheeler 1988). Schuh (2001) stated that it is found in the southern United States but did not cite additional records. This plant bug's sexually dimorphic second antennomere and structure of the male vesica (see Schuh [2001]: fig. 40) do not conform to the current concept of the genus *Plagiognathus*. This species, therefore, was given the status of *incertae sedis* by Schuh (2001). Here I record *P. reinhardi* from the southeastern United States, cite an additional Texas record, and provide notes on its seasonal history and habits.

METHODS AND STUDY SITES

I discovered *P. reinhardi* in South Carolina in 1988, but surveys to learn more about its southeastern distribution were not initiated until 1999. *Crataegus* spp. in the fall-line sandhills from southern North Carolina to eastern Alabama were sampled during 1999–2001 by tapping branches over a shallow net. Sampling also was conducted in northern Florida in 2000–2002. At each site where adults were found, one or more specimens were collected and deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

During March–May 2000–2001, hawthorns in the fall-line sandhills of South Carolina were sampled to determine when the overwintered eggs of *P. reinhardi* begin to hatch, when the adults begin to appear, and the period of time they are present. The main study site was a disturbed sandhill in Richland County, 2.5 km southwest of Pontiac. The approximate time of egg hatch and the period of adult occurrence also were determined at several sites in the northern peninsula of Florida (see Distribution for specific localities). The number of individuals observed on each sample date varied but generally was <20. Early instars were particularly difficult to find because they were not easily dislodged from partially closed vegetative buds. Only limited numbers (<10) of nymphs typically were observed when overwintered eggs were beginning to hatch. First and second instars were collected, placed in 70% ethanol, and sorted to stage in the laboratory using a binocular microscope; later instars were identified in the field and their relative proportions estimated.

DISTRIBUTION
(Fig. 1)

In the following list of new records for *P. reinhardi,* those based only on nymphs are indicated as "(n)." All collections were from *Crataegus* (for comments on identification of the host, see Habitats and Host Plants) by the author, except the one from Texas and those from Washington County, Florida.

ALABAMA: Russell Co., Rt. 165, 5 km N of Fort Mitchell, 32°23.1′N, 85°02.2′W, 9 Apr. 2000 (3 ♂, 1 ♀); Rt. 165, 4 km N of Holy Trinity, 32°15.5′N, 85°00.1′W, 9 Apr. 2000 (n); Rt. 169, 1.5 km NW jct. Rt. 431, NNW of Seale, 32°19.6′N, 85°10.5′W, 9 Apr. 2000 (n). FLORIDA: Alachua Co., Rt. 441, 1.7 km NW of High Springs, 29°50.2′N, 82°36.1′W, 3 Mar. 2000 (n) and 22 Mar. 2000 (6 ♂, 5 ♀), 19 Mar. 2002 (n); Columbia Co., Ichetucknee Springs State Park, ca. 6.5 km NW of Fort White, 29°57.5′N, 82°46.0′W, 3 Mar. 2000 (n) and 22 Mar. 2000 (20 ♂, 6 ♀), 2 Mar. 2001 (n) and 17 Mar. 2001 (10 ♂, 2 ♀), 19 Mar. 2002 (n); Hamilton Co., Rt. 129, ca. 4 km NW of Jasper, 30°32.6′N, 82°58.4′W, 23 Mar. 2000 (n); Rt. 129, 0.7 km N of Suwannee River, NE of Suwannee Springs, 30°23.8′N, 82°56.1′W, 23 Mar. 2000 (n); Suwannee Co., Rt. 27, 5 km E of Branford, 29°57.1′N, 82°52.6′W, 3 Mar. 2000 (n); jct. Rts. 75 & 136, 4.6 km SW of White Springs, 30°19.2′N, 82°48.4′W, 21 Mar. 2000 (n); Washington Co., Rt. 279, 7 km N of Greenhead & jct. Rt. 77, 30°34.6′N, 85°40.1′W, 19 Apr. 2001, T. J. Henry & A. G. Wheeler, Jr. (1 ♂, 1 ♀); Rt. 79, 2.4 km S of New Hope, 30°33′17″N, 85°49′14″W, 19 Apr. 2001, T. J. Henry & A. G. Wheeler, Jr. (1 ♂). GEORGIA: Chattahoochee Co., Rt. 26, 1 km N of Cusseta, 32°18.9′N, 84°46.4′W, 9 Apr. 2000 (3 ♂, 1 ♀); Crawford Co., Rt. 96, 0.5 km E of Flint River, 8.2 km E of Reynolds, 32°32.8′N, 84°00.7′W, 9 Apr. 2000 (n); Crisp Co., Rt. 257, 1.3 km SW of Dooly Co. line, 0.8 km SW of Lambtown, 32°01.3′N, 83°5.5′W, 21 Apr. 2001 (2 ♀); Glascock Co., Rt. 123, 0.1 km NNW of Mitchell, 33°13.2′N, 82°42.3′W, 18 May 1999 (1 ♀); Jefferson Co., Rt. 221, 9.8 km N of Wrens, 33°18.7′N, 82°22.7′W, 18 May 1999 (4 ♂, 8 ♀); Jones Co., Rt. 129, 3.8 km NE of Gray, 33°02.4′N, 83°30.7′W, 9 Apr. 2000 (n); McDuffie Co., CR-86 nr jct. CR SE 75, 2.5 km W of Dearing, 33°25.5′N, 82°24.6′W, 18 May 1999 (3 ♂, 3 ♀); Ellington Airline Rd., 3 km SW of Dearing, 33°24.1′N, 82°24.9′W, 1 Apr. 2000 (n); Marion Co., jct. Rts. 41 & 127, 14 km N of Buena Vista, 32°26.4′N, 84°32.1′W, 8 Apr. 1997 (adults, sex unknown) and 9 Apr. 2000 (n); Oconee Co., Rt. 129, 0.5 km SW of Farmington, 33°46.4′N, 83°25.6′W, 9 Apr. (n) & 20 Apr. 2000 (n, 3 ♂ reared); Pulaski Co., Rt. 129A, Hartford community NE of Hawkinsville, 32°17.1′N, 83°26.9′W, 21 Apr. 2001 (3 ♂, 8 ♀); Richmond Co., Wheeler Rd., Augusta, 33°28.9′N, 82°05.2′W, 18 May 1999 (2 ♀); Stewart Co., Rt. 39, 4 km E of Omaha, 32°08.3′N,

Fig. 1. New distribution records of *Plagiognathus reinhardi* in the southeastern United States (Alabama, Florida, Georgia, North Carolina, South Carolina). Note: See Distribution for more precise locations of collection sites and for a new Texas record.

84°58.3′W, 9 Apr. 2000 (n); Talbot Co., Rt. 90, S of Junction City, 32°35.1′N, 84°26.8′W, 15 Apr. 1990 (n); Rt. 96, Junction City, 32°36.3′N, 84°27.7′W, 9 Apr. 2000 (3 ♂, 1 ♀); Warren Co., Rt. 123, 3.6 km S of jct. Rt. 16, SSW of Warrenton, 33°16.0′N, 82°45.2′W, 18 May 1999 (2 ♂, 15 ♀); Wilkinson Co., Rt. 18, 6.1 km S of Gordon, 32°50.4′N, 83°20.0′W, 21 Apr. 2001 (5 ♂, 4 ♀). NORTH CAROLINA: Bladen Co., Rt. 242, 14 km N of Elizabethtown, 34°45.9′N, 78°36.4′W, 23 May

1999 (1 ♂, 3 ♀); Cumberland Co., Rt. 242, 1.9 km S of jct. 210, 4.5 km NNE of Ammon, 34°22.0′N, 78°33.1′W, 23 May 1999 (1 ♂, 4 ♀); Richmond Co., Rt. 177, 1.1 km NE of Hamlet, 34°54.4′N, 79°41.1′W, 22 May 1999 (5 ♂, 17 ♀); Rt. 177, 0.3 km S of Osborne, 34°45.5′N, 79°46.2′W, 23 May 1999 (3 ♀). SOUTH CAROLINA: Aiken Co., Henderson Heritage Preserve, ca. 6 km NW of Aiken, 33°36.3′N, 81°45.2′W, 24 Apr. 1998 (1 ♀) & 16 Apr. 2000 (n); North Augusta, 33°30.3′N, 81°57.9′W, 11 Mar. & 7 Apr. 2001 (n); Bamberg Co., Rt. 321, 3.8 km N of Denmark, 33°21.6′N, 81°08.2′W, 31 Mar. 2001 and 7 Apr. 2001 (n); Barnwell Co., Rt. 39, 2.5 km SSE of jct. Rt. 78, SE of Williston, 33°23.2′N, 81°26.7W, 31 Mar. 2001 (n); Rt. 78, 6.4 km W of Blackville, 33°22.3′N, 81°20.3′W, 7 Apr. 2001 (n); Calhoun Co., co. rd. 31 E of jct. Rt. 26, ca. 4 km NW of Sandy Run, 33°48.6′N, 81°00.4′W, 20 May 2001 (1 ♀); Rt. 176, 5 km SE of Sandy Run, 33°46.3′N, 80°55.5′W, 20 May 2000 (1 ♀); Chesterfield Co., jct. Rts. 1 & SR-13-29, 4.3 km NE of Middendorf, 34°32.6′N, 80°07.4′W, 22 May 1999 (1 ♂, 8 ♀); Edgefield Co., S-19-407 nr. jct. S-19–37, ca. 8.5 km SW of Eureka, 33°39.5′N, 81°51.6′W, 18 May 1999 (1 ♂, 15 ♀), 6 June 1999 (1 ♀), 12 May 2001 (1 ♂, 5 ♀); jct. Rt. 25 & Whitlock Rd., 8.8 km SSW of Trenton, 33°40.0′N, 81°52.4′W, 18 May 1999 (1 ♂, 3 ♀); Fairfield Co., Rt. 34, 0.6 km W of Kershaw Co. line, 12.6 km SSE of Ridgeway, 34°16.4′N, 80°49.9′W, 20 May 2000 (1 ♂, 2 ♀); Kershaw Co., jct. S-28-47 & S-28-367, ca. 3.8 km SE of Elgin, 34°09.1′N, 80°45.7′W, 22 May 1999 (2 ♂, 8 ♀); Rt. 1, ca. 8.5 km NE of Camden, 34°18.8′N, 80°32.4′W, 22 May 1999 (2 ♀); Lexington Co., Rt. 302, S of Cayce, 13 May 1988 (1 ♀); jct. Rt. 178 and Gantt Mill Rd., 7.5 km W of Pelion, 33°45.3′N, 81°19.7′W, 6 May 1989 (2 adults, sex unknown); Rt. 321, 0.8 km S of jct. S-32-952, 33°48.4′N, 81°05.8′W, Gaston, 11 & 31 Mar. 2001 (n); Rt. 321, 3 km N of Gaston, 33°50.3′N, 81°05.3′W, 26 Apr. 1998 (1 ♂, 1 ♀); Peachtree Rock Preserve, 3.5 km SE of Edmund, 33°49.9′N, 81°12.0′W, 26 May 1995 (2 ♀), 7 Apr. (n) & 28 Apr. 2001 (4 ♂, 1 ♀); Marlboro Co., Rt. 177, 0.9 km S of Fulton, 34°46.2′N, 79°47.7′W, 23 May 1999 (2 ♂, 6 ♀); Richland Co., Valhalla Dr., 0.1 km S of Rt. 1, 2.5 km SW of Pontiac, 34°07.0′N, 80°52.8′W, 15 May (9 ♂, 6 ♀), 22 May (1 ♂, 10 ♀) & 26 May 1999 (2 ♀); 16 Apr. (2 ♀), 6 May (4 ♂, 6 ♀), & 20 May 2000 (10 ♀); Sumter Co., Rt. 261, Manchester State Forest, 4.7 km S of Wedgefield, 33°51.5′N, 80°31.0′W, 26 May 1999 (1 ♀).

TEXAS: Victoria Co., Rt. 59, 9 km NE of Inez, 28°56.5′N, 96°42.5′W, 18 Apr. 1983, T. J. Henry & A. G. Wheeler, Jr. (adults, sex unknown).

HABITATS AND HOST PLANTS

Plagiognathus reinhardi was found mainly in the fall-line sandhills from southern North Carolina through South Carolina and Georgia to eastern Alabama, and in xeric sand communities in northern Florida. In South Carolina counties such as Edgefield and Fairfield, which lie mainly in the piedmont and contain a sliver of sandhills, this mirid was found only in the sandhills ecoregion. In Georgia, however, *P. reinhardi* was collected in the piedmont as far north as Oconee County (Fig. 1).

The host plant of *P. reinhardi* is a species of *Crataegus* (or complex of "microspecies" *sensu* Phipps 1988b) characteristic of xeric sand communities from southern North Carolina to eastern Alabama and northern Florida. This plant often is found in disturbed sites such as vacant lots, along highways, and railroad rights-of-way, and it is the most common hawthorn in the sandhills of South Carolina (Schoenike 1982). Belonging to the section (and series) *Lacrimatae* (Phipps et al. 1990), this taxon often is misidentified as *C. flava* Ait. (e.g., Duke 1961, Radford et al. 1968, Clark 1971, Clewell 1985, Godfrey 1988, Partridge et al. 2000; see also Phipps et al. 1990). *Crataegus flava*, however, is rare or

Fig. 2. Host plant of *Plagiognathus reinhardi,* a hawthorn of series *Lachrimatae* (probably *Crataegus alabamensis* or *C. meridiana*), in disturbed sandhills near Pontiac (Richland County), South Carolina.

even extinct in the wild, apparently is no longer in cultivation, belongs to another section of *Crataegus,* and has not been correctly identified subsequent to Beadle's (1903) treatment (Phipps 1988a, Phipps et al. 1990). In addition to *C. flava* sensu auctt. Amerr. non Ait., the common *Crataegus* species of southeastern sandhills has been referred to as *C. meridiana* Beadle (Coker and Totten 1945) and *C. michauxii* Pers. (e.g., Thorne 1954, Weakley 1997). Specific identifications in *Lacrimatae,* as in many other sections of *Crataegus,* are problematic. In many cases the original descriptions not only are insufficiently diagnostic to discriminate species, but type specimens, including those for taxa named from the southeastern states by C. D. Beadle and others, often are in poor condition or lacking. Apomixis and hybridization, as well as polyploidy, contribute to the "*Crataegus* problem" (e.g., Phipps 1988b, Phipps et al. 1990, Lance 1995).

The host of *P. reinhardi* at the sample site in Richland County, South Carolina, might be *C. alabamensis* Beadle or *C. meridiana* (Fig. 2). This plant is a shrub or small tree with a dense growth habit, pendulous branches at maturity, short and stout thorns, twigs generally zigzag at the nodes, small leaves with their margins conspicuously gland dotted and white-tomentose above when young, petioles glandular; inflorescences compact and few flowered (generally 4–7 in cymes) with flowers small and the calyx lobes usually glandular-punctate, stamens 20; and fruit oval, yellow to red in clusters of 1–3, nutlets 2–5. Specimens from the main study site near Pontiac, South Carolina, labeled *Crataegus* aff. *alabamensis* Beadle by J. B. Phipps, 17 July 2000, and annotated to *C. meridiana* Beadle by R. Lance, 5 June 2002, are in the Clemson University Herbarium (CLEMS 55280; Townsend #2200).

The morphologically similar hosts of *P. reinhardi* in Alabama, Florida, Georgia, North Carolina, and at other sites in the South Carolina sandhills also belong to series *Lachrimatae* but may or may not be conspecific with what is thought to be *C. alabamensis* or *C. meridiana* in Richland County, South Carolina. Material from sample sites in Florida will key to *C. michauxii* in Godfrey (1988) and Wunderlin (1998). Other plants found consistently with *C. alabamensis* or *C. meridiana* (or other species of *Lachrimatae*) in disturbed sandhills of South Carolina were American joint-weed, *Polygonella americana* (Fisch. & Mey.) Small (Polygonaceae); eastern prickly-pear, *Opuntia humifusa* (Raf.) Raf. (Cactaceae); longleaf pine, *Pinus palustris* Mill. (Pinaceae); silk-grass, *Pityopsis graminifolia* (Michx.) Nutt. (Asteraceae); and turkey oak, *Quercus laevis* Walter (Fagaceae).

SEASONALITY AND HABITS

In the South Carolina sandhills near Pontiac (Richland Co.), first instars were observed on 12 March 2000. No nymphs had been found on 26 February when vegetative buds were still tightly closed. Collections on 1 April consisted of one first, two third, two fourth, and two fifth instars. Populations on 16 April contained mostly fifth instars, with fourth instars and teneral adults also present. Only adults (4 ♂, 6 ♀) were found on 6 May, and only adult females (n = 10) on 20 May. The latest record of *P. reinhardi* in South Carolina, a female from Edgefield County, was 6 June 1999.

In 2001, collections in South Carolina on 11 March consisted only of first instars at North Augusta (Aiken Co.) and Gaston (Lexington Co.). Second through fourth instars (predominately thirds) were observed at Gaston on 31 March, and fourth instars were collected on that date near Denmark in Bamberg County. Collections on 31 March in Aiken, Bamberg, and Barnwell counties consisted of third through fifth instars.

On 9 April 2000, adults (3 ♂, 1 ♀) were observed at one of three sites (north of Fort Mitchell) that were sampled in Russell County, Alabama, in the East Gulf Coastal Plain. Populations at all three Alabama sites consisted mainly of fourth and fifth instars, although a few second and third instars were present near Seale and a few third instars at the site north of Holy Trinity. Mirid populations in the East Gulf Coastal Plain of Georgia also consisted mainly of late instars and smaller numbers of teneral adults on 9 April 2000.

The populations of *P. reinhardi* sampled in northern Florida (Alachua, Columbia, and Suwannee counties) consisted of first and second instars on 3 March 2000. At Ichetucknee Springs State Park in Columbia County, adults (20 ♂, 6 ♀), many of them teneral, were present on 22 March with about equal numbers of late (fourth and fifth) instars. In 2001, development of this mirid on the single hawthorn that had been sampled the previous March in Ichetucknee Springs State Park was advanced compared to 2000; second through fourth instars were found on 2 March, indicating that egg hatch had begun by late February (no nymphs, however, were found on this same plant on 22 and 26 February 2002). Collections from this same plant on 17 March 2001 indicated that fifth instars were most numerous, with smaller numbers of fourth instars and mostly teneral adults (10 ♂, 2 ♀) also present. The population of *P. reinhardi* at Ichetucknee Springs State Park developed later in 2002 than in either of the two previous seasons; second through fourth instars were observed on 19 March. Extensive sampling on 14 April 2001 did not yield adults at the Alachua County site near High Springs, but small numbers of adults were still present in the panhandle (Washington Co.) on 19 April 2001.

First and second instars were found within unfolding leaves and presumably feed on the young foliage. Third through fifth instars were associated mainly with the flower buds and inflorescences of host hawthorns.

DISCUSSION

The phyline plant bug *P. reinhardi,* known previously only from the type locality in Texas, can be added to the fauna of the southeastern United States. A characteristic insect of the fall-line sandhills of Georgia, North Carolina, South Carolina, and eastern Alabama, it often is found in disturbed sites within pine-scrub oak sandhill communities. This mirid also can be found in disturbed sandhills in xeric sand communities of northern Florida. Arthropods associated with xeric longleaf pine habitats, which include sandhills, tend to be poorly known (Folkerts et al. 1993). The South Carolina sandhills, important for their biotic richness, provide habitats for numerous plant and animal species that are considered rare or endangered (e.g., Pittman 2001).

Plagiognathus reinhardi is a hawthorn specialist. The host plant in South Carolina apparently is *Crataegus alabamensis* or *C. meridiana,* a hawthorn with glandular leaf margins, petioles, and calyx lobes. This plant frequently is misidentified as *C. flava* Ait. Elsewhere, *P. reinhardi* also develops on glandular hawthorns of series *Lachrimatae.* The use of glandular host plants is common in the Miridae (see Wheeler 2001). *Plagiognathus reinhardi* was not found on nonglandular species of *Crataegus,* including *C. spathulata* Michx. growing in Oconee County, Georgia, within two meters of a glandular hawthorn that harbored nymphs of the mirid.

Overwintered eggs of this univoltine plant bug begin to hatch at or slightly after vegetative budbreak of their hosts. Egg hatch apparently begins about the second week of March in the South Carolina sandhills and, in some years, as early as late February in northern Florida. In South Carolina, adults appear by mid-April, with fifth instars sometimes present until late April. These nymphal "stragglers" usually are parasitized by a euphorine braconid. Adults begin to appear in northern Florida by about mid- to late March. The appearance of adults generally corresponds with the period of late bloom on host hawthorns. Adults are present only for four to six weeks. Late-season populations, like those of most Miridae (Wheeler 2001), are strongly female biased.

The only other phytophagous mirid that co-occurred with *P. reinhardi* on glandular hawthorns was the orthotyline *Heterocordylus malinus* Slingerland. It was observed at about half of the sites sampled in both Georgia and South Carolina and was present at one of three sites sampled in Russell County, Alabama (new state record). *Heterocordylus malinus* is a univoltine plant bug whose seasonality in Alabama, Georgia, and South Carolina is similar to that of *P. reinhardi,* the overwintered eggs hatching by mid-March and adults appearing about a month later. Nymphs of *H. malinus* are red to reddish brown, whereas those of *P. reinhardi* are yellow to yellow green.

ACKNOWLEDGMENTS

I am grateful to J. B. Phipps (University of Western Ontario, London) for identifying the hawthorn from Richland County, South Carolina; J. F. Townsend (formerly with Clemson University) for identifying several plant species from disturbed sandhills, preparing herbarium specimens of *Crataegus,* and identifying *C. spathulata* from Georgia; T. J. Henry (Systematic Entomology Laboratory, USDA, % National Museum of Natural History, Washington, D.C.) for verifying the identification of *P. reinhardi* and for his companionship in the field in Florida and Texas; S. H. Bennett (South Carolina Department of Natural Resources, Columbia) for issuing a permit that allowed me to collect insects in the Henderson Heritage Preserve; D. C. Soblo (formerly with the South Carolina Nature Conservancy, Columbia) for allowing me to collect in the Peachtree Rock Preserve; G. J. Steck (Florida Department of Agriculture and Consumer Services, Gainesville) and the Division of Recreation and Parks, Florida Department of Environmental Protection, Tallahassee, for the permit authorizing the collection of insects in Ichetucknee Springs State Park; G. R. Carner (Clemson University) for photographing the host plant, and P. H. Adler (Clemson University) for offering suggestions that improved the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 265–282

REVISION OF *DESMOMETOPA* LOEW (*LITOMETOPA* SABROSKY) (DIPTERA: MILICHIIDAE), WITH DESCRIPTIONS OF SIX NEW SPECIES

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Abstract.—The Afrotropical genus *Litometopa* Sabrosky is relegated to subgeneric status within *Desmometopa* Loew and revised. *Desmometopa* (*L.*) *glabrifrons* (Sabrosky), the type species, is redescribed, and six **new species, *D.* (*L.*) *brachycephala*, *D.* (*L.*) *dolichocephala*, *D.* (*L.*) *flavicornis*, *D.* (*L.*) *glandulifera*, *D.* (*L.*) *nigrifemorata*,** and ***D.* (*L.*) *sabroskyi***, are described. The subgenus is redescribed, including a description of sclerotized structures within the male abdomen possibly representing a gland, and a specialization of the female ovipositor, known as the secondary ovipositor. A key to all species is given. The relationship between *Litometopa* and other taxa within *Desmometopa* and among species of *Litometopa* is discussed.

Key Words: Diptera, Milichiidae, *Desmometopa* (*Litometopa*), new status, Afrotropical

In 1965 Sabrosky established the genus *Litometopa* for his new species, *L. glabrifrons* Sabrosky, based on four specimens collected in Tanzania. The genus was not recorded again until Brake (2000) discussed it in her study of the Milichiids. Although museum specimens are relatively scarce, about 130 recently have become available to us, including six new species, which are described herein.

In his description of *Litometopa,* Sabrosky stated that *Litometopa* is closely related to *Desmometopa* Loew and wrote: "In a sense, it [*Litometopa*] is an extreme form of the latter [*Desmometopa*], with interfrontal hairs and stripes absent, and orbital bristles and mesonotal hairs greatly reduced." In his revision of *Desmometopa,* Sabrosky (1983) recorded several polished black species, which were intermediate between *Desmometopa* and *Litometopa* in that they shared most (plesiomorphic) characters of *Desmometopa* but lacked the (apomorphic) interfrontal stripes. He mentioned the possibility that these were degrees of reduction from the interfrontal stripes of *Desmometopa* but prefered to retain the distinctness of the stripes as uniquely characteristic of *Desmometopa.* According to the phylogenetic study of *Litometopa* and *Desmometopa* present in this paper, *Litometopa* is closely related to some *Desmometopa* species and is part of this genus. Therefore, we include *Litometopa* as a subgenus of *Desmometopa.* Based on new characters, the subgenus *Litometopa* and its type species, *D.* (*Litometopa*) *glabrifrons* (Sabrosky), are redescribed. In her key to genera of Milichiidae Brake (2000) pairs *Litometopa* with the branch leading to *Desmometopa, Leptometopa* Becker, and *Madiza* Fallén, differing by the presence of only one orbital seta and by the absence of interfrontal setulae, except for an anterior pair. The identification of species of *Litometopa* is in some cases quite difficult, because, while they do not differ in male or female terminalia, leg coloration and the shape of the head do differ but these characters are somewhat variable. As an added complication, the shape of the head is sexually dimorphic.

Future research on *Litometopa* should include histological sections of the male abdomen, which contains sclerotized reservoirs of possible glandular function.

The terminology essentially follows McAlpine (1981) with a few exceptions. We follow White et al. (2000) in using "microtrichia" instead of McAlpine's "pruinescence," because the body surface is covered with microscopic outgrowth of the cuticle and not with dust or a waxy substance (pruinose). For the vertical setae we use the terms "medial" and "lateral" (White et al. 2000) instead of the traditional "inner" and "outer," respectively. The terminology of the prothorax follows Speight (1969), and that of the male genitalia Cumming et al. (1995). The definition of "dark" is brown and black. Descriptions are composite. For the most part information given in the description of the genus is not repeated in the species descriptions.

We thank the following curators and institutions for lending specimens.

HU	Museum für Naturkunde der Humboldt Universität, Berlin, Germany (Dr. M. Kotrba)
SMNS	Staatliches Museum für Naturkunde, Stuttgart, Germany (Dr. H.-P. Tschorsnig)
TAU	Tel Aviv University, Tel Aviv, Israel
UBI	Fakultät für Biologie, Universität Bielefeld, Bielefeld, Germany (Dr. M. von Tschirnhaus)
USNM	National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (Dr. W. N. Mathis)

Some paratypes will be deposited in the following institutions (as well as the USNM):

BM	The Natural History Museum, London, U.K.
NMW.Z	National Museum and Galleries of Wales, Cardiff, U.K.
ZFMK	Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany
ZSM	Zoologische Staatssammlung München, Germany

Desmometopa subg. *Litometopa* Sabrosky, **new status**

Litometopa Sabrosky 1965: 4.

Type species: *Litometopa glabrifrons* Sabrosky. Original designation.

Description.—*Head* (Figs. 4–5, 7–8, 10–11): About as long or longer than high, black, only base of arista and often base of palpus yellowish, polished except for microtrichose antenna, fovea, and ventral facial margin. Frons glabrous, polished, 1.3–2.0× as long as broad (length measured from ptilinal fissure to base of postocellar setae; breadth measured at narrowest point between eye margins). Frontal width nearly equal in male and female (Fig. 10); lacking interfrontal stripes or setulae, except pair of setulae anteriorly. Frontal triangle small, not extended beyond ocelli. One reclinate and slightly lateroclinate orbital seta and 2 medioclinate frontal setae. Two proclinate setulae between orbital seta and posterior frontal seta, anterior seta slightly larger than posterior one, possibly representing reduced anterior orbital seta. One medioclinate setula present close and anterior to posterior frontal seta, and one medioclinate setula present anterior to anterior frontal seta. Lateroproclinate ocellar and medial and lateral vertical setae present. Postocellar setae parallel to slightly convergent. Lunule visible, extended to basal part of first flagellomere, triangular, pointed, with pair of setulae. Face concave, antenna short, first flagellomere round; arista long, slender, microscopically pubescent. Vibrissal angle produced,

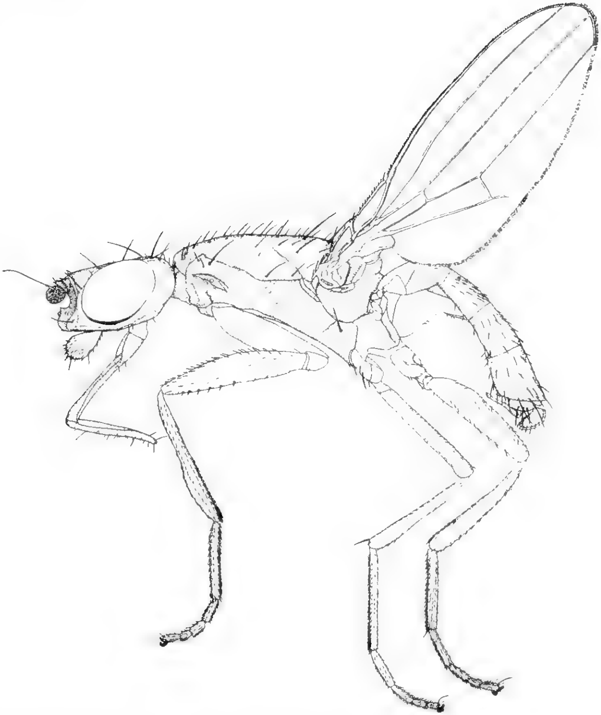


Fig. 1. *Desmometopa dolichocephala*, male, habitus (after Brake 2000).

usually half as broad as first flagellomere, but sometimes equibroad or broader (vibrissal angle measured from anteriormost point of eye margin to anterior tip of vibrissal angle), vibrissa well developed. Gena about 0.1–0.2× as high as eye. Postorbital region (i.e., space between eye and postocular setulae) in male 2–3× longer than in female, up to about a third as long as eye (Fig. 4) (length of eye measured as horizontal line between anteriormost and posteriormost points of eye; length of postorbital region measured at posteriormost point of eye). Palpus flat, elongate spatulate to rather broad (Figs. 6, 9), with small setulae and two longer setae at anterolateral edge; in male entirely microtrichose, in female ventrally glabrous and shiny. Clypeolabral membrane at base of palpus slightly sclerotized. Prementum broader and thicker than combined labella, which have four pseudotracheae each. In female, pseudotracheal teeth on medial pseudotrachea extremely long and thin (Fig. 20, arrow), bent to about 90°, and with small subsidiary tooth at angle. Small subsidiary teeth also present on teeth of other pseudotracheae. In male, teeth on all pseudotracheae about equally long and neither bent nor toothed (Fig. 19).

Thorax: Black, narrow and elongate (Fig. 1). Mesonotum 1.5–2.0× as long as broad, finely shagreened, subshiny, almost bare of setulae, with only dorsocentral row of setulae and median (unpaired) acrostichal row, that becomes 2 irregular rows posteriorly, and few scattered setulae laterally. Anepisternum and furcasternum elongate and fused. Basisternum with precoxal bridge, similar to variant "Q/T" of Speight (1969) (Fig. 12). Pleura strongly shiny, though in part somewhat rugose, anepimeron and katepisternum posteriorly and meron, katatergite and anatergite entirely dull, gray microtrichose. Scutellum shiny, glabrous. Chaetotaxy: 1 long postpronotal seta and 2 postpronotal setulae, of which one may be longer and directed dorsad, 2 notopleural setae, 1 presutural represented by setula, 1 short supraalar, 1 long postalar, 1 short intraalar, 2 dorsocentral setae, anterior one about half length of posterior one, and row of dorsocentral setulae progressively shortened anteriorly, 1 apical and 1 basal scutellar setae, basal seta ½ as long as apical seta, anepisternum bare, 1 katepisternal and no anepimeral seta.

Legs: Foreleg large, appearing raptorial, with elongate coxa and often incrassate femur with anteroventral and posteroventral rows of 6–8 strong spines each (Fig. 1). Forecoxa bright yellow, and foretibia and foretarsus black in all studied species, whereas forefemur varies between species, from predominantly black to almost entirely yellow. Foreleg appears thicker due to brush of black setulae ventrally at distal end of tibia and on tarsus. Mid- and hindlegs more or less normal. Mid- and hindtibiae and mid- and hindtarsi except distal tarsomeres yellow. Basal two tarsomeres of hindleg with posteroventral brush of either pale (yellow) or dark (brown or black) setulae. Pale setulae more coarsly and more spirally fluted than normal black setulae in *D. brachycephala* (Fig. 21). Structure of setulae in brush not studied in other species.

Wing: Hyaline. R_{4+5} and M_{1+2} very slightly convergent (Fig. 13). Last section of M_{1+2} about 2.75× as long as penultimate section. Cell cup closed, but only weakly differentiated.

Abdomen: Black, slender and elongate. Male usually with paired sclerotized internal saclike structures (see next section). Male terminalia similar to those of other *Desmometopa* species. Cercus as large as epandrium in lateral view (Fig. 17); 2–4 long setae laterally on epandrium, number sometimes varying between sides. Surstylus partly fused to epandrium, covered by setulae medially (Fig. 18), similar to flame of candle in ventral view. Pregonite with 2 setulae distally. Distiphallus forming long membranous tube, which is widened in middle, dorsobasally with sclerotized strip.

Female with tergite and sternite 6 and 7 not reduced in size (reduced in many other Milichiidae). Lateral margins of sternite 7 and tergite 7 overlapping (Fig. 22). Sternite 6 anteromedially with small pointed process (Fig. 16). Segment 7 internally with secondary ovipositor (Brake 2000; and see next section). Female internal reproductive system without any sclerotized structures. Spermathecal ducts elongated and loosely (i.e., the ducts are not lying directly next to each other) rolled together distally into one small coil. Spermathecal duct basally wider and possibly surrounded by muscles. Duct and surrounding epithelium in coil narrower. No sclerotized spermathecal capsule. Distal end of spermathecal duct projecting out of coil and surrounded by epithelial gland cells. Tip of duct slightly enlarged (see fig. 24H, *D. sabroskyi,* in Brake 2000).

Peculiarities of the male and female genitalia.—Males of *Litometopa* usually have peculiar paired structures within the fifth abdominal segment (Fig. 14). Each structure consists of two sclerotized reservoirs, which are surrounded by tissue. The reservoirs are elongate sacs connected by ducts, which are sclerotized in the same manner. The duct leading to the anterior reservoir is longer than the one leading to the posterior reservoir. The ducts lie dorsally, but the sacs are directed ventrad. Near the terminalia, the ducts of both reservoirs meet and fuse to form a common duct. The common ducts of either side open close to each other dorsally between the fifth tergite and the terminalia. On each common duct there is a spiracle, probably spiracle 7. A second spiracle lies in the membrane between the duct opening and the fifth tergite. This is probably the spiracle 6. There does not seem to be a valve for the reservoirs. The sclerotized wall of the reservoirs is covered by slight, longish indentations, similar to the surface of a golfball. A few short setulalike structures are on these indentations towards the lumen of the reservoir. It is possible that each of these structures represents a connection between the surrounding tissue and the reservoir. However, in SEM dissections no holes in the tip of the setulalike structures could be discerned. The reservoirs in all dissected specimens (both dry and alcohol-preserved material) seemed to be empty. We suppose that this structure represents a gland, based on the tissue surrounding the reservoirs and on the setulalike structures in the reservoirs. We will use the term "abdominal reservoirs" for this structure. The abdominal reservoirs possibly evolved from synsternite 7/8, which is absent in *Litometopa*, because the 6th and 7th spiracle are often in synsternite 7/8 in Milichiidae and especially in *Desmometopa*.

In females there is a specialized structure inside segment 7, which is called a secondary ovipositor and is used for oviposition (Fig. 15) (Brake 2000). Presumably, while ovipositing, the secondary ovipositor is everted telescopelike between sternite 7 and the subanal plate. Basally the structure consists of a broad membranous ring with many anteriorly directed barbed spines. Distally there are two weakly sclerotized strips each with a row of yellow setulae. These strips originate ventrolaterally and meet dorsally at the functional tip of the ovipositor. Between these strips, which represent sternite 8, lies the genital opening. When the secondary ovipositor is retracted, only the basal part is turned over, with the barbed spines now directed posteriorly. In addition to the secondary ovipositor, *Litometopa* is characterised by a very small tergite 8, a bare supra-anal plate and short, round cerci. This combination of characters is not restricted to the subgenus *Litometopa*, but is found in *Desmometopa* species and in *Pholeomyia* and is therefore probably plesiomorphic.

Distribution.—Afrotropical (Fig. 2): Ethiopia, Kenya, Tanzania, Uganda, Rwanda, Congo, Nigeria, and South Africa. This apparently disjunct pattern indicates a possibly wider and more homogenous distribution in the Afrotropical Region.

Biology.—Nothing is known about the biology of *Litometopa* species. Most specimens were swept with a net from flowers, savanna trees and bushes, and some specimens were sampled by canopy fogging.

Since sclerotized reservoirs are found in the abdomen of males only, it is possible that they represent glands that produce sex pheromones. Abdominal glands are quite rare in Diptera. Hennig (1973) gives an overview of the known cases. If only present in one sex, glands were found mostly in females, for example in Phoridae, Lauxaniidae, and some Tephritidae. However in other Tephritidae, Chloropidae (*Thaumatomyia notata* Meigen), and Milichiidae (*Madiza glabra* Fallén) glands were found only in males. These glands have no similarity to the abdominal reservoirs in *Litometopa,* because they are not sclerotized. The only record of sclerotized glandlike structures is from Empididae (Smith and Davies 1964). However, in contrast to *Litometopa,* the two pairs of abdominal organs of males of *Austrodrapetis* lie beneath the third and fourth tergite and have no apparent opening to the surface. Rectal glands are known from Sepsidae, Tephritidae, and Coelopidae and were shown to have a defensive function in Sepsidae (Meier and Dettner 1998).

Cladistic analysis.—The data set for the computer-based cladistic analysis comprises 19 characters and 13 taxa, including 12 spe-

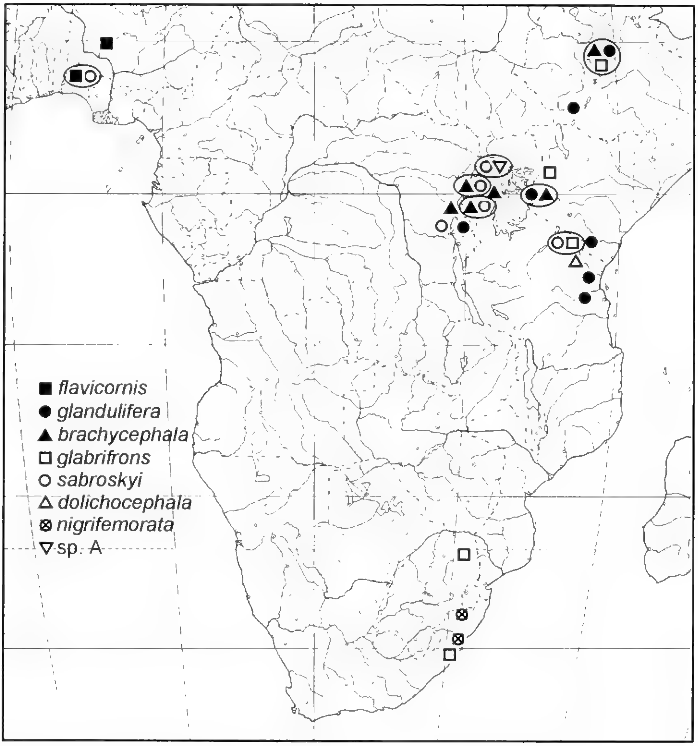


Fig. 2. Distribution records of *Desmometopa* (*Litometopa*) in Africa.

cies of *Desmometopa* and the stem-species pattern of Milichiidae as an outgroup. *Desmometopa m-nigrum* Zetterstedt is a representative of the subgenus *Desmometopa* Loew; *D. tarsalis* Loew, *D. floridensis* Sabrosky, *D. meridionalis* Sabrosky, and *D. melanderi* Sabrosky are representatives of the subgenus *Platophrymia* Williston of *Desmometopa*, and the other species belong to the subgenus *Litometopa* Sabrosky. All characters were treated as unordered. The cladistic analysis was carried out using the exhaustive search option "ie" of Hennig86, which finds the most parsimonious cladogram(s). The precise character distribution can be seen in the data matrix (Table 1).

HEAD

1. Interfrontal stripes: (0) not present; (1) present. In *Desmometopa* and some *Pholeomyia* and *Phyllomyza* species, the row of interfrontal setulae is emphasized by sclerotizations at the base of the setulae and the development of microtrichia. In such cases the rows are called interfrontal stripes. Interfrontal stripes are the only known apomorphic character for the genus *Desmometopa* (Sabrosky 1983).
2. Posterior orbital seta: (0) present; (1) absent. According to Brake (2000) the small medio-reclinate seta posterior to

Table 1. Character matrix for species of *Desmomentopa (Litometopa)* and outgroup.

	[illegible]
Stem-species pattern of Milichiidae	00000 0?000 00[illegible]
D. (D.) m-nigrum	10000 00000 [illegible]
D. (P.) tarsalis	10000 11000 00[illegible]0 0010
D. (P.) floridensis	10000 11000 00110 0010
D. (P.) meridionalis	10000 11100 00110 0010
D. (P.) melanderi	10000 11100 00010 0010
D. (L.) dolichocephala	01101 11111 11113 1101
D. (L.) glabrifrons	01111 10011 1111[illegible]
D. (L.) glandulifera	01111 11011 1111[illegible]
D. (L.) sabrosky	[illegible]
D. (L.) flavicornis	[illegible]
D. (L.) nigrifemorata	01110 11[illegible]
D. (L.) brachycephala	[illegible]

the large lateroclinate orbital setae in *Desmometopa* is homologous to the posterior ("upper") orbital seta in the stem-species pattern of Milichiidae. This seta is apomorphically absent in *Litometopa*.

3. Middle orbital seta: (0) lateroclinate; (1) latero-reclinate. As discussed above, the posterior orbital seta in *Litometopa* is absent. Therefore the posteriormost orbital seta in this subgenus is probably homologous to the middle orbital seta in the stem-species pattern of Milichiidae (Brake 2000). A change in the inclination of the middle orbital seta from lateroclinate and only slightly reclinate to mainly reclinate and only slightly lateroclinate occurred several times within the Milichiidae and is apomorphic for *Litometopa*. The anterior orbital seta in *Litometopa* is possibly represented by the anterior of two setulae between middle orbital seta and frontal setae.
4. Anterior frontal seta: (0) 0.66–1.00× as long as posterior frontal seta; (1) about half as long as posterior frontal seta. In Milichiidae the frontal setae usually have the same length.
5. Setulae between frontal setae: (0) two; (1) one. The number of setulae between the frontal setae in Milichiidae is often two. In *Desmometopa* the number is two in all studied species of the subgenera *Desmometopa* and *Platophrymia*. Therefore the presence of only one setula is considered to be apomorphic.
6. Face: (0) not concave; (1) concave. The comparatively protuberant ventral margin of the head and deeply concave face as seen in profile, is one of the characters Sabrosky (1983) used to separate the subgenus *Platophrymia* from the subgenus *Desmometopa*, in which the face is only slightly concave. Since the face is only slightly concave in most Milichiidae, this character state is supposed to be plesiomorphic.
7. Palpus coloration in male: (0) basally yellow; (1) entirely black. The coloration of the palpus varies within Milichiidae and within *Desmometopa*. Therefore the polarity of this character is unknown.
8. Palpus shape in male: (0) not enlarged; (1) enlarged. In the stem-species pattern of Milichiidae the palpus is short and clavate. The shape of the palpus in several *Desmometopa* species differs from the stem-species pattern in that it is slightly longer with the width a third of the vertical eye diameter or more. Within *Desmometopa* an enlarged palpus occurs in two species of the subgenus *Desmometopa* and in less than half of the species of *Platophrymia*.
9. Palpus microtrichia in female: (0) entirely microtrichose; (1) polished ventrally. In all Milichiidae we studied (for list of studied species see Brake 2000), including members of *Desmometopa*, the palpus is entirely microtrichose. Therefore a ventrally polished palpus is considered apomorphic.

THORAX

10. Presutural seta: (0) as long as or longer than supraalar seta; (1) shorter than su-

praalar seta. The size reduction of the presutural seta is apomorphic for *Litometopa.*

11. Mesonotum setulation: (0) with many setulae; (1) almost bare of setulae except for dorsocentral row of setulae and median (unpaired) acrostichal row, that becomes two irregular rows posteriorly, and few scattered setulae laterally. In all Milichiidae we studied, the mesonotum is covered by many acrostichal setulae. The reduction of the number of acrostichal setulae is therefore considered apomorphic for *Litometopa.*
12. Suture between anepisternum and furcasternum (0) present; (1) absent. In all Milichiidae we studied, the suture between anepisternum and furcasternum is present. The absence of this suture is therefore considered apomorphic for *Litometopa.*

LEGS

13. Forecoxa coloration: (0) black; (1) yellow. In most Milichiidae all coxae are black. However, the forecoxa is yellowish in several species of *Neophyllomyza* and *Leptometopa.*
14. Forecoxa: (0) not elongate; (1) elongate. In *Litometopa* and *Platophrymia* the thorax and forecoxa are elongate, especially in relation to the height of the thorax at the base of the coxa.
15. Forefemur coloration: (0) black; (1) slightly yellow at base; (2) basal 0.25–0.60 yellow; (3) almost entirely yellow except for anterodorsal brown stripe distally. In most Milichiidae, including members of *Desmometopa,* the forefemur is black. Therefore a yellow forefemur is considered apomorphic.
16. Midfemur and hindfemur coloration, except for apices: (0) black; (1) yellow. In most Milichiidae, including members of *Desmometopa,* the midfemur and hindfemur are black. Therefore yellow mid- and hindfemora are considered apomorphic.
17. Apices of midfemur and hindfemur: (0) black; (1) yellow. Dark legs with yellow apices of the midfemur and hindfemur are known in several species of Milichiidae, but seem to have evolved several times independently. As the apices are black in all studied species of the subgenera *Desmometopa* and *Platophrymia,* yellow apices are considered to be apomorphic.
18. Posteroventral brush on hindtarsus: (0) black or brown; (1) yellow. The coloration of this brush varies within Milichiidae, and the polarity of this character is unknown.

ABDOMEN

19. Sclerotized reservoires in male abdomen: (0) absent; (1) present. Sclerotized reservoirs are unique to *Litometopa* and have neither been found in other Milichiidae, nor in other acalyptrate flies.

The cladistic analysis found 48 most parsimonious trees of 32 steps (consistency index: 0.65; retention index: 0.86). The Nelson tree of these 48 trees is depicted in Fig. 3.

Discussion (numbers in square brackets refer to the characters used in the cladistic analysis).—*Litometopa* is closely related to *Desmometopa* (*Platophrymia*) (Sabrosky 1965, 1983), sharing the shiny black lateroventral corner of the facial plate, immediately mesad of the vibrissal angle and the concave face [6] (Brake 2000). However, there are two rows of strong spines on the forefemur in *Litometopa,* but only one anteroventral row of weak spines in these *Platophrymia* species. Within *Platophrymia, Litometopa* is most closely related to the group around *D. floridensis, D. melanderi,* and *D. meridionalis,* sharing the enlarged palpus [8] and the elongated yellow [13, 14] forecoxa and often incrassate forefemur. However, *Litometopa* is Afrotropical, whereas the related *Platophrymia* spp. are Nearctic or Neotropical. The close relationship between *Litometopa* and some *Plato-*

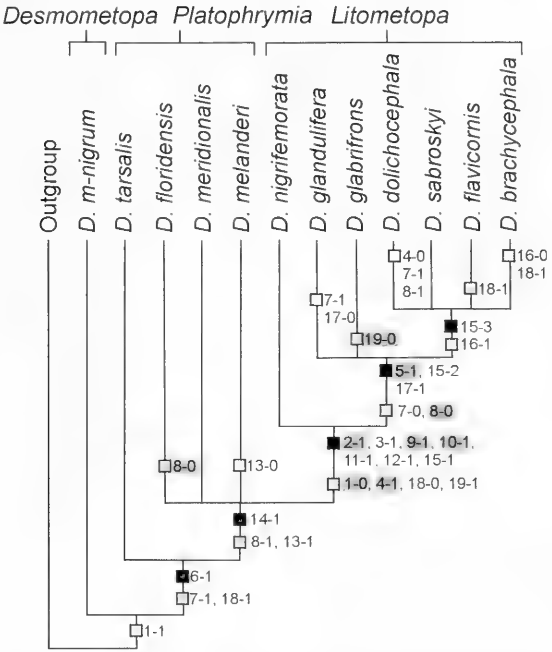


Fig. 3. Phylogenetic tree of *Desmometopa* subgenera; shaded hatchmarks indicate character changes that either reverse or evolved at least twice on the tree; black hatchmarks indicate changes that do not reverse and evolved only once; reductions are marked with a dark shading.

phrymia species results in a paraphyly of *Platophrymia*. However, we have decided to keep both subgenera separate, as they are easily recognisable and differ from each other in several characters, and a more rigorous phylogenetic study of *Platophrymia* and of the whole genus *Desmometopa*, which would clarify the presence of monophyletic groups within the genus, is still needed.

The subgenus *Litometopa*, as diagnosed above, is clearly a monophyletic group. Its apomorphies are: [2] posterior orbital seta lost (plesiomorph: present); [3] middle orbital seta (in *Litometopa* the actual posterior seta) reclinate (plesiomorph: lateroclinate); anterior orbital seta reduced in size (plesiomorph: as large as the other orbital setae); [9] female palpus polished ventrally (plesiomorph: palpus entirely microtrichose); [10] presutural seta reduced in size (plesiomorph: not reduced); [11] mesonotum almost bare of setulae (plesiomorph: covered with setulae); [12] suture between anepisternum and furcasternum lost (plesiomorph: present); and probably also [19] the presence of abdominal reservoirs in males (plesiomorph: not present), though the state of this character is unknown for *D. nigrifemorata*.

Within *Litometopa*, the yellow forefemur [15–3] is the synapomorphic character of a clade comprising *D. brachycephala, D. dolichocephala, D. flavicornis,* and *D. sabros-*

kyi. These four species together with *D. glabrifrons* and *D. glandulifera* form a clade that is supported by the following apomorphic characters: only one setula present between frontal setae [5–1], basal 0.25–0.60 of forefemur yellow [15–2], and apices of mid- and hindfemora yellow [17–1].

KEY TO SPECIES OF *DESMOMETOPA* (*LITOMETOPA*)

1. Posteroventral brush of hindtarsus yellow . . . 2
– Posteroventral brush of hindtarsus black or brown 4
2. Mid- and hindfemora black. Male with first flagellomere black . . . . *D.* (*L.*) *brachycephala,* new species
– Mid- and hindfemora yellow. Male with first flagellomere yellowish medially and basally 3
3. Male with postorbital region about ⅙ as long as eye . . . . *D.* (*L.*) *flavicornis,* new species
– Male with postorbital region about ⅒ as long as eye . . . . *D.* (*L.*) species A
4. Femora yellow 5
– At least distal ⅖ of forefemur black; mid- and hindfemora mainly or entirely black 6
5. Head of male (Fig. 7) distinctly longer than high, vibrissal angle distinctly produced and antenna in deep fovea. Head of female (Fig. 8) not distinctly longer than high, vibrissal angle less produced than in male. Palpus black and enlarged in both sexes (Fig. 9). Anterior frontal seta 0.66–1.00× as long as posterior frontal seta . . . . *D.* (*L.*) *dolichocephala,* new species
– Head of both sexes as long as high, vibrissal angle only slightly produced in both sexes (Fig. 11). Palpus black or yellow with black tip, not enlarged. Anterior frontal seta less than half as long as posterior frontal seta . . . . *D.* (*L.*) *sabroskyi,* new species
6. Forefemur almost entirely black, only slightly yellow at base. Mid- and hindfemora entirely black. Both sexes with black enlarged palpus (as in Fig. 9) . . . . *D.* (*L.*) *nigrifemorata,* new species
– Forefemur yellow on basal 0.25–0.60, rest black. Mid- and hindfemora entirely black, or apices yellow. Palpus not enlarged, base often yellow (as in Fig. 6) 7
7. Forefemur yellow on basal 0.60. Apex of mid- and hindfemora yellow . . . . *D.* (*L.*) *glabrifrons* (Sabrosky 1965)
– Forefemur yellow on basal 0.25–0.40. Mid- and hindfemora entirely black . . . . *D.* (*L.*) *glandulifera,* new species

Desmometopa (*Litometopa*) *brachycephala* Brake and Freidberg, new species

(Figs. 4–6, 19–21)

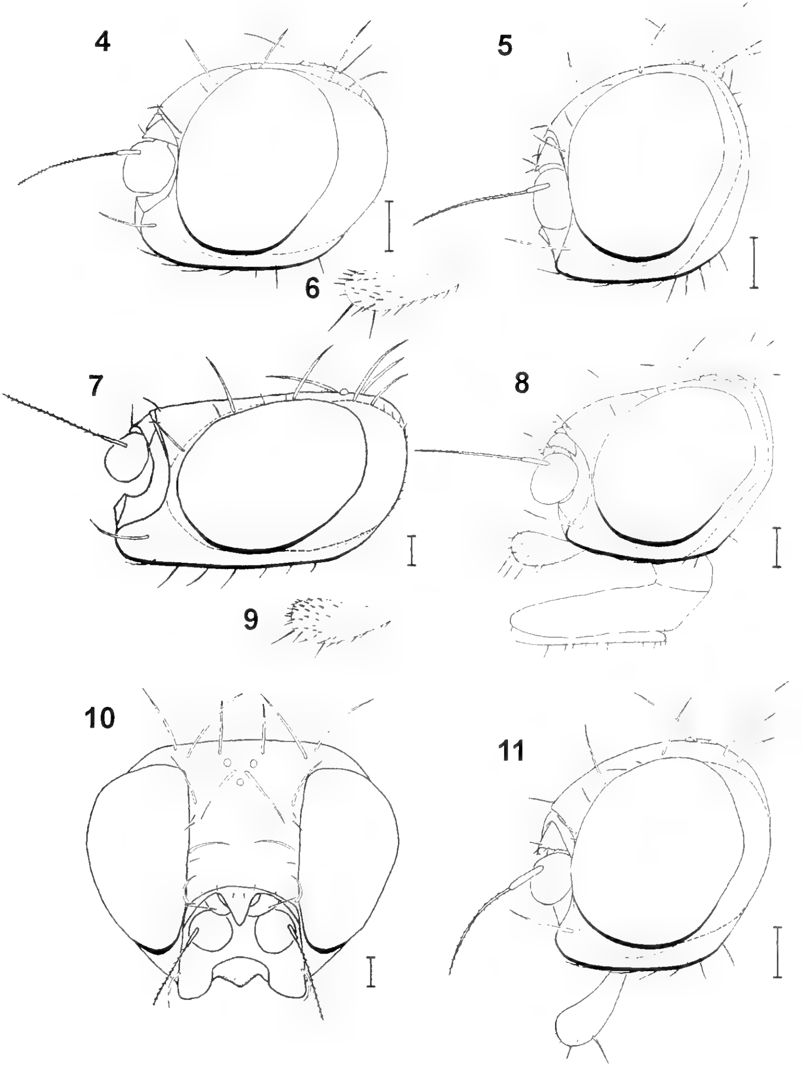
Litometopa sp. 2: Brake 2000: 11.

Diagnosis.—This species is distinguished from its congeners by the following combination of characters: Forefemur almost entirely yellow, with anterodorsal brown stripe distally; mid- and hindfemora predominantly black, apices yellow; posteroventral brush on hindtarsus yellow.

Male.—Predominantly black; forecoxa, forefemur except anterodorsal brown stripe distally, apices of mid- and hindfemora, mid- and hindtibiae, and mid- and hindtarsi except distal tarsomeres yellow. Palpus largely yellow with black tip. Posteroventral brush on hindtarsus yellow. *Head:* Anterior frontal seta about half as long as posterior frontal seta (Fig. 4). Postorbital region very long, about ⅓ as long as eye. Palpus as in Fig. 6. *Wing:* Length: 1.8–2.6 mm (holotype: 2.5 mm). *Abdomen:* Tergites 1–4 microtrichose and subshiny medially, lateral and posterior margins polished; microtrichose spots progressively decreasing posteriorly, so that tergite 4 microtrichose only anteromedially or entirely polished. Tergite 5 and all sternites polished. Abdominal reservoirs present. Male genitalia as in Fig. 16.

Female (Fig. 5).—Differs from male in palpus more extensively black and slightly broadened.

Type material.—Holotype male: "UGANDA. S.W.: Fort Portal, 5 km NW, 2,000 m, 10.I.1996, I. Yarom & A. Freidberg." The holotype is double mounted, is in excellent condition, and is deposited in TAU. Paratypes: 10 ♂ and 3 ♀, same collection data as holotype (TAU, USNM). UGANDA. S.W. Kabale, 7 km NE, 1,950 m, 23.XII.1995, I. Yarom & A. Freidberg (5 ♂; TAU); Mpigi, 1,400 m, 40 km SW Kampala, 22.XII.1995, I. Yarom & A. Freidberg (2 ♂; TAU); Kisoro, 2,000 m, 26.XII.1995, I. Yarom & A. Freidberg (1 ♂; TAU). KENYA. Bungoma, 12.–



Figs. 4–11. 4–6, *Desmometopa brachycephala*. 4, Head, lateral view, male. 5, Head, lateral view, female. 6, Palpus, male. 7–10, *D. dolichocephala*. 7, Head, lateral view, male. 8, Head, lateral view, female. 9, Palpus, male. 10, Head, frontal view. 11, *D. sabroskyi*, head, lateral view, male. Scales: 0.1 mm.

13.I.1996, I. Yarom & A. Freidberg (1 ♂, forelegs missing; TAU); 10.X.1998, F. Kaplan & A. Freidberg (1 ♂; TAU). ETHIOPIA. Shewa, Wendo Genet, 2,100 m, 29.I.2000, A. Freidberg & I. Yarom (6 ♂, 5 ♀; TAU, NMW.Z, BM); 1,900 m, 28.I.2000, A. Freidberg & I. Yarom (9 ♂, 3 ♀; TAU, SMNS).

Non-type material.—KENYA. West Pokot, Chepareria, 4–5.XI.1983, A. Freidberg (1 ♀; TAU). UGANDA. S.W. Ishaka, 25 km N, 1,900 m, 5.I.1996, I. Yarom & A. Freidberg (1 ♀; TAU).

Etymology.—The species name is derived from the Greek *brachys* = short and *cephalae* = head, denoting the short head.

Remarks.—The non-type female from Kenya differs from the type specimens in the black apex of the forefemur. The non-type female from Uganda was not added to the type series, because the head is shriveled.

Desmometopa (*Litometopa*) *dolichocephala* Brake and Freidberg, new species
(Figs. 1, 7–10, 17–18)

Litometopa sp. 1: Brake 2000: 11.

Diagnosis.—This species is distinguished from its congeners by the following combination of characters: Male with head longer than high, distinctly produced vibrissal angle, and strongly warped upward facial margin. Both sexes with anterior frontal seta 0.66–1.00× as long as posterior seta. Palpus black and enlarged. Forefemur almost entirely yellow with anterodorsal brown stripe distally; mid- and hindfemora yellow; posteroventral brush on hindtarsus dark.

Male.—Predominantly black; coxae and femora, mid- and hindtibiae and mid- and hindtarsi except distal tarsomeres yellow. *Head:* Anterior frontal seta 0.66–1.00× as long as posterior frontal seta (Figs. 7–8). Postorbital region $\frac{1}{5}$–$\frac{1}{4}$× as long as eye. Vibrissal angle distinctly produced anteriorly, as broad as first flagellomere, the angle emphazised by shiny black lateroventral corner of facial plate immediately mesad of vibrissal angle and usually warped forward and upward beyond it. Ventral margin of head comparatively long and face deeply concave as seen in profile, antenna in deep fovea. Palpus enlarged (Fig. 9). *Wing:* Length: 1.9–2.8 mm (holotype: 2.6 mm). *Abdomen:* Tergites 1–4 microtrichose and subshiny medially, lateral and posterior margins polished, microtrichose spots progressively decreasing posteriorly, so that tergite 4 is microtrichose only anteromedially. Tergite 5 and all sternites polished. Abdominal reservoirs present. Male genitalia as in Figs. 17–18.

Female.—Differs from male in head not elongated (Fig. 8) and vibrissal angle less than half as long as first flagellomere.

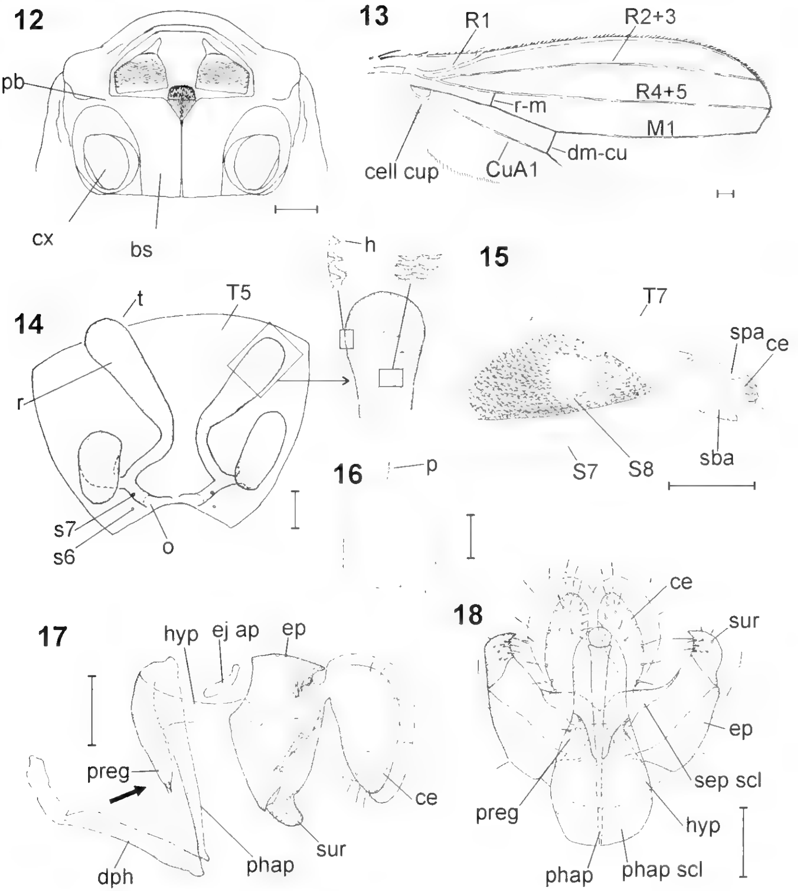
Type material.—Holotype male: "TANZANIA, Same, Rt. B1, 8–16.IX.1992, A. Freidberg." The holotype is double mounted, is in excellent condition, and is deposited in TAU. Paratypes: 9 ♂ and 1 ♀, same collection data as holotype (TAU, USNM). TANZANIA. Same, Rt. B1, 22.VIII.1996, A. Freidberg (2 ♂; TAU); 8.IX.1996, A. Freidberg (7 ♂, 1 ♀; TAU, HU).

Etymology.—The species name is derived from the Greek *dolichos* = long and *cephalae* = head, denoting the particularly long head of the male.

Desmometopa (*Litometopa*) *flavicornis* Brake and Freidberg, new species

Diagnosis.—This species is distinguished from its congeners by the following combination of characters: First flagellomere in male yellowish medially and at extreme base, dark only around base of arista; forefemur in both sexes almost entirely yellow, with anterodorsal brown stripe distally; mid- and hindfemora yellow; posteroventral brush on hindtarsus yellow.

Male.—Predominantly black; forecoxa, forefemur except anterodorsal brown stripe distally, mid- and hindfemora, mid- and hindtibiae, and mid- and hindtarsi except distal tarsomeres yellow. Palpus yellow



Figs. 12–18. 12, *Desmometopa sabroskyi*, prothorax, ventral view (from Brake 2000), bs—basisternum, cx—base of coxa, pb—precoxal bridge. 13–14, *Desmometopa* sp. A, male. 13, Wing (from Brake 2000), CuA—anterior cubitus, cell cup—posterior cubital cell, dm-cu—discal medial-cubital crossvein, M—media, R—radius, r-m—radial-medial crossvein. 14, Abdominal reservoirs, ventral view, h—setulae on indentations, r—reservoir, t—tissue, o—opening, s—spiracle, T—tergite. 15–16, *D. sabroskyi*, female. 15, Tip of ovipositor with secondary ovipositor inverted, lateral view (from Brake 2000), ce—cerci, S—sternite, sba—subanal plate, spa—supra-anal plate, T—tergite. 16, Sternite 6 (from Brake 2000), p—process at anterior margin. Scales: 0.1 mm. 17–18, *D. dolichocephala*, male terminalia. 17, Lateral view. 18, Viewed in direction of black arrow in Fig. 17. Scales: 0.1 mm.

with light brown to brown tip. Posteroventral brush on hindtarsus yellow. *Head:* Anterior frontal seta half as long as posterior frontal seta. Postorbital region about $\frac{1}{6}\times$ as long as eye. Palpus as in Fig. 6. *Wing:* Length: 2.1–2.5 mm (holotype: 2.2 mm). *Abdomen:* Tergites 1–5 microtrichose and subshiny medially, polished laterally. Abdominal reservoirs present. Male genitalia as in Fig. 17.

Female.—Differs from male in entirely black first flagellomere. Palpus black except mesobasally.

Type material.—Holotype male: "NIGERIA: Ife, 2 Aug. 1969/J. T. Meddler Coll." The holotype is double mounted, is in excellent condition, and is deposited in the USNM. Paratypes: 2 ♂ and 2 ♀, same collection data as holotype (USNM). NIGERIA. Niger State: Mariga River, 80 km NW Minna, 11.XII.1987, Fini Kaplan (1 ♀; TAU).

Etymology.—The species name is derived from the Latin *flavus* = light and *cornus* = horn, denoting the yellowish first flagellomere of the males.

Desmometopa (*Litometopa*) *glabrifrons* (Sabrosky), **new combination**

Litometopa glabrifrons Sabrosky 1965: 4.

Diagnosis.—This species is distinguished from its congeners by the following combination of characters: Basal $\frac{3}{5}$ of forefemur yellow, remainder black; mid- and hindfemora black, except for apices; posteroventral brush on hindtarsus dark; male without abdominal reservoirs.

Male.—Predominantly black; basal $\frac{2}{3}$ of palpus, forecoxa, basal $\frac{3}{5}$ of forefemur, apices of mid- and hindfemora, mid- and hindtibiae and mid- and hindtarsi except distal tarsomeres yellow. *Head:* Anterior frontal setae half as long as posterior frontal seta. Postorbital region $\frac{1}{5}$–$\frac{1}{6}$ as long as eye. Palpus as in Fig. 6. *Wing:* Length: 2.2–2.6 mm (holotype: 2.6 mm). *Abdomen:* Tergites 1–4 microtrichose and subshiny medially, polished laterally, microtrichose spots progressively decreasing posteriorly; tergite 5 and all sternites polished. Abdominal reservoirs absent, but small base of ducts present (in dissections of paratype and nontype material). Male genitalia as in Fig. 17.

Female.—Differs from male in basal half of palpus yellow and palpus slightly broader.

Type material.—The holotype male bears several labels: "O. Afrika, T. T. Marangu, 1.–20. Maerz 1959, Lindner leg." On the lower side of the label the date is specified as "17.III." The second label reads "Holotype, *Adesmometopa glabrifrons,* male, C. W. Sabrosky." The third label says "*Adesmometopa glabrifrons,* det. Sabrosky." The fourth label reads "*Litometopa glabrifrons* Sabrosky." The second and third labels were probably written by Sabrosky himself and indicate that he first considered naming the genus *Adesmometopa.* However, in his description he named the genus *Litometopa* and therefore the correct name is stated on the fourth label, which was probably not written by Sabrosky himself. The holotype is double mounted, is in good condition except for the slightly shriveled head, and is deposited in the SMNS. One male paratype bears the first label with the same data as the holotype but with "10.III." on the lower side (USNM). The second label says "Paratype, *Litometopa glabrifrons,* male, C.W. Sabrosky," and the third label reads "*Litometopa glabrifrons,* det. Sabrosky." For the other two original paratypes see below.

Additional specimens examined.—TANZANIA. Marangu, E. Lindner, 10.III.1959 (1 ♀; SMNS). SOUTH AFRICA. Natal, Uvongo, South Coast, 11.X.1983, A. Freidberg (2 ♂, 1 ♀; TAU); North Transvaal, Tzaneen, 1977, Van Eeden, at *Euphorbia* flowers (1 ♀; USNM). KENYA (West). Kapenguria—Tartar Road, 24.XI.1989, A. Freidberg & F. Kaplan (1 ♀; TAU). ETHIOPIA. Shewa, Wendo Genet, 1,900 m, 28.I.2000, A. Freidberg & I. Yarom (1 ♂; TAU); 2,100 m, 29.I.2000, A. Freidberg & I. Yarom (2 ♂; TAU).

Remarks.—Two of the original paratypes, one male and one female (allotype), were found not to be conspecific with the holotype and are redescribed below as *D. sabroskyi*. These two specimens differ from the holotype of *D. glabrifrons* by the yellow mid- and hindfemora and the almost entirely yellow forefemur with an anterodorsal brown stripe distally.

One male from South Africa, Natal, Uvongo, differs from the holotype in the forefemur being black on the distal half posteriorly and distal ⅖ anteriorly and in the shape of the head, which is similar to *D. brachycephala*. The female from South Africa, North Transvaal, differs from the holotype in the black apices of the mid- and hindfemora. These specimens nevertheless are considered variants of *D. glabrifrons*.

Desmometopa (*Litometopa*) *glandulifera* Brake and Freidberg, new species

Diagnosis.—This species is distinguished from other congeners by the following combination of characters: Basal ¼–⅖ of forefemur yellow, rest black; mid- and hindfemora black; posteroventral brush on hindtarsus dark.

Male.—Predominantly black; forecoxa, basal ¼–⅖ of forefemur, mid- and hindtibiae and mid- and hindtarsi except distal tarsomeres yellow. Mid- and hindtibiae in some specimens quite dark. Palpus brown with darker tip, but in some specimens palpus mesobasally yellow. *Head:* Anterior frontal seta half as long as posterior frontal seta. Postorbital region ⅙–⅕× as long as eye. Palpus as in Fig. 6, in some specimens slightly narrower. *Wing:* Length: 1.9–2.4 mm (holotype: 2.4 mm). *Abdomen:* Tergites 1–4 microtrichose and subshiny medially, polished laterally, microtrichose spots progressively decreasing posteriorly; tergite 5 and all sternites polished. In some specimens anterior margin of tergite 5 subshiny. Abdominal reservoirs present. Male genitalia as in Fig. 17.

Female.—Does not differ from male except for the usual differences between male and female.

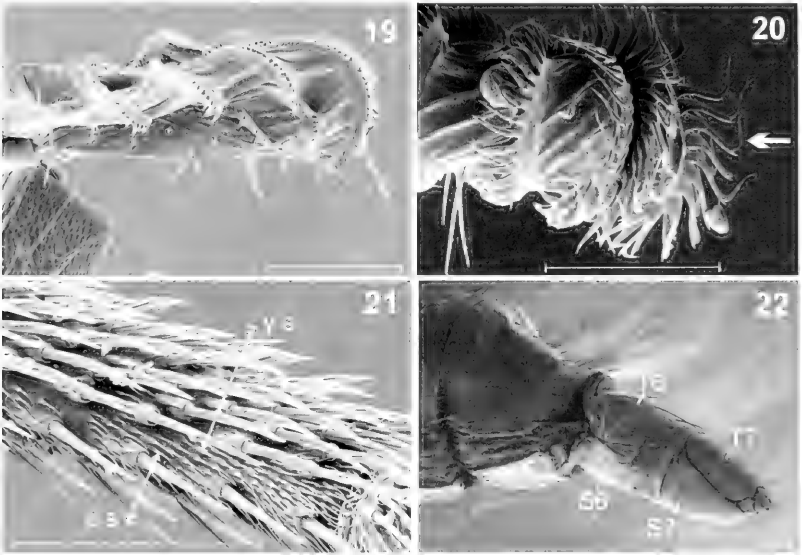
Type material.—Holotype male: "ETHIOPIA: Shewa, Wendo Genet, 1,900 m, 28.I.2000, A. Freidberg & I. Yarom." The holotype is double mounted, is in excellent condition, and is deposited in TAU. Paratypes: 3 ♂ and 1 ♀, same collection data as holotype (TAU, USNM). ETHIOPIA. Shewa, Wendo Genet, 2,100 m, 29.I.2000, A. Freidberg & I. Yarom (1 ♂; TAU); Gamo, Gofa, 3 km NE Arba Minch, 1,300 m, 'Forest', 5.II.2000, A. Freidberg & I. Yarom (1 ♀; TAU). KENYA. Bungoma, 12.–13.I.1996, I. Yarom & A. Freidberg (1 ♀; TAU). KENYA. Kabarnet, 11.–12.X.1998, F. Kaplan & A. Freidberg (1 ♂; TAU); Tsavo West, Ngulia Lodge, 16.–17.VIII.1983, A. Freidberg (1 ♀; TAU). RWANDA. Rusumu, Ibanda Makera, 2°09′S/30°55′E, 1,350 m, canopy fogging on *Teclea nobilis*, gallery forest; 7.XI.1993, Th. Wagner, stored in ethanol (X 1006-T.n.5, 1 ♀; X 1006-T.n.6, 1 ♂; X 1006-T.n.8, 1 ♂; X 1006-T.n.10, 1 ♂) (ZSM, ZFMK, UBI). TANZANIA. Lugoba, Rt B 1218, 25.VIII.1996, A. Freidberg (3 ♂, 1 ♀; TAU); Manga, Rt. B1218, 6.IX.1996, A. Freidberg, on mango, (1 ♂; TAU).

Etymology.—The species name is derived from the Latin *glands* = gland and *ferre* = carry, bear, denoting the abdominal reservoirs.

Desmometopa (*Litometopa*) *nigrifemorata* Brake and Freidberg, new species

Diagnosis.—This species is distinguished from its congeners by the following combination of characters: Both sexes with entirely black and enlarged palpus; forefemur black except for base; mid- and hindfemora black; posteroventral brush on hindtarsus dark.

Male.—Predominantly black; forecoxa, base of forefemur, mid- and hindtibiae and mid- and hindtarsi except distal tarsomeres yellow. Palpus black. *Head:* Anterior frontal seta half as long as posterior frontal seta. Two setulae between frontal setae. Length



Figs. 19–22. SEM, 19–21, *Desmometopa brachycephala.* 19, Labella, lateral view, male. 20, Tip of labella, lateral view, female. 21, First tarsomere of hindleg, female, y s—yellow setae, d s—dark setae. 22, *D. sabroskyi*; ovipositor, lateral view (from Brake 2000), S—sternite, T—tergite. Scales: 0.1 mm.

of postorbital region not recognizable because of shriveled head. The same holds true for the vibrissal angle. Palpus as in Fig. 9. *Wing:* Length: 2.5–2.6 mm (holotype: 2.6 mm). *Abdomen:* Tergites 1–4 microtrichose and subshiny medially, polished laterally, microtrichose spots progressively decreasing posteriorly; tergite 5 and all sternites polished.

Female.—Differs from male in slightly narrower palpus. In female from Uvongo, anterior frontal seta about ¾× as long as posterior frontal seta.

Type material.—Holotype male: "SOUTH AFRICA: Natal, Uvongo, South Coast, 11.X.1983, A. Freidberg." The holotype is double mounted, is slightly shriveled, and is deposited in TAU. Paratypes: 1 ♀, same collection data as holotype (TAU). SOUTH AFRICA. Itala Game Reserve, 27°30′S/31°20′E, 27.–29.I.1994, U. Göllner (1 ♀; HU).

Etymology.—The species name is derived from the Latin words *niger* = black and *femur* = thigh, femur, denoting the black femora.

Desmometopa (Litometopa) sabroskyi Brake and Freidberg, new species

(Figs. 11–12, 15–16, 22)

Litometopa ?glabrifrons: Brake 2000: 11 (in part).

Diagnosis.—This species is distinguished from its congeners by the following combination of characters: Forefemur almost entirely yellow with anterodorsal brown stripe distally; mid- and hindfemora yellow; posteroventral brush on hindtarsus dark.

Male.—Predominantly black; fore- and hindcoxae, forefemur except anterodorsal brown stripe distally, mid- and hindfemora, mid- and hindtibiae, and mid- and hindtarsi except distal tarsomeres yellow. Palpus yellow with dark tip or entirely dark. *Head:* Anterior frontal seta less than half as long as posterior frontal seta. Postorbital region moderately long, ⅙–⅕× as long as eye (Fig. 11). *Wing:* Length: 1.8–2.0 mm (holotype: 2.0 mm). *Abdomen:* Tergites 1–4 microtrichose and subshiny medially, polished laterally; tergite 5 and all sternites polished.

Female.—Does not differ from male except for the usual differences between male and female.

Type material.—Holotype ♂: "UGANDA: S.W., Fort Portal, 5 km NW, 2,000 m, 10.I.1996, I. Yarom & A. Freidberg." The holotype is double mounted, is in excellent condition, and is deposited in TAU. Paratypes: 1 ♂, same collection data as holotype (TAU); 1 ♀, same collection data but "7.I.1996" (TAU). NIGERIA. Ife, 2. Aug. 1969/J. T. Meddler Coll. (3 ♀; USNM). UGANDA. S.W. Kabale, 7 km NE, 1,950 m, 23.XII.1995, I. Yarom & A. Freidberg (1 ♀; TAU); District Masindi, Budongo Forest, N'River Sonso, 1°45′N/31°25′E, 1,200 m, canopy fogging on *Cynometra alexandri* (C.a.) and *Rinorea beniensis* (= *ardisiifolia*) (R.a.), seasonal rain forest, 19.VI.–31.VII.1995, Th. Wagner, stored in ethanol (X 1259-C.a.3, 2 ♀; X 1259-C.a.16, 1 ♀; X 1259-R.a.1, 2 ♀, X 1259-R.a.3, 3 ♀; X 1259-R.a.7, 1 ♀; X 1259-R.a.12, 1 ♀; X 1259-R.a.13, 1 ♀; X 1259-R.a.15, 1 ♀; X 1259-R.a.16, 1 ♀) (ZSM, ZFMK, UBI). CONGO. Kivu-Sud, Irangi, 1°54′S/28°27′E, 950 m, canopy fogging on *Carapa grandifolia*, rain forest, 7.XI.1993, Th. Wagner, stored in ethanol (X 1006-C.g.5, 6, 15, 18, 1 ♀) (ZSM). TANZANIA. Marangu, 3.III 1959, E. Lindner (1 ♂, 1 ♀, para- and allotype of *D. glabrifrons*, Sabrosky, SMNS).

Etymology.—This species is named in memory of Curtis W. Sabrosky, a friend and dipterist, who dominated the taxonomic study of Milichiidae in the twentieth century and described the genus *Litometopa*.

Remarks.—The female from Uganda, Kabale differs from the holotype in the slightly broader palpus. The male and female from Tanzania, Marangu, and one female from Nigeria, Ife, differ from the holotype in the dark apex of the forefemur.

Desmometopa (*Litometopa*), species A
(Figs. 13–14)

Litometopa ?glabrifrons: Brake 2000: 11 (in part).

These specimens differ from *D. flavicornis* in the shape of the head in male. Postorbital region in male short. Palpus nearly yellow in male, black except for medial base in female, and slightly broader than in male. Mid- and hindfemora yellow to light brown. The females cannot be differentiated from the females of *D. flavicornis.*

Material examined.—UGANDA. District Masindi, Budongo Forest, N'River Sonso, 1°45′N/31°25′E, 1,200 m, canopy fogging on *Rinorea beniensis* (R.a.) and *Teclea nobilis* (T.n.), seasonal rain forest; 19.VI.–31.VII.1995, Th. Wagner, stored in ethanol (X 1259-R.a.3, 4 ♀; X 1259-R.a.17, 1 ♀; X 1259-T.n.12, 2 ♂; X 1259-T.n.13, 1 ♀) (ZSM).

Remarks.—We refrain from naming this species, because there are just two males, which are very similar to *D. flavicornis*, so that species A might just be a variant or subspecies of the latter species. The above listed females cannot be differentiated from the females of *D. flavicornis*, and therefore cannot give support for naming species A.

ACKNOWLEDGMENTS

We are grateful to M. Balke, Dr. K. Kiontke, Prof. Dr. W. Sudhaus, and Dr. W. N. Mathis for reviewing a draft of this paper. We thank Dr. L. Cederholm of the Entomologica Scandinavica Supplements for the permission to use the figures 1, 7, 10, 12–13, 16, and 22 from Brake (2000).

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PROC. ENTOMOL. SOC. WASH.
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NEW PEORIINI (LEPIDOPTERA: PYRALIDAE: PHYCITINAE) FROM BRAZIL

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Abstract.—***Metacommotria beckeri*, n. gen., n. sp., *Cipopeoria camura*, n. gen., n. sp.**, and ***Harnochina digitata*, n. sp.** are described from Brazil. A description is also provided for the female of *Zapalla dentata* Shaffer, the first known female representative of the genus. The latter species, previously known only from the type locality of southeastern Brazil, is herein recorded from Planaltina (Distrito Federal), Alto Paraíso (Goias), and Chapada Guimaraes (Mato Grosso). Photographs of adult moths are provided for all four species, male head profiles for the three new species, and male antenna photomicrographs and wing venation drawings for *M. beckeri* and *C. camura*. Male genitalia photographs are given for *M. beckeri, H. digitata, Z. dentata*, and female genitalia photographs for *C. camura* and *Z. dentata*.

Key Words: Peoriini, Phycitinae, moths, Neotropical, taxonomy

I recently had the pleasure of examining a fine assemblage of approximately 100 specimens of Brazilian Peoriini collected by Vitor Becker. Among these were three undescribed species and the first known female of the genus *Zapalla* Shaffer, that of *Z. dentata* Shaffer.

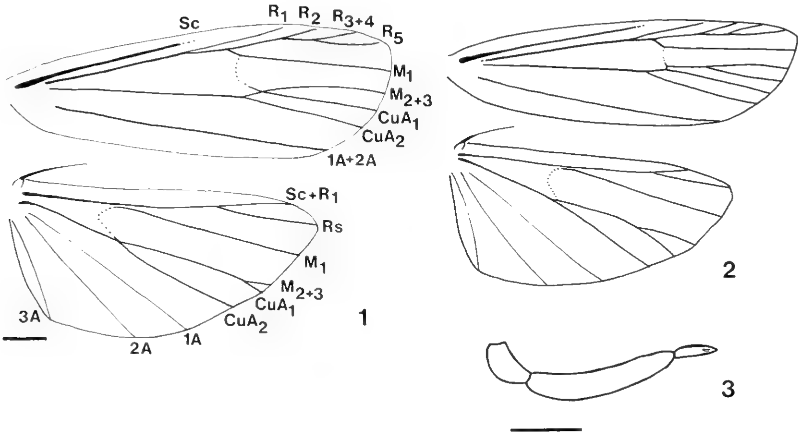
MATERIALS AND METHODS

Prepared microscope slides were mounted in Euparal. Moths and slides were examined using a Wild M5 stereo microscope, and slides were also examined at high power and photographed with an Olympus Vanox AHBT3 microscope. Color names follow the ISCC-NBS Color-Name Charts (Kelly 1965) except for small structures where only general designations could be given. Moths and color samples were viewed together using the Wild microscope and a fluorescent ring light. Holotypes and most paratypes are deposited in the Museu Nacional, Rio de Janeiro [NMRJ], a single paratype each for *M. beckeri* and *C. camura* is deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC [USNM]. All other specimens are in the collection of Vitor Becker [VOB], Brasilia, Brazil.

Metacommotria Shaffer, new genus

Type species.—*Metacommotria beckeri* Shaffer, new species.

Diagnosis.—The male genitalia are similar to those of *Commotria* Berg, particularly in possessing an uncus with a pair of lateral spicate processes which are long, curve cephalad, stout at the base and taper to a sharp point. The medial process of the uncus is somewhat bandlike, not matching that of any particular species of *Commotria*, but falling within the range of variation (most narrowly bandlike) exhibited by that genus. Indeed, this species would fit well within *Commotria* but for the male antennae, which are subserrate rather than pectinate as in *Commotria*.



Figs. 1–3. Wing venation and male palpus. 1, *Metacommotria beckeri.* 2–3, *Cipopeoria camura.* Scale bar = 1 mm (1,2), 0.5 mm (3).

Description.—*Male:* Frons conical. Labial palpus (Fig. 8) porrect to somewhat obliquely ascending with third segment porrect. Maxillary palpus cylindrical, not reaching end of frons. Proboscis much reduced, not usually visible between labial palpi. Ocellus normal, black with clear center, separated from eye by about its own width. Antenna (Fig. 11) shaft subserrate, basal segments fused and enclosed by parallel rows of scales, but otherwise unmodified. Forewing (Fig. 1) with ten veins; R_2 stalked with R_{3+5} about ⅖ length of latter; R_{3+4} stalked about ⅕ that length; from well before upper outer angle of cell; M_1 from the angle; M_{2+3} fused, from lower outer angle of cell, usually from same point as CuA_1 (M_{2+3} well separated from CuA_1 in holotype); CuA_2 from well before the angle. Hind wing with seven veins (1A, 2A, and 3A counted as one vein); M_{2+3} fused and stalked with CuA_1 from about ½ to over ⅘ length of latter, from lower outer angle of cell; CuA_2 from very near the angle.

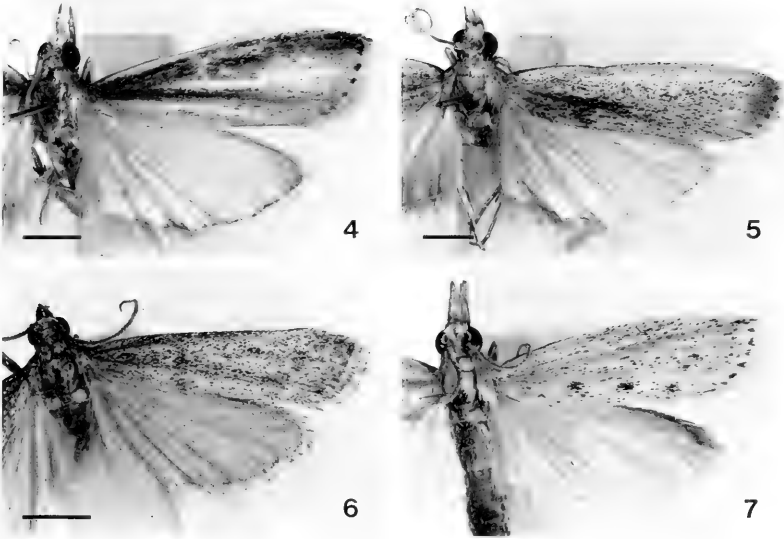
Genitalia (Figs. 13–16) with medial process of uncus an irregular somewhat semicircular band; lateral process a long, curved, sharp-pointed spine. Gnathos arms flat, incomplete, medially with a small sclerite or a few small teeth. Juxta conical, lacking scale tufts. Valva with costa terminating in a small tooth; sacculus hirsute, at base with a cluster of long stiff slightly curved setae, about half as long as valva and parallel to valva axis. Aedoeagus cylindrical, about 4 times as long as wide; vesica with two cornuti (Figs. 15–16), one approximately twice as large as the other, each bearing small pointed scales on one side; vesica devoid of microspines.

Etymology.—The generic name is formed by adding the Greek *meta* (in its meaning of near) to *Commotria,* in reference to the similarity in male genitalia. The name is not necessarily intended to imply close phylogenetic relationship. Gender: feminine.

Metacommotria beckeri Shaffer, new species

(Figs. 1, 4, 8, 11, 13–16)

Diagnosis.—This is the only known species in the genus.



Figs. 4–7. Adults showing right wings. 4, *Metacommotria beckeri*, holotype. 5, *Cipopeoria camura*, holotype. 6, *Harnochina digitata*, holotype. 7, *Zapalla dentata*, ♂, Alto Paraíso, Brazil; to show 3 spots on vein 1A+2A. Scale bar = 2 mm (6 & 7 to same scale).

Description.—*Male:* Frons brownish pink dorsally, light brownish pink to yellowish white laterally. Labial palpus with basal segment white, second segment white to light brownish pink on ventral half of outer side, gradually becoming brownish pink on dorsal half of outer side; third segment brownish pink. Vertex, occiput, patagium, and tegula light reddish brown, tegula darker near wing base. Forewing (Fig. 4) length 8.0–9.5 mm (n = 5). Costa brown on basal third of wing, narrow but prominent band of yellowish white between costa and subcosta extends from wing base to apex. Broader band of nearly solid brown extending from wing base to apex, bounded anteriorly by subcosta, posteriorly by 1A+2A near wing base and by M_1 near apex; a second less prominent brown band between cell and 1A+2A, this band diluted with yellowish pink scales. Band of yellowish pink extending from distal half of cell to outer wing margin, bounded approximately by M_1 and CuA_1. Ground predominantly yellowish pink posterior to 1A+2A. Band of yellowish white on cubitus, especially prominent at lower outer angle of cell, extending onto M_{2+3} and CuA_1, poorly defined to absent on CuA_2, prominent on 1A+2A. Dark brown spots between veins on outer wing margin.

Genitalia as described for the genus.

Holotype ♂.—Brazil, Espirito Santo, Linhares, 40 m, 05–09 April 1992, V. O. Becker; 82680; ♂ genitalia on slide 2671, J. C. Shaffer [NMRJ].

Paratypes.—3 ♂, same data as holotype, one specimen J. C. Shaffer genitalia slide 2678 [USNM]; another, wing slide 2757; third undissected [NMRJ].

Other specimen examined.—♂, Brazil, Rondônia, Vilhena, 600 m, 9 December

Figs. 8–10. Heads, left profile. 8, *Metacommotria beckeri*, holotype. 9, *Cipopeoria camura*, holotype. 10, *Harnochina digitata*, holotype. Scale bar = 0.5 mm (8–10).

1997, V. O. Becker; 111786; J. C. Shaffer genitalia slide 2679; [VOB].

Remarks—A female (J. Shaffer genitalia slide no. 2701) from Acailandia, Maranhão is essentially identical in wing maculation and venation and may be conspecific.

Etymology.—The specific epithet honors the collector, Dr. Vitor Becker.

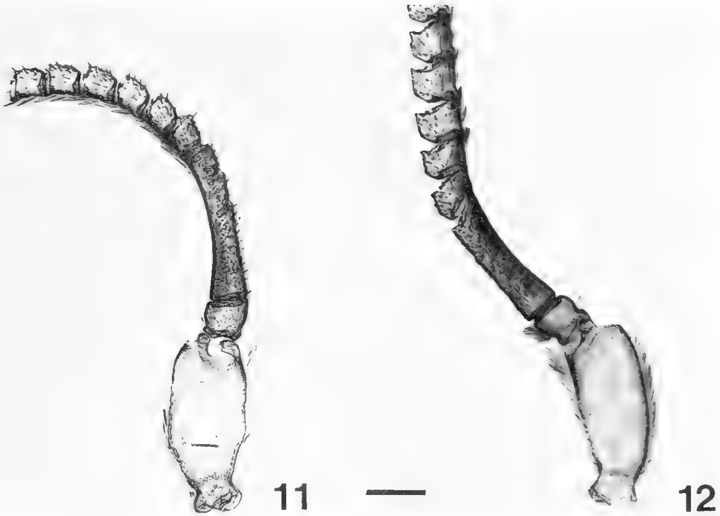
Cipopeoria Shaffer, new genus

Type species.—*Cipopeoria camura* Shaffer, new species.

Diagnosis.—The male genitalia somewhat resemble those of *Homosassa* Hulst, notably in that the lateral arms of the uncus are slender, straight, unbranched, tapering, and ventrally directed in a plane perpendicular to the body axis. The gnathos of *Cipopeoria* lacks the stout lateral arms seen in *Homosassa*. Female genitalia of *Cipopeoria* have a large signum, those of *Homosassa* lack a signum. The male labial palpi of *Cipopeoria* are slender and upturned (Fig. 9), those of *Homosassa* are broader and obliquely ascending (see Fig. 2, Shaffer, 1976b).

Description.—Labial palpus of male (Figs. 3, 9) with second segment slender, curved basally, upturned; of female porrect, about three times as long as eye diameter. Maxillary palpus moderately well developed, extending just beyond eye in male, nearly to end of frons in female. Antenna shaft sublaminate in male, basal segments fused, posterior surface with sinus, sinus surface somewhat concave and bordered by parallel pair of short scale tufts; shaft in female filiform, finely ciliate, lacking basal modification. Ocellus well developed, separated from eye by about its own width. Forewing (Fig. 2) with eleven veins; R_1 well separated from base of $R_{2+5,}$ latter from well before upper outer angle of cell; R_2 from about $\frac{1}{3}$ and R_{3+4} from just over $\frac{1}{2}$ length of R_{2+5}; M_1 from upper outer angle; M_{2+3} stalked about $\frac{1}{3}$ its length, from lower outer angle; CuA_1, from very near the angle; CuA_2 from well before the angle. Hind wing with seven veins (1A, 2A, and 3A counted as one vein); M_{2+3} fused, stalked with CuA_1 about $\frac{2}{3}$ its length.

Male genitalia (Figs. 17–20) with medial process of uncus weak, bandlike; lateral process basally broad, subtriangular, distally slender, straight, unbranched, tapering, and ventrally directed in a plane perpendicular to the body axis. Gnathos a broad bilobed plate with a pair of anteriorly directed medial spines and along lateral margin of each lateral lobe a pair of ventromedially directed spines. Juxta horseshoe shaped, somewhat flared laterally. Valva with costa terminating in blunt tooth. Aedoeagus subcylindrical, 2.5 times as long as maximum width, tapering somewhat posteriorly; vesica with a pair of prominent subequal ser-



Figs. 11–12. Male right antennae, basal region, partially denuded. 11, *Metacommotria beckeri*, holotype. 12, *Cipopeoria camura*, holotype. Scale bar = 0.2 mm (11, 12).

rate cornuti (Figs. 19–20) and a few minute teeth.

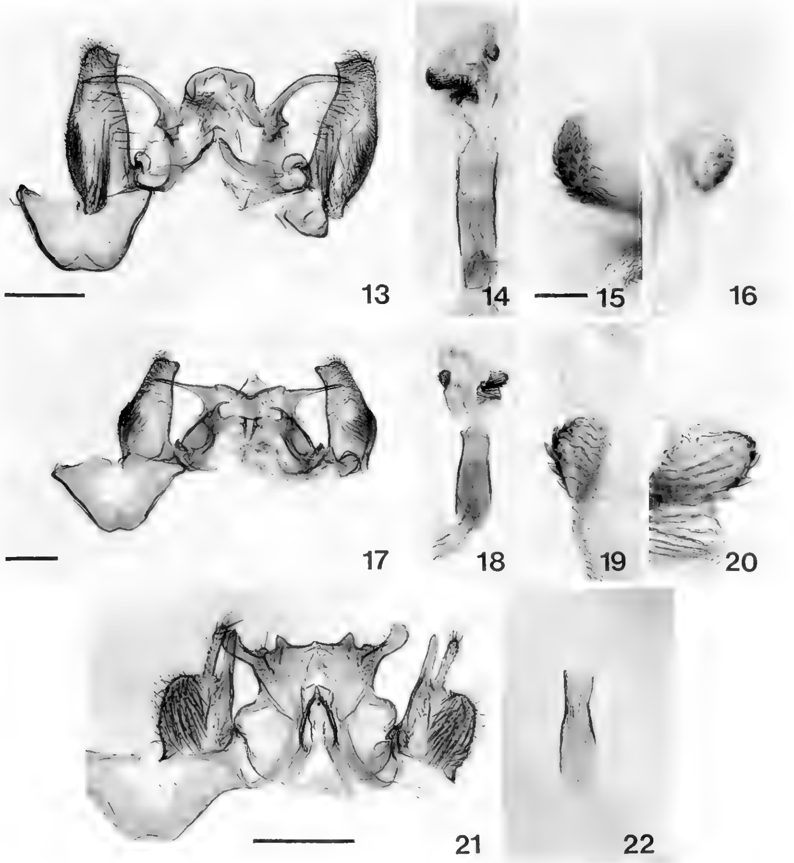
Female genitalia (Figs. 23–24) with ovipositor lobes finely setose, dorsal and posterior elements meeting at 160° angle, weakly sclerotized. Apophyses slender; posterior apophysis weakly curved, about ¾ length of anterior apophysis; anterior apophysis straight. Ovipositor separated little, if any, from eighth abdominal segment, the latter heavily sclerotized, its posterior ⅔ strongly folded. Ostium bursae membranous. Posterior half of ductus bursae well sclerotized, considerably flattened, smooth; anterior half membranous, with scattered minute triangular teeth. Corpus bursae membranous, with large irregular platelike signum bearing numerous inwardly directed spines. Ductus seminalis from tapering posterior end of corpus bursae (Fig. 23, arrow).

Etymology.—The generic name is derived from the name of the type locality of the type species combined with a reference to the Tribe Peoriini. Gender: feminine.

Cipopeoria camura **Shaffer, new species**
(Figs. 2, 3, 5, 9, 12, 17–20, 23–24)

Diagnosis.—This is the only known species in the genus.

Description.—Frons grayish reddish brown dorsally, yellowish white ventrally. Labial palpus with first and second segments grayish reddish brown dorsally, yellowish white ventrally and laterally except grayish reddish brown near dorsal margin and with a few scattered scales of that color elsewhere; third segment pale orange yellow throughout. Vertex grayish reddish brown; yellowish white posterior and posteriolaterally from antenna base. Occiput grayish reddish brown dorsally, similar behind eye, but interrupted with narrow bars of yellowish white. Patagium and tegula light grayish reddish brown, darker at wing



Figs. 13–22. Male genitalia. 13–16, *Metacommotria beckeri*, holotype; 13, Genitalia, aedoeagus removed. 14, Aedoeagus. 15, Large cornutus. 16, Small cornutus. 17–20, *Cipopeoria camura*, holotype. 17, Genitalia, aedoeagus removed. 18, Aedoeagus. 19, Small cornutus. 20, Large cornutus. 21–22, *Harnochina digitata*, holotype. 21, Genitalia, aedoeagus removed. 22, Aedoeagus. Scale bar = 0.5 mm (13–14, 17–18, 21–22), 0.1 mm (15–16, 19–20).

base. Forewing (Fig. 5) length 6.0–11.0 mm (n = 7). Costa grayish reddish brown at base, light orange yellow distally. Ground white anterior to cubitus, heavily sewn with a mixture of grayish reddish brown and dark brown scales, lightest on distal half of wing. Ground light brown posterior to cell and near outer wing margin, a large irregular dark brown patch between 1A+2A and cell, extending posterior to 1A+2A. Terminal line of dark brown spots between veins. All wing markings diffuse, ill defined; no veins with white tracing.

Genitalia as described for the genus.

Holotype ♂.—Brasil, Minas Gerais,

1,400 m, Serra do Cipó, 17–19 April 1991, V. O. Becker; no. 78056; ♂ genitalia on slide 2672 J. C. Shaffer [NMRJ].

Paratypes.—2 ♂, same data as holotype; no. 78056, genitalia slide 2680 [USNM]; no. 78052, genitalia slide 2694. 2 ♀, same data as holotype; no. 78053, genitalia slides 2690, 2704 [NMRJ].

Other specimens examined (1 ♂, 1 ♀).—♂, Nova Lima, Minas Gerais, 25–27 December 1982, V. O. Becker; no. 50267; ♂ genitalia on slide 2670. ♀, Bonito, Bahia, 1,000 m, 25 April 1991, V. O. Becker; no. 78464; not dissected [VOB].

Etymology.—The specific epithet is derived from the Latin *camur* (turned inward) in reference to the inward curving hooks of the gnathos.

Harnochina digitata Shaffer, new species
(Figs. 6, 10, 21–22)

Diagnosis.—The division of the distal portion of the valva of the male genitalia into two slender digitate processes, one membranous, the other a heavily sclerotized extension of the costa is unique within the genus, as is the V-shaped medial process of the gnathos. In the only other known species in the genus, *H. rectilinea* Dyar, the distal half of the valva (see Shaffer 1976a, fig. 11e) is angled relative to the basal half, broadly triangular, the apex rounded and simple; the medial process of the gnathos unbranched, forming a tapering spine.

Description.—*Male:* Labial palpus (Fig. 10) short, about 1.9 times as long as eye diameter; upturned, third segment porrect. Maxillary palpus short (not clearly seen in holotype). Antenna shaft subserrate, cilia about half as long as segment width near base of shaft; basal segments unmodified, sinus absent. Forewing length 8.5 mm (n = 1); with eleven veins; R_1 well before upper outer angle of cell; R_2 free from cell, near to origin and closely parallel to R_{3+5}; R_{3+4} stalked with R_5 about $\frac{2}{3}$ its length, from before the angle; M_1 from the angle; M_{2+3} stalked about half its length, from lower outer angle; CuA_1 from well before the angle; CuA_2 separated from CuA_1 by about same distance. Ground overall light grayish brown, produced from a mixture of brownish pink and dark brown scales on a field of yellowish white scales. Markings darker than ground, diffuse, somewhat indistinct: small discal spot between base of M_1 and base of M_{2+3}; antemedial, postmedial, terminal bands; fringe with two light and two dark bands. Hind wing with seven veins (1A, 2A, and 3A counted as one vein); M_{2+3} fused, stalked with CuA_1 about $\frac{2}{3}$ its length; from lower outer angle of cell.

Genitalia (Figs. 21–22) with medial process of uncus bearing a pair of smooth triangular posterior projections, more distally and dorsally a pair of irregular setose projections; lateral processes a pair of knobbed arms, these setose on posterior margin, smooth elsewhere. Gnathos with medial process a weakly sclerotized plate with a pair of divergent anterior arms and a well sclerotized V-shaped process, its apex posteriorly directed; lateral arms of gnathos broad, flat, weakly sclerotized. Juxta a semilunar plate, posterior margin emarginate. Valva subquadrate, ventral half covered with still anteriorly directed setae; costa heavily sclerotized, smooth, the free distal portion about $\frac{2}{5}$ length of entire costa; membranous digitate process closely parallel to free portion of costa. Anterior margin of vinculum truncated. Aedoeagus about three times as long as maximum width, somewhat constricted on posterior half; vesica unarmed, lacking microspines.

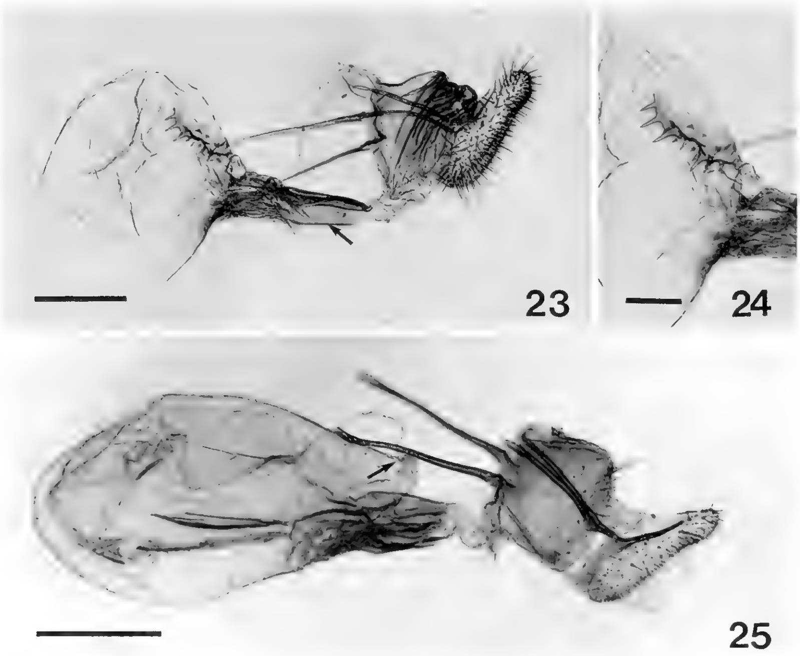
Holotype ♂.—Brazil, Goiás, Alto Paraíso, 1,400 m, 1–6 November 1996, V. O. Becker; 98791; ♂ genitalia on slide 2683, J. C. Shaffer [NMRJ].

Other specimens examined.—None.

Etymology.—The specific epitaph is derived from the Latin *digitus* in reference to the distal digitate extension on the valva of the male genitalia.

Zapalla dentata Shaffer
(Figs. 7, 25)

Zapalla dentata Shaffer 1976a: 322, figs. 3h, 6l, 9f.



Figs. 23–25. Female genitalia. 23–24, *Cipopeoria camura*. 23, Genitalia, arrow shows ductus seminalis origin. 24, Enlarged to show signum. 25, *Zapalla dentata*, genitalia (corpus bursae bearing spermatophore), arrow shows ductus seminalis origin. Scale bar = 0.5 mm (23, 25), 0.2 mm (24).

Previously known only from the male holotype (type locality: "S.E. Brazil"), the Becker material includes specimens from Planaltina (Distrito Federal), Alto Paraíso (Goias), and Chapada Guimaraes (Mato Grosso). Specimens from the latter locality comprise three males and one female (J. Shaffer slide 2700) which forms the basis for the following description.

Description.—Male (see Shaffer, 1976). *Female:* Labial palpus porrect, about 3.5 times as long as eye diameter. Maxillary palpus very short, extending little if at all beyond pilifer, yellowish white.

Eye diameter 0.55 mm. Ocellus well developed, black with clear center, separated from eye by about its own diameter. Antenna filiform, very finely ciliate. Genitalia (Fig. 25) with ovipositor lobes finely setose; upper element a slender well sclerotized rod, vertical element a diffuse lightly sclerotized plate about 3.75 times as high as wide. Apophyses straight or nearly so, anterior apophysis about 1.3 times as long as posterior apophysis. Ostium bursae membranous. Ductus bursae moderately well sclerotized, extensively folded longitudinally, unarmed; joining corpus bursae near its posterior end. Corpus bursae about twice as long as wide; unarmed, lacking signum and microspines [Fig. 25 shows remnants of a single spermatophore nearly filling the corpus bursae]. Ductus seminalis from tapering posterior end of corpus bursae (Fig. 25, arrow).

Remarks.—This is the first female known for the genus. The genitalia are generalized and show no apparent apomorphies. Externally *dentata* and *deliquella* (Zeller) are readily separated by the number of dark spots on vein 1A+2A, two spots in *deliquella,* three spots in *dentata.* An adult male of *dentata* is illustrated herein (Fig. 7) as the photograph (fig. 3h) in Shaffer 1976a does not show the third (middle) spot clearly.

ACKNOWLEDGMENTS

I am most grateful to Vitor Becker, Brasilia, Brazil, for the loan of specimens from his personal collection, and thank Alma Solis (USDA, Systematic Entomology Laboratory) and an anonymous reviewer for helpful comments on the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 292–299

REVIEW OF THE NEW WORLD LEAFHOPPER GENUS *EXCULTANUS* OMAN (HEMIPTERA: CICADELLIDAE: DELTOCEPHALINAE)

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Abstract.—The taxonomy of the New World genus *Excultanus* is reviewed. *Excultanus argillaceus* (Van Duzee) is placed under *E. excultus* (Uhler), **n. syn.** ***Excultanus paraconus*, n. sp.** is described from Cost Rica. The known southward limit of the genus is extended from Guatemala to Misiones, Argentina. A key to the 12 species is provided, as well as a checklist with critical synonymies and distribution summaries.

Key Words: taxonomy, vector, Athysanini, *Excultanus*

About 150 of the 350 genera of U.S. leafhoppers have species in Mexico, yet only about 200 species occur in both countries. Furthermore, the number of leafhoppers known from the U.S. (approximately 3,000) is more than double the number known from Mexico, despite its relatively large size and topographical complexity. The situation for Central America is similar: 80 genera but only 65 leafhopper species are shared with the U.S., and fewer than 900 Central American species have been described. These figures suggest two important generalizations: (1) the Mexican and Central American faunas must be taken into account to provide comprehensive identification tools for U.S. leafhopper genera; and (2) the Mexican and Central American faunas are poorly known and likely contain several thousand leafhopper species new to science, including many belonging to genera that also occur in the United States.

The genus *Excultanus* is one such genus. *Excultanus* occurs in the United States, Mexico, Central America, from which one new species is here described, and South America. While the genus includes a known vector of potential importance to California celery crops [i.e., *E. incurvatus* (Osborn & Lathrop); Nielson 1968b], there have been no synopses of the whole genus.

Literature citations designated with key letters are consistent with the bibliographies by Metcalf (1964a) and Oman et al. (1990).

REVIEW OF LITERATURE

Oman (1949a) erected the new subgenus *Texananus* (*Excultanus*) for eight species having a broadly excavated sternum VII in the female and lacking a posterior extension of the connective in the male genitalia.

Crowder (1952a) provided a key to the four species that occur in the United States. Linnavuori (1959b) elevated *Excultanus* to generic status, the genus being distinguishable from other *Phlepsius*-like genera by the absence of a posterior projection of the connective below the aedeagus. When Linnavuori (1959b) elevated *Excultanus* to generic status, he treated only the Central American species but clearly intended it to include the Nearctic species also treated under the genus-group name, by citing Oman (1949a). Likewise, Nielson (1968b) explicitly accepted the generic rank of *Excultanus* but mentioned only *E. incurvatus*, the single species known to vector phytopathogens.

McKamey (2000) affirmed the placement of the three species already included in *Excultanus* and referred nine other species to the genus: six previously in *Texananus* (*Excultanus*) and three [*E. parrai* (DeLong), E. *plummeri* (DeLong) and E. *horridus* (DeLong)] from *Texananus* but previously unplaced to subgenus, bringing the total number of species to 12. One new species is described and one older species is placed in synonymy in this paper.

MATERIALS AND METHODS

Specimens for the study are from the National Museum of Natural History, Smithsonian Institution, Washington, DC (NMNH); the Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica (INBIO); the DeLong collection of Ohio State University, Department of Entomology, Columbus, Ohio, USA (OSUC); and the California Academy of Sciences, San Francisco, California (CASC).

The pygofers and genitalia were prepared by briefly boiling the abdomen in a weak potassium hydroxide (KOH) solution. KOH-treated parts were preserved in glycerin in polypropylene microvials beneath the specimens.

Digital images were captured at 400 dpi resolution by mounting a Sony DKC5000® digital camera on a Leica MZ-APO™ stereoscopic microscope (for the pygofer) or Leitz Diaplan™ compound microscope (for the aedeagus).

The ventral and dorsal margins of the male pygofer of some species [e.g., *E. conus* (DeLong)] are softer than surrounding areas of the pygofer and curl inwards if the abdomen remains in KOH too long. Hence, DeLong's (1939c, 1944h) description of the pygofer of *E. conus* being "curled inwardly on ventral side, appearing tapered to a pointed apex," while consistent with his illustration (1944h, fig. 3), is an artifact of preparation. Brief treatment in KOH, such as the method used here, does not curl the pygofer margins.

RESULTS

Genus *Excultanus* Oman

Texananus (*Excultanus*) Oman 1949a: 142. Type species by original designation: *Jassus excultus* Uhler 1877.

Excultanus; Linnavuori 1959b: 197 [elev. status].

Diagnosis.—Differing from other Deltocephalinae in having head narrower than pronotum (Fig. 1); forewing with appendix well developed; pronotum and usually forewing with vermiculate pigment lines (pl. 39, fig. 1 of Oman 1949a); subgenital plates with setae; male with genital connective lacking posterior projection below aedeagus; female sternum VII deeply excavated [except *E. hebraeus* (Ball)] and often with portion of underlying membranes visible. Resembles *Texananus* and other *Phlepsius*-like genera in having forewing covered with ramose or vermiculate pigment lines (Fig. 1).

Notes.—Illustrations of the female sternum VII and male pygofer and genitalia for most species were provided by DeLong (1944h) and Crowder (1952a).

KEY TO SPECIES OF *EXCULTANUS*

1. Male pygofer less than or equal to length of subgenital plates; female sternum VII with portion of posterior underlying membranes visible, if excavated almost to base and with minute median projection (*E. conus*), then sternum VII length approximately ⅔ its maximum width 2
– Male pygofer extending beyond subgenital plates; female sternum VII with portion of posterior underlying membranes not visible or, if visible (*E. dorothyae* and *E. eugeneus*), then triangular and attaining posterior margin of sternum VII or excavated almost to base, with minute median projection and sternum VII length approximately ½ its maximum width 6
2. Male with anal segment X strongly produced ventrally, hanging within pygofer; female sternum VII deeply excavated, margins of excavation notched at mid length . . . . . *plummeri*

– Male with anal segment X normal, ringlike, not produced ventrally; female sternum VII deeply excavated without notch at mid length along margins, or not excavated and with median notch 3

3. Male pygofer with conspicuous inner brushes of darkened bristles distally on dorsal and ventral margins; male pygofer length in lateral view about 1.5 × height; female sternum VII deeply excavated and underlying membranes not visible . . . . *horridus*

– Male pygofer without inner brushes of bristles on margins; male pygofer in lateral view about as long as tall; female sternum VII deeply excavated and underlying membranes visible or if membranes not visible (*E. hebraeus*), then not excavated and with median notch 4

4. Male pygofer apex bluntly rounded; female sternum VII with visible portion of posterior underlying membranes rectangular, extending from median excavation to lateral margin . . . . *dorothyae*

– Male pygofer apex truncate; female sternum VII underlying membranes either not visible or with visible portion oval and lying entirely within deep excavation (as in Fig. 5) 5

5. Male pygofer apex bilobed dorsoposteriorly; aedeagal shaft extending nearly to dorsal margin of pygofer; female sternum VII not excavated, with median notch, underlying membranes not visible . . . . *hebraeus*

Male pygofer apex single-lobed; aedeagal shaft extending dorsally to about mid height of pygofer; female sternum VII deeply excavated and with small median projection, underlying membranes visible . . . . *eugeneus*

6. Male pygofer without distal brush of bristles on ventral margin or apex; male pygofer in lateral view with distal half forming an equilateral triangle; female sternum VII sinuously excavated and smoothly concave medially with underlying pair of membranes triangular . . . . *excultus*

– Male pygofer with conspicuous inner brush of darkened bristles distally (Fig. 2), though not always at apex; male pygofer in lateral view with distal half length greater than pygofer height, not forming an equilateral triangle; female sternum VII excavation either not sinuous or bearing acute notch medially, with underlying pair of membranes oval (Fig. 5) . . 7

7. Male pygofer with inner brushes of bristles on dorsal and ventral margins; female sternum VII excavated approximately halfway to base with acute, V-shaped median notch . . . . *parrai*

– Male pygofer with inner brushes of bristles on ventral margins or at apex, or both (Fig. 2), but not on dorsal margins; female sternum VII excavated at least ⅔ to base, excavation medially either smoothly concave or with small median projection 8

8. Male pygofer with inner brushes of bristles on ventral margins, sometimes continuing to apex; female sternum VII length at least ⅔ its maximum width, posterior angles acute (Fig. 5) or excavation with small median projection, or with both conditions 9

– Male pygofer with inner brushes of bristles at apex only; female sternum VII length approximately ½ its maximum width, posterior angles truncate or rounded, excavation without median projection 11

9. Male pygofer apex weakly sclerotized, without bristled fringe; female sternum VII with posterior angles rounded, excavated almost to base and with distinct median projection . . . . *paralus*

– Male pygofer with strong sclerotization and bristle-fringed ventral margins continuing to apex; female sternum VII with posterior angles acute, excavation depth variable, sometimes with minute median projection 10

10. Male pygofer with bristle-fringed ventral margins linear (whether curled inwardly in KOH-prepared specimens or not curled inwardly); female sternum VII excavated almost to base . . . . *conus*

– Male pygofer with bristle-fringed ventral margins sinuous (Fig. 2); female sternum VII excavated about ⅔ its length (Fig. 5) . . . . *paraconus*, n.sp.

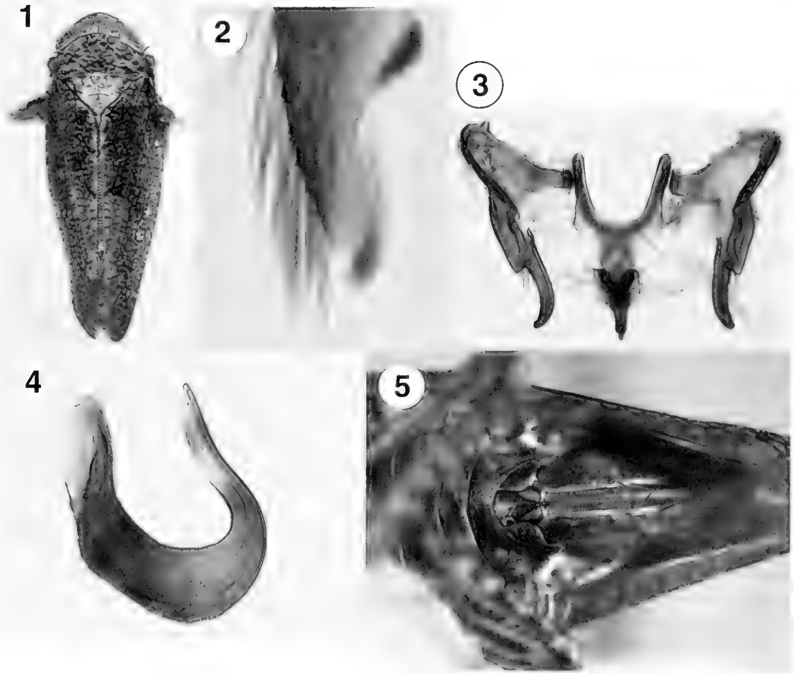
11. Male subgenital plates triangular, connective anterior arms V-shaped, and style with preapical concavity U-shaped; length including wings in repose 5.7–6.2 mm; female sternum VII with visible portions of underlying membranes about as long as wide . . . . . . *incurvatus*

– Male subgenital plates subtriangular but weakly attenuate on lateral margins, connective anterior arms U-shaped, and style with preapical concavity V-shaped; length including wings in repose 7.0–8.0 mm; female sternum VII with visible portions of underlying membranes about twice as long as wide . . . . *neomexicanus*

***Excultanus paraconus* McKamey, new species**

(Figs. 1–5)

Diagnosis.—Male pygofer with ventral margins sinuous and bearing a brush of dense bristles; female sternum VII with posterior angles acute, excavated posteriorly for about ⅔ of its length.



Figs. 1–5. *Excultanus paraconus*. 1, Male, dorsal view. 2, Male pygofer, right portion of ventral margin, ventral view, showing bristle-fringed, sinuous ventral margin. 3, Aedeagus, connective, and styles, dorsal view. 4, Aedeagus, lateral view. 5, Female sterna, ventral view, showing excavated sternum VII with visible ovoid portions of underlying membranes.

Description.—Measurements (mm). Length: male 6.6–7.0; female 7.0–7.6. Width across eyes: male 1.9, female 1.9–2.0.

Male and female similar externally. Frontoclypeus and pronotum darkly mottled fuscous, vertex and scutellum paler, forewing covered throughout with vermiculate infuscate marks (Fig. 1). *Abdomen:* Male. Pygofer heavily sclerotized throughout, triangular in lateral view, covered with macrosetae, ventral margins (Fig. 2) sinuous in ventral view, with dense fringe of dark bristles, which are longest at convexities, almost absent at concavity, pygofer length exceeding subgenital plates by half length of their mesal margins; subgenital plates triangular, lateral margins straight. Connective (Fig. 3) Y-shaped, anterior arms subparallel and separated from each other by approximately their length. Aedeagus (Fig. 4) articulated to connective, U-shaped, gradually tapering from base to apex; style (Fig. 3) with broad base quickly tapered, at mid length abruptly narrowed to slender distal ⅓. Female sternum VII (Fig. 5) with posterior angles acute, excavated posteriorly for about ⅔ its length.

Types.—Holotype ♂ [USNM] COSTA RICA: Puntarenas Prov., Puntarenas, 12-

VIII-1972, J. Maldonado C[apriles]. Paratypes [USNM]: COSTA RICA: 9 mi. NW Esparta, 22-VII-1965, 1 ♂, 1 ♀. Paratypes [INBIO]: COSTA RICA: Guanacaste Prov., Finca Jenny, 30 km N. Liberia, Guanacaste National Park, IX-1989, R. Espinoza, 8 ♂ 3 ♀, INBIO Bar Code No. CRI000025028, CRI000025546, CRI000152442, CRI-000476339, CRI000476749, CRI000476741, CRI000025219, CRI000476734, CRI-000476733, CRI000025606, CRI000476725; same locality, X-1989, E. Araya & R. Espinoza, 3 ♂ 4 ♀, INBIO Bar Code No. CRI-000081664, CRI000108821, CRI000109428, CRI000130815, CRI000131397, CRI-000130888, CRI000131051; same locality, XI-1989, 1 ♂, E. Araya & R. Espinoza, INBIO Bar Code No. CRI000138115; Estación Palo Verde, elev. 10 m, 12-23-XI-1991, R. U. Chavarria & D. Acevedo, Malaise 1 ♀, INBIO Bar Code No. CRI002800906, same locality 12 VIII-12 IX-1991, 1 ♀, INBIO Bar Code No. CRI002800983; Estación Experimental E. Jimenez Nuñez, 30-VII-1993, G. Allen, Malaise 6:00 pm–8:00 am, 1 ♀, INBIO Bar Code No. CRI002088831; same locality and nocturnal Malaise, 12-VIII-1993, 1 ♀, INBIO Bar Code No. CRI002072231; same locality and nocturnal Malaise, 15-VIII-1993, 2 ♂, 2 ♀, INBIO Bar Code No. CRI-002088173, CRI001951879, CRI002072694 and CRI002072719; Parque Nacional Barra Honda, elev. 100 m, VIII 1994, M. Reyes, 1 ♀, CRI002005809.

Note.—One difference between *E. paraconus* and *E. conus* may be the strong curvature of the aedeagus in the latter. The variation of aedeagal curvature observed elsewhere in the genus when there are more specimens, for example in *E. excultus,* suggests that this is not as reliable a feature to distinguish the species. The distinctive ventral margin of the male pygofer in *E. paraconus,* on the other hand, appears consistent and can usually be observed in undissected specimens.

Etymology.—The specific epithet (adjective) is formed by adding the Greek prefix "*para-*," for near, to the name of the species it resembles most, *Excultanus conus.*

CHECKLIST AND DISTRIBUTION SUMMARY FOR OTHER SPECIES OF *EXCULTANUS*

E. conus (DeLong)

Texananus conus DeLong 1939c: 386 [n.sp.].
Texananus (*Excultanus*) *conus*; Oman 1949a: 142 [subgen. comb.].
Excultanus conus; McKamey 2000: 214 [n.comb.].

Summary of distribution.—MEXICO: Chiapas. NICARAGUA.

Note.—Maes et al. (1999) reported *E. conus* from Nicaragua.

E. dorothyae (DeLong)

Texananus dorothyi [sic] DeLong 1939c: 387 [n.sp.].
Texananus (*Texananus*) *dorothyae*; DeLong & Hershberger 1949a: 173 [subgen. comb.].
Texananus (*Excultanus*) *dorothyae*; Oman 1949a: 142 [subgen. comb.].
Excultanus dorothyae; McKamey 2000: 214 [n.comb.].

Summary of distribution.—MEXICO: Guerrero, Nuevo León, Puebla, Morelos, San Luis Potosí. UNITED STATES: Arizona, New Mexico, Texas.

Note.—In the original description, the species was explicitly dedicated to Dorothy Johnson Knull, so the correct spelling of the name is as used by DeLong & Hershberger (1949a) and others, including this work.

E. eugeneus (Ball)

Phlepsius (*Texananus*) *eugeneus* Ball 1918b: 384 [n.sp.]. Lectotype ♂ USNM.
Texananus eugeneus; DeLong & Caldwell 1937c: 43 [n.comb.].
Texananus (*Excultanus*) *eugeneus*; Oman 1949a: 142 [subgen. comb.].
Excultanus eugeneus; McKamey 2000: 214 [n.comb.].

Summary of distribution.—COSTA RICA: Guanacaste, Finca Jenny, 30 km N. Liberia, Guanacaste National Park, IX-1989, R. Espinoza, INBIO Bar Code No. CRI000024958 and CRI000025105. MEXICO: Guerrero, Jalisco, Morelos.

Notes.—This species was originally described from 12 syntypes. Previously recorded only from Mexico, the known range is here extended to Costa Rica. A syntype from the USNM is here designated as the lectotype to stabilize the nomenclature of the species. The lectotype has the following label data: "Amula/Guerrero,/6000 ft./Sept. H. H. Smith," "TYPE," "Cotype No./[blank]/U.S.N.M.," "Phlepsius/eugeneus/Ball," and a lectotype label.

E. excultus (Uhler)

Jassus excultus Uhler 1877a: 467 [n.sp.].
Phlepsius excultus; Southwick 1892a: 288 [n.comb.].
Phlepsius (*Texananus*) *excultus*; Ball 1918b: 386 [subgen. comb.].
Phlepsius argillaceus Van Duzee 1923a: 185 [n.sp.; holotype ♂ CASC], **new synonymy.**
Texananus agrillaceus [sic]; DeLong & Caldwell 1937c: 43 [n.comb.].
Texananus excultus; DeLong & Caldwell 1937c: 43 [n.comb.].
Texananus (*Texananus*) *excultus*; DeLong & Hershberger 1949a: 176.
Texananus (*Excultanus*) *agrillaceus* [sic]; Oman 1949a: 142 [subgen. comb.].
Texananus (*Excultanus*) *excultus*; Oman 1949a: 142 [subgen. comb.].
Excultanus excultus; Linnavuori 1959b: 198 [n.comb.].
Excultanus agrillaceus [sic]; McKamey 2000: 214 [n.comb.].

Summary of distribution.—ARGENTINA: Misiones. BAHAMAS. BELIZE. EL SALVADOR. GUATEMALA: San José. MEXICO: Baja California, Chiapas, Jalisco, Sonora, Veracruz. UNITED STATES: Alabama, Arizona, California, Florida, Georgia, Louisiana, New Mexico, North Carolina, South Carolina, Texas.

Notes.—The specimens from Argentina are identical with respect to all features except the aedeagal apex is almost in contact with the base, i.e., they are the closest to the 0-shape in the U- to 0-shape variation in this species. Also, although the species was already the most widespread, it is even more dispersed than previously thought, from the United States and Bahamas to Argentina (USNM specimen). The holotype of *argillaceus* was examined and dissected; the aedeagus is U-shaped with a weakly deflexed apex, also falling within the variation of *E. excultus.* The type locality of *argillaceus,* Baja California, is consistent with the other records of *excultus* in northern Mexico.

E. hebraeus (Ball)

Phlepsius (*Iowanus*) *hebraeus* Ball 1918b: 383 [n.sp.].
Texananus hebraeus; DeLong & Caldwell 1937c: 44 [n.comb.].
Iowanus hebraeus; DeLong & Hershberger 1948d: 115 [n.comb.].
Excultanus hebraeus; Linnavuori 1959b: 198 [n.comb.].

Summary of distribution.—GUATEMALA: Guatemala City. MEXICO: Chiapas, Guerrero.

Note.—This species was described from eight females, including one from the Vienna Museum that was not examined in this study. A syntype from the USNM is here designated as the lectotype to stabilize the nomenclature of the species. The lectotype has the following label data: "Amula/Guerrero,/6000 ft./Sept. H. H. Smith," "TYPE," "Cotype No./[blank]/U.S.N.M.," "Phlepsius/hebraeus/Ball," and a lectotype label.

E. horridus (DeLong)

Texananus horridus DeLong 1944h: 234 [n.sp.].
Excultanus horridus; McKamey 2000: 214 [n.comb.].

Summary of distribution.—MEXICO: Guerrero, Oaxaca.

E. incurvatus (Osborn & Lathrop)

Phlepsius (*Iowanus*) *incurvatus* Osborn & Lathrop 1923a: 346 [n.sp.].
Texananus incurvatus; DeLong & Caldwell 1937c: 44 [n.comb.].
Texananus (*Texananus*) *incurvatus*; DeLong & Hershberger 1949a: 178 [subgen. comb.].
Texananus (*Excultanus*) *incurvatus*; Oman 1949a: 142 [subgen. comb.].
Excultanus incurvatus; Nielson 1968b: 285 [n.comb.].

Summary of distribution.—MEXICO: Jalisco, Sonora. UNITED STATES: Arizona, California, Georgia, New Mexico.

Note.—This species, a vector of western strain of North American aster yellows virus, is potentially important in the spread of this disease in celery in California.

E. neomexicanus (Baker)

Phlepsius neomexicanus Baker 1895b: 13 [n.sp.; holotype ♂ USNM].
Phlepsius (*Iowanus*) *neomexicanus*; Osborn & Lathrop 1923a: 346 [subgen. comb.].
Phlepsius (*Texananus*) *neomexicanus*; Ball 1931g: 85 [subgen. comb.].
Texananus neomexicanus; DeLong & Caldwell 1937c: 44 [n.comb.].
Texananus (*Texananus*) *neomexicanus*; DeLong & Hershberger 1949a: 176.
Texananus (*Excultanus*) *neomexicanus*; Oman 1949a: 142 [subgen. comb.].
Excultanus neomexicanus; McKamey 2000: 214 [n.comb.].

Summary of distribution.—MEXICO: Sinaloa. UNITED STATES: Arizona, New Mexico, Texas.

E. paralus (DeLong)

Texananus paralus DeLong 1939c: 385 [n.sp.].
Texananus (*Excultanus*) *paralus*; Oman 1949a: 142 [subgen. comb.].
Excultanus paralus; McKamey 2000: 214 [n.comb.].

Summary of distribution.—MEXICO: Chiapas, Guerrero, Michoacán, Morelos.

E. parrai (DeLong)

Phlepsius parrai DeLong 1939c: 382 [n.sp.; holotype ♂ OSUC].
Texananus parrai; DeLong 1944h: 234 [n.comb.].
Excultanus parrai; McKamey 2000: 214 [n.comb.].

Summary of distribution.—MEXICO: Guerrero.

E. plummeri (DeLong)

Texananus plummeri DeLong 1939c: 385 [n.sp.; holotype ♂ OSUC].
Texananus cassus DeLong 1939c: 385 [n.sp.; holotype ♂ OSUC]. Synonymy by DeLong 1944h: 233.
Excultanus plummeri; McKamey 2000: 214 [n.comb.].

Summary of distribution.—MEXICO: Chiapas, Guerrero, Michoacán, Morelos.

Note.—*Excultanus plummeri* and its synonym *Texananus cassus* represent opposite sexes of the same species, of which a mixed series (males of females) was later collected.

ACKNOWLEDGMENTS

For lending specimens I am grateful to Carolina Godoy (INBIO), Andrey Sharkov (OSUC), and Keve Ribardo (CASC). The manuscript was improved by suggestions from P. Freytag (University of Kentucky), T. Henry, D. Smith (both USDA/ARS Systematic Entomology Laboratory) and two anonymous reviewers.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 300–303

A NEW SPECIES OF *CIRROSPILUS* WESTWOOD (HYMENOPTERA: EULOPHIDAE) FROM SOUTHEASTERN ARIZONA

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Abstract.—**Cirrospilus infuscatus, n. sp.** (Hymenoptera: Eulophidae), is described from southeastern Arizona. This species was reared from *Tischeria bifurcata* Braun (Lepidoptera: Tischeriidae) on *Ceanothus fendleri* A. Gray (Rhamnaceae).

Key Words: Hymenoptera, Eulophidae, *Cirrospilus,* taxonomy, Chalcidoidea

Species of the cosmopolitan genus *Cirrospilus* Westwood parasitize cryptically-feeding insects, most often leaf-rollers, leaf-miners and galling insects in the orders Lepidoptera, Diptera, Hymenoptera and Coleoptera (Schauff et al. 1997, Bouček 1988). Species of *Cirrospilus* are predominantly larval ectoparasitoids, but also have been documented both as hyperparasitoids on primary ichneumonoid parasitoids and as primary parasitoids on several life stages of the primary host (Bouček and Askew 1968). Over 300 nominal species of *Cirrospilus* occur worldwide, primarily in the Holarctic (Noyes 1998).

Species of *Cirrospilus* possess a two-segmented funicle, complete notauli that extend to the transscutal articulation (TSS) (Fig. 2), and the postmarginal vein is shorter than or equal in length to the stigmal vein (Schauff et al. 1997). However, the location of the axilla can vary within *Cirrospilus* from being almost entirely posteriad to slightly anteriad of the TSS (LaSalle, personal communication). Further, as a member of Cirrospilini (Gauthier et al. 2000), *Cirrospilus* are characterized by a transverse sulcus on the face (Fig. 3) and the posterior separation of the propleura. A closely related genus, *Zagrammosoma* Ashmead, has been separated from *Cirrospilus* on the basis of characters that intergrade between the two genera (Gordh 1978, LaSalle 1989, Gates 2000). For example, the placement of the axilla relative to the TSS cited by Yefremova (1996) appears useful in differentiating the two genera in some instances, but by no means all. For a discussion of generic character intergradation, see Gates (2000) and a summary in Table 1.

Acronyms used are: USNM = National Museum of Natural History, Smithsonian Institution, Washington, DC; DLWC = David Wagner collection, University of Connecticut, Storrs, CT.

Cirrospilus infuscatus Gates and Schauff, new species

(Figs. 1–5)

Type material.—Holotype, ♀, "AZ: Cochise Co., Huachuca Mtns., Hunter Cyn 5100′, 14-IV-1986 Wagner; DLW Lot: 86D70, em. 26-IV/10-V1986, Host: *Tischeria bifurcata*" (USNM). Paratypes, 3 ♀ 1 ♂, same data as holotype (1 ♀ 1 ♂ point-

Table 1. Character distribution in *Cirrospilus* and *Zagrammosoma*.

Character	*Cirrospilus*	*Zagrammosoma*
Vertex vaulted	Rarely	Typical
Propodeum with strong median carina	Often	Rarely
Notaulus orientation	Extends straight to TSS	Curves to intercept axilla
Axilla shape	Triangular	Elongate
Axilla placement	Mostly posterior to TSS	Mostly anterior to TSS

mounted, 1 ♀ slide/SEM stub mounted (USNM); 1 ♀ card mounted (DLWC).

Etymology.—This species is named for its infuscate wing pattern.

Diagnosis.—This species has the following unique features within *Cirrospilus*: petiolate gaster in both sexes with the petiole 1.4–1.7× as long as broad; an infuscate fore wing; strong, wide submedian lines on the scutellum; and the brachypterous male with the apex of the fore wing not extending beyond the basal ¼ of the gaster.

Description.—Female: Length 1.6–1.7 mm. Head and body deep golden, gaster dark brown laterally and with transverse bands dorsally, antenna dark brown. Legs golden, tarsi paler except apical tarsomeres brown. Wings hyaline except forewing infuscate in medial half (Fig. 5), venation brown.

Head: Finely reticulate with even coverage of fine brown setae. Roughly quadrate in frontal view, 1.0–1.1× as high as broad (Fig. 3). Malar space 0.4–0.5× eye height. Eye glabrous (minute setae apparent at high magnification) (Fig. 3). Scrobal depression shallow, unmargined. Scape 4.6–5.5× as long as broad, two anelli transverse and short; pedicel 2.3–2.8× as long as broad; F1 1.3–1.6× as long as broad; F2 1.0–1.8× as long as broad; clava 2.0–2.4× as long as broad, 3-segmented, tapering apically (Fig. 4).

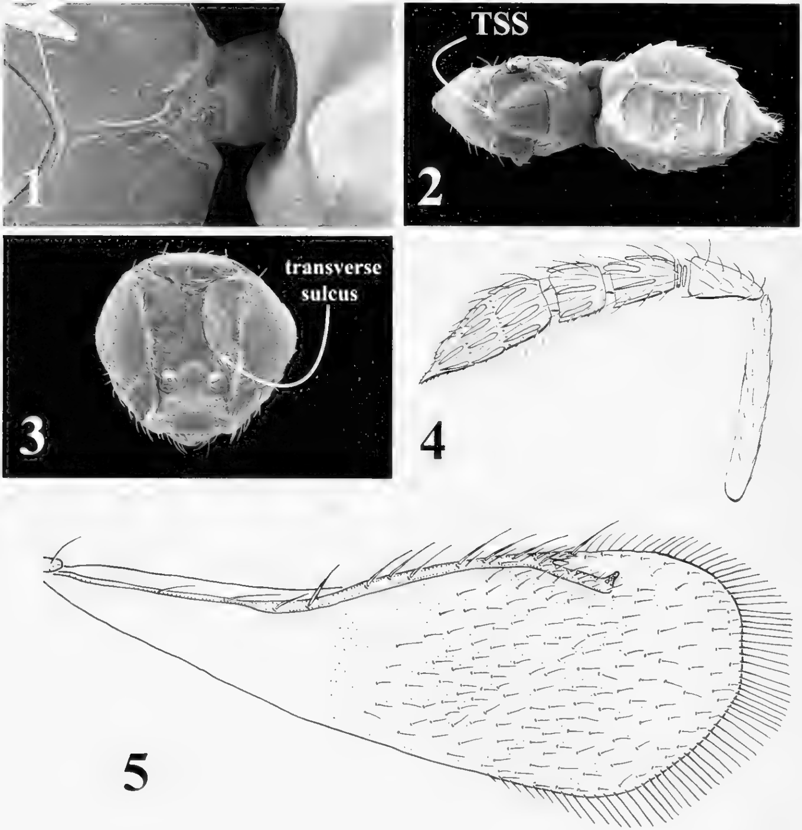
Mesosoma: Transversely reticulate anteriorly, becoming reticulate medially to glabrate posteriorly (Fig. 2). Midlobe of mesoscutum 1.1–1.2× as long as broad. Scutellum 1.0–1.1× as long as broad, with distinct submedial grooves most closely approaching each other anteriorly (Fig. 2); convex in lateral view. Mesopleuron glabrous to faintly reticulate. Propodeum glabrous with fine median carina; callus with row of at least 8 setae. Fore wing 2.5–3.1× as long as broad, setose in apical half (Fig. 5); marginal vein 8.0–10.0× as long as postmarginal vein; stigmal vein 3.3–3.5× as long as postmarginal vein.

Metasoma: Petiole 1.4–1.7× as long as broad, finely rugulose (Fig. 1). Gaster 1.1–1.2× as long as mesosoma. Tips of ovipositor sheaths visible in dorsal view (Fig. 2).

Male: Length 1.2 mm. Identical to female except as follows: malar space 0.6× eye height; scape 4.2× as long as broad; pedicel 1.8× as long as broad; F1 2.3× as long as broad; F2 1.2× as long as broad; clava 2.6× as long as broad; midlobe of mesoscutum 1.3× as long as broad; forewing brachypterous, 3.8× as long as broad; marginal vein 20× as long as postmarginal vein; stigmal vein 6.0× as long as postmarginal vein; petiole 1.4× as long as broad; gaster 0.9× as long as broad.

Variation.—The type series is essentially invariant.

Biology.—These specimens were reared from *Tischeria bifurcata* Braun (Lepidoptera: Tischeriidae) mining the leaves of *Ceanothus fendleri* A. Gray (Rhamnaceae) in the Huachuca Mountains of southeastern Arizona. A small proportion of total leaf mines collected were formed by a species of *Recurvaria* (Lepidoptera: Gelechiidae), but it is unlikely that these parasitoids emerged from those mines (Wagner, personal communication). Like other species of *Cirrospilus* (Gates 2000), *C. infuscatus* may be a gregarious parasitoid, as all specimens emerged on the same day. Unfortu-



Figs. 1–5. *Cirrospilus infuscatus*, female. 1, Dorsal petiole. 2, Dorsal mesosoma and gaster; TSS = transscutal articulation. 3, Frontal head. 4, Antenna. 5, Fore wing.

nately, it is unknown if all specimens emerged from a single host insect. *Tischeria bifurcata* forms an irregular track on a single leaf with the mesophyll not completely consumed between epidermal layers. The frass is forced out of the lower epidermis and the pupa is also thrust through the lower epidermis (Wagner, field notes).

ACKNOWLEDGMENTS

We are grateful to David Wagner (University of Connecticut) for allowing access to his reared leaf miner materials where this species was discovered. Thanks also to John LaSalle (CSIRO, Canberra, Australia), John Heraty (University of California, Riverside, CA), Norm Woodley and Dave Smith (both USDA, Systematic Entomology Laboratory, Washington, DC) for critical comments on earlier drafts of this manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 304–311

REDESCRIPTION OF THE LARVA OF *GOMPHUS MILITARIS* HAGEN (ODONATA: GOMPHIDAE), WITH DISTRIBUTIONAL AND LIFE HISTORY NOTES

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Abstract.—The final larval instar of *Gomphus militaris* Hagen is described, diagnosed, and figured from exuviae and larval specimens from Missouri, Texas, and Kansas. A previous description was erroneously attributed to *G. militaris,* but actually pertained to *Arigomphus lentulus.* Thus, the use of many previously published characteristics to identify this species will result in misidentification. Larvae of *G. militaris* were common and widespread in ponds in the prairie region of Missouri. We report data on life history based on larval and adult collections.

Key Words: Odonata, Gomphidae, *Gomphus, Arigomphus,* larva, Missouri

Gomphus militaris Hagen is primarily a species of the southern Great Plains of North America and has been reported from Iowa and North Dakota, south to New Mexico and Nuevo Leon, Mexico (Dunkle 2000, Needham et al. 2000). It was the "most frequent species of the genus" in Oklahoma (Bick and Bick 1957), the most widely distributed and commonly encountered species of Gomphidae in Texas (Abbott 2001), and common throughout Kansas (Huggins et al. 1976, Beckemeyer and Huggins 1997). Recently, it was reported to be common in western Missouri (L. Trial and J. F. Belshe, in litt.).

Due in part to its limited range, information regarding the ecology and life history of *G. militaris* is scant. It is a species of ponds or sluggish streams (Bird 1934; Beckemeyer and Huggins 1997; Dunkle 2000; L. Trial and J. F. Belshe, in litt.) where the larvae burrow in the sediment and detritus along the margins (personal observation). The adult flight season is 19 March to 15 August in Texas (Abbott 2001), and June and July in Kansas (Beckemeyer and Huggins 1997). In Texas, most specimens collected between 18 May and 1 June were reported to be teneral (Bick and Bick 1957). In Oklahoma, the peak of larval emergence occurred during mid-May (Bird 1934). Specimens reared in Kansas by D. G. Huggins emerged during early June (unpublished data).

We conducted a survey of the larval Odonata of ponds in the prairie (*sensu* Steyermark 1963, Pfleiger 1989, Bailey 1998) or plains (*sensu* Branson 1944, Thornbury 1965, Thom and Wilson 1980, Omernick 1987) regions of Missouri in 1998 and 1999. When determining specimens collected during this survey, we repeatedly encountered a single morphospecies of Gomphidae that could not be determined using existing keys that include the Midwestern fauna (i.e., Needham and Westfall 1955, Needham et al. 2000). These larvae superficially resembled those of the genus *Ari-*

gomphus Needham in general form and most often keyed to that genus. However, these larvae lacked the large, jagged teeth on the labial palps and the mid-dorsal ridge characteristic of larvae of *Arigomphus*. Moreover, adults of *G. militaris* frequently had been collected at ponds in the region, but no larvae had been encountered that could be attributed to this species using the published characters. However, our larvae possessed several characteristics which were contradictory to those attributed to *G. militaris* in the existing keys (i.e., Needham and Westfall 1955, Young and Bayer 1979, Needham et al. 2000) and in the larval description given by Bird (1934).

Specimens were sent to K. J. Tennessen who determined that they were indeed *G. militaris* and informed us that larvae of this species may not agree with published characters (personal communication). We also reared a male specimen and determined it as *G. militaris*. We present a redescription of the larva of *G. militaris*, with distributional data and notes on its life history in Missouri.

MATERIALS AND METHODS

We measured 10 specimens: exuviae of one partially emerged male specimen, exuviae of one unreared final instar, and eight final instars. Three of the larvae were from Texas, one from Kansas, and the remaining six specimens from Missouri.

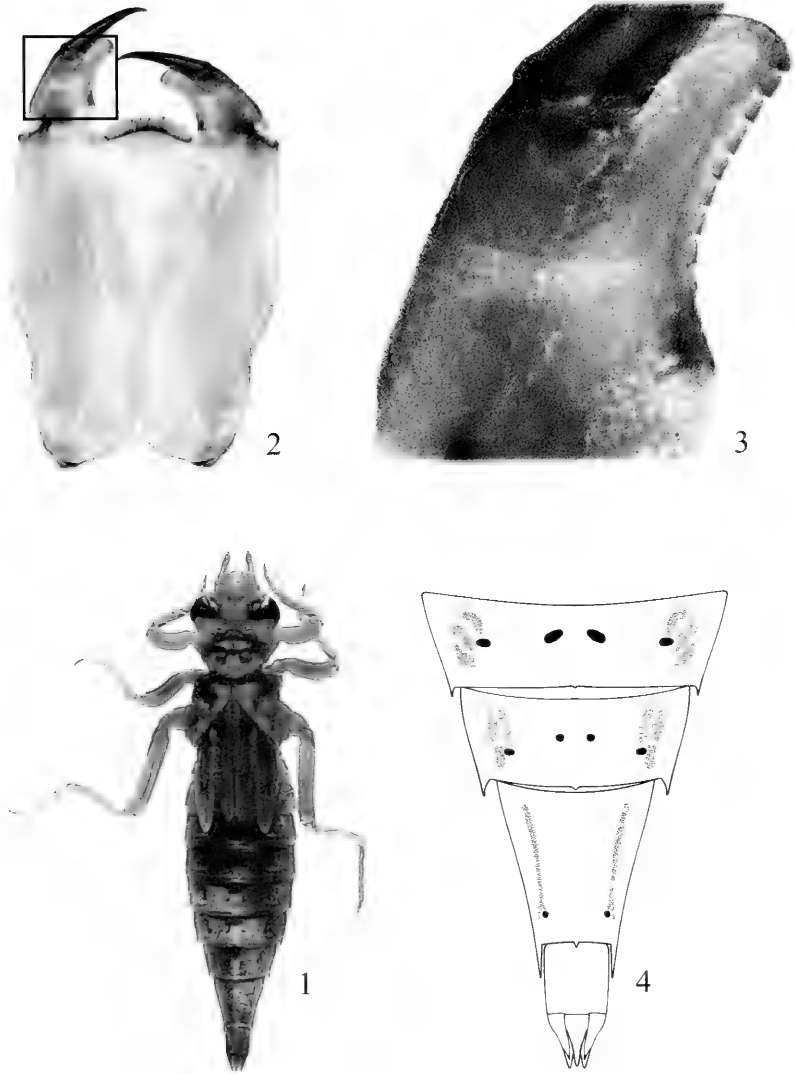
All measurements were performed in dorsal view and represent maximum values, unless otherwise stated. Due to non-uniform telescoping of the abdomen, exact measures of total length and length of abdomen are impossible to obtain (see Calvert 1934, Huggins and Harp 1985). Therefore, these measurements were performed to the nearest mm using calipers. All other measurements were performed using an ocular micrometer. The head was measured from the anterior margin of the clypeus to the posterior margin of the postocciput, and the abdomen to the tip of the caudal appendages. The outer surface was considered the dorsal aspect of the leg. Wingpads were measured from the dorsal juncture with the thorax to the tip. Mid-dorsal and mid-ventral abdominal segment lengths were measured from anterior to posterior margins of a sclerite, excluding dorsal hook, if present. Lateral margins of abdominal segments were measured from the anterolateral corner to the tip of the lateral spine. Lateral spines were measured from the posterior margin of the tergite immediately adjacent to the spine, to the tip of the spine. Basal width of abdominal segments were maximum values, measured just beyond the slight basal constriction. To compensate for lateral distortion of the abdomen in exuviae and preserved larvae (see Tennessen and Louten 1984, Huggins and Harp 1985), the abdomen was depressed for abdominal segment width measurements (except segment X) so that the ventral surface was flat in cross section. Caudal appendages were measured from the posterodorsal margin of segment X to the tip of the appendage.

SYSTEMATICS

Gomphus militaris Hagen

Description.—Total length 28–30 mm (mode = 30 mm). Overall body shape elongate fusiform, slightly depressed (Fig. 1). Body color light brown with darker brown markings. Dorsal surface of body finely granulose with glabrous patches on muscle scars. Minute, scalelike setae emanating from granules. Ventral surface generally not granulose, but with very fine setae. Larvae collected *in situ* with fine dorsal setation generally obscured by layer of fine silt and detritus.

Head: Width 5.25–5.67 mm ($\bar{y}$ = 5.50), length 3.08–3.33 mm ($\bar{y}$ = 3.21). Posterolateral margins abruptly rounded. Clypeus extending anteriorly to apex of second antennal segment, labrum to about middle of third segment. Compound eyes with mesal margins converging posteriorly. Antenna with segments III and IV darker than light brown general body color, segment III expanding slightly to apex and bowed up-



Figs. 1–4. *Gomphus militaris* larva. 1, Dorsal view of larva. 2, Ventral view of labium. 3, Blade of labial palp (detail of inset of Fig. 2). 4, Dorsal view of abdominal segments VII–X and terminal appendages of female.

ward. Ratio of antennal segment lengths 5:3:13:1. Prementum, in ventral aspect, constricted in proximal ca. ⅓, lateral margins subparallel in apical ⅔ (Fig. 2). Mid-ventral length of prementum, excluding hinge, 3.20–3.32 mm ($\bar{y}$ = 3.25), width 2.40–2.64 mm ($\bar{y}$ = 2.51). Anterior margin of prementum between bases of labial palps (ligula) evenly convex with dense fringe of long, stout, scalelike setae, and without distinct median tooth (Fig. 2). Blade (first segment) of labial palp rounded apically, with 7–12 (mode = 9) very short, nearly obsolete, squarely truncate teeth along the slightly arcuate mesal margin, distal-most tooth triangular but not longer than remaining teeth (Fig. 3). Long, conspicuous hairs on antennal segments, distal margin of labrum, and lateral margin of head beneath the compound eye from base of antennae to postocciput. Glabrous areas on dorsum of head comprising proximal portion of clypeus; V-shaped spot in center of frons; oval area lateral to V-shaped spot and adjacent to mesal margin of compound eye; spots immediately anterior to postocciput at mid-line and ca. ⅖ length from mid-line to posterolateral corner; thin, elongate spot above posterolateral corner.

Thorax: Areas of darker pigmentation variously developed, comprising margins of mesothoracic spiracle; dorsal portion of meso- and metapleural sutures; thin, longitudinal line dorsally between mesepisterna; immediately lateral to anal angle of metathoracic wingpads. Prothorax with ring shaped glabrous area lateral to mid-line, confluent anterolaterally with glabrous area on pleuron above base of coxa. Glabrous areas also present on and immediately adjacent to meso- and metapleural sutures. Fringe of long, conspicuous hairs along lateral margins of thorax. Pigmentation of legs slightly darker at apex of tibia. Legs hairy, with distinct fringes on dorsal and ventral surfaces. Pro- and mesotibial borrowing hooks well developed. Length of hind femur 5.42–5.83 mm ($\bar{y}$ = 5.53 mm), apex attaining ca. mid-length of abdominal segment IV. Glabrous areas of legs comprising triangular areas on both anterior and posterior surfaces of coxae; triangular area on the ventral surface of trochanters; longitudinal lines extending from base to near apex of femora on anterior, posterior, and dorsal surfaces; similar, less conspicuous lines on tibiae. Length of metathoracic wingpad 6.42–6.83 mm ($\bar{y}$ = 6.61 mm), attaining ca. mid-length of abdominal segment IV. Mesothoracic wingpad slightly overhanging anterior margin of abdominal segment IV. Wingpads densely granulose and pubescent on margins, less so on major veins of metathoracic wingpads, remainder glabrous. Dark coloration at nodi and tips of meso- and metathoracic wingpads, and proximal anal region of metathoracic wingpad.

Abdomen: Slender and gradually tapering to tip (Fig. 1), moderately depressed. Lateral margins with fringe of long setae. Posterior margin of tergites with sparse fringe of shorter setae, densest near mid-line. Length of abdomen 18–21 mm (mode = 21 mm), maximum width 7.0–7.4 mm ($\bar{y}$ = 7.2 mm). Integument glabrous at muscle scars, external surfaces of terminal appendages, and entirety of segment X. Segments I–VIII dorsally with paired dark spots near mid-length of each segment just lateral to mid-line (Fig. 4). Mesal margin of each muscle scar also with dark spot. Segment IX with dark spot at posteromedial corner of muscle scar (Fig. 4). Spots absent from segment X, and fading on segments anterior to IV. Lateral margins diverging moderately to segment IV, converging gradually beyond segment V to parallel-sided segment X (Fig. 1). Dorsal mid-line without ridge or impressed line. Segments I–VII with low, posteromedial protuberance occupying ca. ½ length of segment. Posteromedial protuberance of segment VIII very low. Female with rudimentary lobes of vulvar lamina projecting slightly from posterior margin of abdominal sternite VIII. Dorsum of segment IX, in cross section, nearly tectate anteriorly, circular posteriorly. Mid-dorsal length of segment IX, excluding hook, 83–

99% ($\bar{y}$ = 92%) basal width, and 84–94% ($\bar{y}$ = 87%) mid-ventral length. Segment 10 cylindrical. Basal width of segment X 83–97% ($\bar{y}$ = 93%) mid-dorsal length. Lateral spines present on abdominal segments VII—IX (rarely a minute spine on VI). Lateral spines of VII and VIII small, comprising 8–14% ($\bar{y}$ = 10%) and 11–20% ($\bar{y}$ = 13%), respectively, of lateral margin of segment. Lateral spine of segment IX long, slender, and somewhat appressed to side of segment X, 36–50% ($\bar{y}$ = 43%) as long as mid-dorsal length of segment X, usually extending slightly short of mid-length of segment X. Length of lateral spine of segment IX 0.56–0.72 mm ($\bar{y}$ = 0.64 mm). Mid-dorsal posterior hook present on segment IX, usually present on segment VIII, and occasionally present on segment VII. Hook on segment VIII and VII, if present, minute and formed by gradual recurvature of posterior margin of tergite on either side immediately lateral to mid-line, to form an acuminate process. Hook of segment IX flat, slightly larger than that of segment VIII, more abruptly protruding from posterior margin of tergite, and slightly overhanging anterior margin of segment X. Length of epiproct 80–88% ($\bar{y}$ = 84%) mid-dorsal length of abdominal segment X, and 93–100% ($\bar{y}$ = 97%) length of paraprocts. Male epiproct, in dorsal view, abruptly narrowed immediately beyond mid-length, forming a pair of rounded, lateral humps. Female epiproct tapering more regularly to tip (Fig. 4). Length of cercus 83–96% ($\bar{y}$ = 92%) that of epiproct.

Diagnosis.—The larva of *Gomphus militaris* can be distinguished from North American congeners by the following combination of characters: length of abdominal segment X subequal to or decidedly greater than basal width; mid-dorsal length of abdominal segment IX subequal to or less than basal width; lateral spines of abdominal segment VI absent or minute; distal margin of labial palp rounded and without end hook; teeth of labial palp truncate and nearly obsolete. *Gomphus militaris* can be distinguished from species of *Arigomphus* by the absence of a mid-dorsal ridge on the anterior portion of the middle abdominal tergites, and the teeth of the labial palp small, squarely truncate, and much shorter than basal width. Examination of earlier instar specimens indicates that these characteristics are quite stable in specimens as small as ca. 15 mm in total length. Abdominal segment X becomes slightly more elongate and the lateral spines of IX extend a proportionately shorter distance in progressively earlier instars.

Material examined.—TEXAS: *Kimble Co.:* N. Llano R. 1.7 mi. W. on Rt. 377, V-24-1987, RWS, 1 larva; *Mason Co.:* James R. near London, IV-11-1992, RWS, 2 larvae; KANSAS: *Elk Co.:* Big Caney R.—1 mi. W. Grenoda at U.S. 160 hwy. br., V-12-1982, B. Coler & D. G. Huggins, 1 larva; MISSOURI: *Audrain Co.:* Robert M. White II Conservation Area, UTM (Universal Transverse Mercator) zone 15 597050E, 4353000N, IV-24-1999, BHPL & N. Whiteman, 1 larva; *Boone Co.:* Ashland Lake, UTM zone 15 568980E 4290420N, V-6-2001, BHPL, 1 male (partially emerged V-26 2001); *Caldwell Co.:* Bonanza Conservation Area, UTM zone 15 418010E 4385720N, III-10–1999, BHPL & N. Whiteman, 1 larva; *Monroe Co.:* Otter Cr., UTM zone 15 569650E 4384400N, VI-21-2001, BHPL, exuviae (1 specimen); *Platte Co.:* Guy B. Park Conservation Area, UTM zone 15 345150E 4365040N, III-21-1999, BHPL & N. Whiteman, 1 larva; *Vernon Co.:* Douglas Branch Conservation Area, UTM zone 15 379030E 4198180N, III-22-1999, BHPL & N. Whiteman, 1 larva.

Additional Missouri material examined.—*Atchison Co.:* Tarkio Prairie Conservation Area, BHPL & N. Whiteman, UTM zone 15 313200E 4485890N, IX-12–1998; same data, UTM zone 15 312230E 4486100N, BHPL & N. Whiteman; *Audrain Co.:* Robert M. White II Conservation Area, UTM zone 15 597100E 4353150N, IX-9-1998, BHPL & N. Whiteman; *Barton Co.:* Shawnee Trail Conservation Area, UTM zone 15 359735E 4143150N, IX-26-1998; Dorris Creek Prairie Conservation Area, UTM zone 15 390765E 4137060N, IX-27-1998, BHPL & N. Whiteman; same data, VI-9-1999, BHPL & N. Whiteman; Clear Creek Conservation Area, UTM zone 15 390900E 4166300N, VI-9-1999, BHPL & N. Whiteman; *Carroll Co.:* Bunch Hollow Conservation Area, UTM zone 15 449350E 3380150N, IX-13-1998, BHPL & N. Whiteman; *Harrison Co.:* Wayne Helton Memorial Conservation Area, UTM zone 15 432000E 4454000N, VI-23-1999, BHPL & N. Whiteman; *Henry Co.:* Connor O. Fewel Conservation Area, UTM zone 15 439600E 4259650N, IX-20-1998, BHPL & N. Whiteman; *Holt Co.:* Riverbreaks Conservation Area, UTM zone 15 321210E 4420700N, VI-15-1999, BHPL & N. Whiteman; *Knox Co.:* Henry Sever Lake Conservation Area, UTM zone 15 587200E 4429840N, IX-6-1998, BHPL & N. Whiteman; *Lafayette Co.:* Maple Leaf Lake Conservation Area, UTM zone 15 431410E 4316450N, IX-18-1998, BHPL & N. Whiteman; *Livingston Co.:* Poosey Conservation Area, UTM zone 15 442000E 4420220N, IX-12-1998, BHPL & N. Whiteman; *St. Clair Co.:* Taberville Prairie Conservation Area, UTM zone 15 414800E 4211890N, IX-26-1998, BHPL & N. Whiteman; *Vernon Co.:* Little Osage Prairie Natural Area, UTM zone 15 381800E 4180440N, IX-26-1998, BHPL & N. Whiteman; *Worth Co.:* Emmett and Leah Seat Memorial Conservation Area, UTM zone 15 396450E 4471620N, IX-12-1998, BHPL & N. Whiteman.

Discussion

The results demonstrate that previously published characters will not correctly distinguish larvae of *Gomphus militaris* from those of congeners. In their key to species of the subgenus *Gomphus*, Needham and Westfall (1955) characterized *G. militaris* as the only species of the subgenus not possessing lateral spines on abdominal segments VII and VIII. As such, the larva of *G. militaris* will key to *G. spicatus* Hagen with Needham and Westfall (1955). This shortcoming is corrected only partially by Needham et al. (2000), who characterized *G. militaris* as possessing lateral spines on abdominal segments VIII and IX, or IX only. In that key, the larva can not be keyed to any species. As shown here, lateral spines are present on abdominal segments VII–IX.

The results of this analysis also reveal the inadequacy of existing keys to reliably distinguish *G. militaris* from species of *Arigomphus*. The abdomen of species of *Arigomphus* has been characterized as tapering, whereas that of species of *Gomphus* as ending more abruptly (Needham and Westfall 1955, Young and Bayer 1979, Needham et al. 2000). However, the abdomen of *G. militaris* is tapering, as in species of *Arigomphus*. Also, abdominal segment X of species of *Arigomphus* has been characterized as "distinctly" longer than wide (Young and Bayer 1979, Needham et al. 2000) and segment IX as wider than long (Needham et al. 2000), whereas abdominal segment X in species of *Gomphus* has been characterized as not longer than wide (Young and Bayer 1979), or if longer, then with segment IX longer than wide (Needham et al. 2000). As shown here, segment X of *G. militaris* is usually longer than wide, but abdominal segment IX is not. Finally, species of *Gomphus* with the abdomen acuminate and abdominal segment X longer than wide have been characterized as possessing large end hooks on the labial palps (Needham et al. 2000); however, *G. militaris* possesses no such end hooks.

The inability of published characters to diagnose the larva of *G. militaris* is not due to intraspecific variation. Larvae from throughout the range of this species were consistent in the manifestation of key characteristics. In addition to the specimens measured in the description, six final instar exuviae, reared by D. G. Huggins, and numerous larvae from Kansas (Kansas State Biological Survey collection, housed at the

University of Kansas Natural History Museum and the Snow Museum of Entomology) were examined but not measured, and diagnostic characters were consistent throughout. Further, although Young and Bayer (1979) accurately figured the labium and abdomen of *G. militaris*, the characters provided in their key were inadequate to diagnose the species.

Much of the confusion can be traced to the published larval description by Bird (1934), upon which existing keys seem, at least partially, to be based. Bird's description was based on the exuviae from the emergence of a single female from a pond in Oklahoma on V-10-1932. The teneral imago escaped "one hour and seventeen minutes after the nymph had left the water." The association was based upon photographs and notes of the teneral imago. The senior author has examined the exuvial specimen described by Bird and determined it to be that of *Arigomphus lentulus* (Needham).

Determination of female specimens of Gomphidae is difficult, even when working with mature material in the laboratory, and field identification of teneral specimens is highly suspect. Additionally, adult specimens of *Arigomphus* are less darkly pigmented than those of related genera, and *G. militaris* displays reduced dark markings relative to other species of the genus *Gomphus*. Further, the nymph of *A. lentulus* was unknown at the time of Bird's description. Thus, Bird's field identification was a reasonable error.

The description by Bird was the first formal description of the larva of *A. lentulus*, and should be cited as such. There can be little doubt that the exuviae examined by BHPL are those described by Bird. The vial bears his determination label as *Gomphus militaris*, and the female specimen was collected by Bird in McClain Co., Oklahoma on V-10-1932, which matches the data given in his description. Only one specimen bearing this information was found in Bird's collection, housed at the Sam Noble Oklahoma Museum of Natural History, University of Oklahoma (Ken Hobson, personal communication). No information regarding an associated imago is recorded on the label. The specimen exactly matches Bird's figures and agrees with the description, except on two points: Bird stated that lateral spines are present only on abdominal segment IX, and that no dorsal "teeth" are present on any abdominal segment. However, the figures which accompany Bird's description clearly depict a small dorsal hook on abdominal segment IX, and indicate lateral spines on at least segments VIII and IX. The specimen does, in fact, bear a small dorsal hook on segment IX, and small lateral spines on segments VII and VIII in addition to the large lateral spines of segment IX. Additionally, it should be noted that other larval specimens of *A. lentulus* often bear a small dorsal hook on segment VIII. Interestingly, as evidenced by Bird's description, the length of abdominal segment X of specimens of *A. lentulus* often is no greater than the basal width.

Gomphus militaris was the most frequently encountered species of the family Gomphidae in ponds in the prairie region of Missouri. Final instars were collected only during the spring, but much smaller instars were also collected at this time. Samples from early summer contained only intermediate instars, and samples from late summer contained both early and late instars. A final instar collected on 6 May died while emerging on 26 May, and exuviae were collected on 21 June. This emergence, coupled with adult collection data, establishes the flight season as 26 May to 5 August in Missouri. The instar distribution and flight season data indicate that *G. militaris* emerges somewhat synchronously during the spring and at least some individuals may require more than one year to complete development in Missouri.

The larval distribution records indicate that *G. militaris* is more widespread in Missouri than previously shown. The collection records from Shelby, Audrain, and Knox counties extend the known eastern limit of the species range ca. 150 km beyond that given in the most recently published, detailed account (Dunkle 2000). Also, the collection of exuviae from Shelby County demonstrates adult recruitment at this limit, and the Knox County record places the known limit within ca. 40 km of the Mississippi River.

ACKNOWLEDGMENTS

We thank Ken J. Tennessen for determination of specimens and a critical review of the manuscript. We are grateful to Jordan Yochim, University of Kansas Natural History Museum, and Dr. James S. Ashe, Snow Entomological Museum, University of Kansas, for the opportunity to examine material housed in their collections. Dr. Ken Hobson, Sam Noble Oklahoma Museum of Natural History, University of Oklahoma, was instrumental in obtaining Dr. Bird's specimen. Linden Trial, Missouri Department of Conservation, provided adult material. Funding for RWS was provided in part by project #PSSL0232 of the Missouri Agricultural Experiment Station.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 312–319

ANNOTATED LIST OF THE BARK AND AMBROSIA BEETLES (COLEOPTERA: SCOLYTIDAE) OF DELAWARE, WITH NEW DISTRIBUTIONAL RECORDS

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Abstract.—A total of 64 species of Scolytidae are reported from Delaware. Fifty-one species are reported for the first time: *Hylastes porculus* Erichson, *H. salebrosus* Eichhoff, *H. tenuis* Eichhoff, *Hylurgops rugipennis pinifex* (Fitch), *Hylesinus aculeatus* Say, *Dendroctonus frontalis* (Zimmermann), *D. valens* LeConte, *Cnesinus strigicollis* LeConte, *Phloeotribus liminaris* (Harris), *Phloeosinus dentatus* (Say), *Carphoborus bifurcus* Eichhoff, *Hylocurus rudis* (LeConte), *H. flaglerensis* Blackman, *Micracisella opacicollis* (LeConte), *Thysanoes fimbricornis* LeConte, *Ips grandicollis* (Eichhoff), *I. pini* (Say), *Orthotomicus caelatus* (Eichhoff), *Pityogenes hopkinsi* Swaine, *Dryoeocetes autographus* (Ratzeburg), *D. granicollis* (LeConte), *Lymantor decipiens* (LeConte), *Xyloterinus politus* Say, *Ambrosiodmus obliquus* (LeConte), *A. rubricollis* (Eichhoff), *A. tachygraphus* (Zimmermann), *Euwallacea validus* (Eichhoff), *Xyleborus atratus* Eichhoff, *X. celsus* Eichhoff, *X. ferrugineus* (Fabricius), *X. pelliculosus* Eichhoff, *X. pubescens* Zimmermann, *X. sayi* (Hopkins), *Xylosandrus crassiusculus* (Motschulsky), *X. germanus* (Blandford), *Hypothenemus crudiae* (Panzer), *H. dissimilis* (Zimmermann), *H. eruditus* Westwood, *Conophthorus coniperda* (Schwarz), *Corthylus columbianus* Hopkins, *Gnathotrichus materiarius* (Fitch), *Monarthrum fasciatum* (Say), *M. mali* (Fitch), *Pityophthorus cariniceps* LeConte, *P. confusus* Blandford, *P. liquidambarus* Blackman, *P. opaculus* LeConte, *P. puberulus* (LeConte), *P. scriptor* Blackman, *Pseudopityophthorus minutissimus* (Zimmermann), *P. pubescens* Blackman. Fourteen of the species are not native to North America.

Key Words: Scolytidae, distribution, Delaware

Though its geographical area is comparatively small, Delaware exhibits an extraordinary diversity of tree species and forest associations. Due to its location in a north/south floral transition zone, many of the forests that typify northern, central, and southern regions of the eastern United States can be found in Delaware (Tatnall 1946, Phillips 1978). Of the approximately 600 species of trees native to the entire United States, about 115 are native to Delaware (Taber 1939). About one third of the land in Delaware is covered with mostly second and third growth forests representing a fragmented patchwork of the original contiguous forest.

The diversity of tree species and forest associations in Delaware is not adequately reflected by the previously documented members of the Scolytidae in the state (Wood and Bright 1992). Such a disparity prompted a preliminary survey of this important forest insect group in 1997 followed by a more intensive state-wide survey in 1998.

In 1997, twelve Lindgren funnel traps baited with 95% ethanol and natural turpentine were placed in two forested areas and monitored from April through September. In 1998, thirty-six funnel traps were placed at 19 forested sites throughout the state and monitored from March through October. Traps were baited with a variety of lures including ethanol, turpentine, cut tree branches, and various commercially available (PheroTech Inc, Delta, BC, Canada) bark beetle pheromones such as frontalin (*Dendroctonus frontalis* (Zimmermann) pheromone) and sulcatol (a pheromone for a species of *Gnathotrichus*). Also in 1998, specimens at the University of Delaware in Newark were examined, as well as specimens collected by the Delaware Department of Agriculture during several years of agricultural pest surveys.

Two catalogs of Scolytidae (Wood and Bright 1992, Bright and Skidmore 1997) list only 11 scolytids from Delaware. We report an additional 51 species. Two additional species, *Xyleborus californicus* Wood and *Dryoxylon onoharaensum* (Murayama), were reported from Delaware for the first time in recent publications (Vandenberg et al. 2000, Bright and Rabaglia 1999). Almost all of these new records are for species that have been recorded from neighboring states, but were not recorded from Delaware. *Hylocurus flaglerensis* Blackman was not previously reported from the area, having been only known from Florida (Rabaglia 2003, also reported this species as new in Maryland). *Pityophthorus scriptor* Blackman is reported for the first time north of North Carolina.

Of the 64 species now reported from Delaware, 14 are not native to North America. Eight of these are ambrosia beetles in the tribe Xyleborini. Atkinson et al. (1990) pointed out the increasing occurrence of these beetles in the eastern United States.

Several species recorded from neighboring states likely will be found with further collecting in Delaware. In addition, Delaware's location on the east coast and increasing international trade in the area will result in additional exotic species becoming established. Three exotic species, *Tomicus piniperda* (L.), *Hylastes opacus* Erichson, and *Xyleborus pfeili* Eichhoff, and two western North American species of *Hylesinus* have recently been reported in Maryland (Vandenberg et al. 2000, Rabaglia and Williams 2002, Rabaglia 2003). Hoebeke (1991) reported the exotic ambrosia beetle, *Ambrosiodmus lewisi* (Blandford), for the first time in North America in southeastern Pennsylvania, near Delaware.

Abbreviations for repositories of specimens new to Delaware are: UDCC—University of Delaware, Newark DE; RJRC—Robert J. Rabaglia collection, Annapolis MD. Numbers of specimens appear in parentheses with abbreviations. Sources of published records are from Wood and Bright 1992, Bright and Skidmore 1997.

NEW DELAWARE RECORDS OF SCOLYTIDAE

Subfamily Hylesininae

Hylastes porculus Erichson

Distribution.—USA: AL, AR, CT, DC, FL, GA, IN, LA, ME, MD, MA, MI, MN, MS, NH, NJ, NY, NC, PA, SC, SD, TN, TX, VT, VA, WV, WI, DE: Kent Co., Little Creek Wildlife Area, 22 April 1998, M. A. Valenti coll. (2, RJRC); Sussex Co., Woodside, 20 April 1930, J. M. Amos coll. (1, UDCC).

Hylastes salebrosus Eichhoff

Distribution.—USA: AL, AR, FL, GA, LA, MD, MS, NJ, NC, SC, TX, VA, DE: New Castle Co., Blackbird State Forest, Tybout Tract, 27 May 1997, M. A. Valenti coll. (1, RJRC); Sussex Co., Redden State Forest, HQ Tract, 16 May 1997, M. A. Valenti coll. (2, RJRC).

Hylastes tenuis Eichhoff

Distribution.—USA: AL, AZ, AR, CA, DC, FL, GA, ID, IN, KY, LA, MD, MA,

MS, NV, NM, NY, NC, OR, PA, SC, TN, TX, UT, VA, WV, DE: New Castle Co., Blackbird State Forest, Wright Tract, 27 May 1997, M. A. Valenti coll. (2, RJRC); Sussex Co., Redden State Forest, HQ Tract, 24 April 1998, M. A. Valenti coll. (1, RJRC).

Hylurgops rugipennis pinifex (Fitch)

Distribution.—USA: AL, AZ, CA, CO, DC, GA, ID, ME, MD, MA, MI, MN, MT, NH, NJ, NM, NY, NC, OH, OR, PA, RI, SC, UT, VA, WV, WI, WY, DE: New Castle Co., Blackbird State Forest, Wright Tract, 30 April 1997, M. A. Valenti coll. (1, RJRC); Sussex Co., Redden State Forest, Appenzellar Tract, 24 June 1997, M. A. Valenti coll. (1, RJRC).

Hylesinus aculeatus Say

Distribution.—USA: AR, CO, CT, DC, GA, IL, IN, IA, KS, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NY, NC, ND, OH, OK, PA, SC, SD, TN, TX, VA, WV, WI, DE: New Castle Co., Newark, 3 May 1904, C. O. Houghton coll. (1, UDCC).

Dendroctonus frontalis (Zimmermann)

Distribution.—USA: AL, AZ, AR, DC, FL, GA, KY, LA, MD, MS, NC, OK, PA, SC, TN, TX, VA, WV, DE: Sussex Co., Oak Orchard, Jan. 5 1961, D. F. Bray coll. ex. Loblolly pine (9, UDCC).

Dendroctonus valens LeConte

Distribution.—USA: AZ, CA, CO, ID, IL, IN, KS, ME, MD, MA, MI, MN, MT, NV, NH, NJ, NM, NY, NC, OH, OR, PA, SD, UT, VT, VA, WA, WV, WI, WY, DE: New Castle Co., Blackbird State Forest, Wright Tract, 30 April 1997, M. A. Valenti coll. (2, RJRC); Kent Co., Blackiston Wildlife Area, 23 April 1998, M. A. Valenti coll. (1, RJRC).

Cnesinus strigicollis LeConte

Distribution.—USA: DC, FL, GA, IL, LA, MD, MI, MO, NJ, NY, NC, OH, PA, SC, TN, TX, VA, WV, DE: New Castle Co., Blackbird State Forest, White Rd Tract, 27 May 1997, M. A. Valenti coll. (1, RJRC); Kent Co., NG Wilder Wildlife Area, 26 May 1998, M. A. Valenti coll. (1, RJRC).

Phloeotribus liminaris (Harris)

Distribution.—USA: CT, DC, FL, IA, KY, MD, MA, MI, MS, NH, NJ, NY, NC, OH, PA, SC, VA, WV, DE: Kent Co., N. Dover, June 1999, M. A. Valenti coll. (1, RJRC); New Castle Co., Newark, April 1911 (5, UDCC).

Phloeosinus dentatus (Say)

Distribution.—USA: AL, AR, DC, FL, GA, IL, IA, KS, KY, MD, MA, MN, MS, MO, NE, NH, NJ, NY, NC, OH, OK, PA, SC, SD, TN, TX, VA, WV, DE: Sussex Co., Prime Hook Wildlife Refuge, 27 April 1998, M. A. Valenti coll. (3, UDCC).

Carphoborus bifurcus Eichhoff

Distribution.—USA: DC, FL, GA, MD, MS, MO, NY, NC, OK, PA, TN, VA, WV, DE: Kent Co., Dover, 15 April 1998, Del Dept of Ag coll. ex. Ipslure-baited trap, (1, RJRC); Sussex Co., Redden State Forest, Appenzellar Tract, 1 May 1997, M. A. Valenti coll. (1, RJRC).

Hylocurus rudis (LeConte)

Distribution.—USA: DC, GA, KS, KY, MD, MI, NJ, OH, PA, TX, VA, DE: Kent Co., Killens Pond SP, 1 July 1998, M. A. Valenti coll. (1, RJRC).

Hylocurus flaglerensis Blackman

Distribution.—USA: FL, MD, DE: Kent Co., Blackiston Wildlife Area, 23 April 1998, M. A. Valenti coll. (1, RJRC).

Micracisella opacicollis (LeConte)

Distribution.—USA: DC, IL, GA, KS, MA, MD, MI, MN, MO, NJ, NY, NC, OH, PA, VA, WV, DE: Kent Co., Milford, 5 May 1932 (1, UDCC).

Thysanoes fimbricornis LeConte

Distribution.—USA: DC, FL, IL, MD, MS, NJ, NC, PA, TX, VA, WV, DE: Kent Co., Milford Neck, 26 May 1998, M. A. Valenti coll. (6, RJRC).

Ips grandicollis (Eichhoff)

Distribution.—Australia; USA: AL, AR, CT, DC, FL, GA, IL, IN, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, OH, PA, SC, TN, TX, VA, WV, WI, DE: New Castle Co., 24 Aug 1938, J. M. Amos coll. (1 UDCC); Sussex Co., Bethany Beach, 27 August 1974, Frank Boys coll. ex: Japanese black pine (2 UDCC).

Ips pini (Say)

Distribution.—USA: AK, AL, AR, CA, CO, CT, DC, FL, GA, ID, IL, IN, IA, KS, LA, ME, MD, MS, MI, MN, MS, MT, NE, NV, NH, NJ, NY, NC, OH, OR, PA, SD, TX, UT, VT, VA, WV, WI, WY, DE: New Castle Co., Wilmington, 14 April 1998, DDA coll. ex: ipslure-baited trap (1, RJRC).

Orthotomicus caelatus (Eichhoff)

Distribution.—Africa; USA: AK, AL, AR, CA, CO, CT, DC, FL, GA, ID, IL, IN, IA, KS, LA, ME, MD, MS, MI, MN, MS, MT, NE, NV, NH, NJ, NY, NC, OH, OR, PA, SD, TX, UT, VT, VA, WV, WI, WY, DE: Kent Co., Little Creek Wildlife Area, 22 April 1998, M. A. Valenti coll. (1, RJRC); Sussex Co., Redden State Forest, HQ Tract, 24 April 1998, M. A. Valenti coll. (1, RJRC).

Pityogenes hopkinsi Swaine

Distribution.—USA: CT, GA, IL, IN, IA, ME, MD, MA, MI, MN, NH, NJ, NY, NC, OH, PA, SC, TN, VA, WV, WI, DE: New Castle Co., Wilmington, 27 May 1998, DDA coll. ex: Ipslure-baited trap (2, RJRC).

Dryocoetes autographus (Ratzeburg)

Distribution.—Africa, Asia, Europe; USA: AK, CA, CO, ME, MD, MI, MN, MT, NV, NH, NM, NY, NC, OR, PA, SD, TN, UT, VA, WA, WV, WI, WY, DE: New Castle Co., Blackbird State Forest, Tybout Tract, 13 June 1997, M. A. Valenti coll. (1, RJRC).

Dryocoetes granicollis (LeConte)

Distribution.—USA: AR, DC, FL, GA, IL, KY, LA, MD, MO, NJ, NY, NC, OH, PA, TX, VA, DE: New Castle Co., Newark, 2 June 1901 (1, UDCC).

Lymantor decipiens (LeConte)

Distribution.—USA: IA, KY, ME, MD, MA, MI, MN, MS, NJ, NY, OH, PA, VA, WV, DE: New Castle Co., Blackbird State Forest, Tybout Tract, 7 August 1997, M. A. Valenti coll. (3, RJRC).

Xyloterinus politus Say

Distribution.—USA: CT, DC, GA, IL, KY, ME, MD, MA, MI, MO, MS, NH, NJ, NY, NC, OH, PA, VA, WV, WI, DE: Kent Co., Little Creek Wildlife Area, 22 April 1998, M. A. Valenti coll. (1, RJRC); New Castle Co., Newark, 14 March 1958, Donald MacCreery coll. (1, UDCC); Sussex Co., Redden State Forest, HQ Tract, 24 April 1998, M. A. Valenti coll. (1, RJRC).

Ambrosiodmus obliquus (LeConte)

Distribution.—Africa, South America; USA: DC, FL, GA, LA, MD, MS, NC, VA, DE: Kent Co., Blackiston Wildlife Area, 17 June 1999, M. A. Valenti coll. ex: funnel trap (3, RJRC); Sussex Co., Redden State Forest, Appenzellar Tract, 28 May 1997, M. A. Valenti coll. ex: turpentine and ethanol funnel trap (1, RJRC).

Ambrosiodmus rubricollis (Eichhoff)

Distribution.—Asia, Australia; USA: AL, CT, FL, MD, PA, SC, TN, VA, DE: Kent Co., Blackiston Wildlife Area, 1 October 1999, M. A. Valenti coll. ex: funnel trap (3, RJRC).

Ambrosiodmus tachygraphus (Zimmermann)

Distribution.—USA: AL, DC, FL, GA, IL, MD, MS, NJ, NC, OH, PA, SC, VA, WV, DE: Sussex Co., Assawoman Wildlife Area, 27 April 1998, M. A. Valenti coll. (2, RJRC).

Euwallacea validus (Eichhoff)

Distribution.—Asia; USA: MD, NY, PA. DELAWARE: Kent Co., Blackiston Wildlife Area, 23 April 1998, M. A. Valenti coll. (2, RJRC); New Castle Co., Claymont, 20 May 1997, C. Bartlett coll. (1, UDCC); Sussex Co., Redden State Forest, HQ Tract, 24 April 1998, M. A. Valenti coll. (1, RJRC).

Xyleborus atratus Eichhoff

Distribution.—Asia; USA: FL, GA, MD, TN, VA, WV. DELAWARE: Kent Co., Blackiston Wildlife Area, 23 April 1998, M. A. Valenti coll. (5, RJRC); Sussex Co., Redden State Forest, HQ Tract, 24 April 1998, M. A. Valenti coll. (2, RJRC).

Xyleborus celsus Eichhoff

Distribution.—USA: AR, CT, DC, FL, GA, IL, IN, IA, KS, LA, MD, MI, MS, MO, NJ, NY, NC, OH, PA, SC, TX, VT, VA, WV. DELAWARE: New Castle Co., Newark, 22 June 1990, C. Bartlett coll. ex: blacklight trap (4, UDCC).

Xyleborus ferrugineus (Fabricius)

Distribution.—Africa, Asia, Australia, South America; USA: AL, AZ, AR, DC, FL, GA, HI, IL, IN, KY, LA, MD, MA, MI, MS, MO, NJ, NY, NC, OH, PA, SC, TN, TX, VA, WV. DELAWARE: Kent Co., NG Wilder Wildlife Area, 26 May 1998, M. A. Valenti coll. (1, RJRC); New Castle Co., Newark, 21 June 1901 (1, UDCC); Sussex Co., Redden State Forest, Owens Tract, 24 June 1998, M. A. Valenti coll. (1, RJRC).

Xyleborus pelliculosus Eichhoff

Distribution.—Asia; USA: MD, PA. DELAWARE: Kent Co., Blackiston Wildlife Area, 23 April 1998, M. A. Valenti coll. (1, RJRC).

Xyleborus pubescens Zimmermann

Distribution.—USA: AL, AR, DC, FL, GA, KY, LA, MD, MS, NJ, NY, NC, PA, SC, TX, VA, WV, DE: Kent Co., Little Creek Wildlife Area, 25 June 1998, M. A. Valenti coll. (1, RJRC); New Castle Co., Newark, 20 May 1907 (2, UDCC); Sussex Co., Bethany Beach, April 9, 1932 (2, UDCC).

Xyleborus sayi (Hopkins)

Distribution.—USA: CT, DC, IL, IN, KY, ME, MD, MI, MO, NJ, NY, NC, OH, PA, TN, VA, WV, DE: Sussex Co., Redden State Forest, HQ Tract, 11 August 1997, M. A. Valenti coll. (1, RJRC).

Xylosandrus crassiusculus (Motschulsky)

Distribution.—Africa, Asia; USA: FL, GA, LA, MD, MS, NC, SC, TX. DELAWARE: Kent Co., Little Creek Wildlife Area, 22 April 1998, M. A. Valenti coll. (2, RJRC); Sussex Co., Redden State Forest, HQ Tract, 26 May 1998, M. A. Valenti coll. (2, RJRC).

Xylosandrus germanus (Blandford)

Distribution.—Asia, Europe; USA: CT, IL, IN, KY, NJ, NY, NC, OH, PA, WV. DELAWARE: Kent Co., Blackiston Wildlife Area, 23 April 1998, M. A. Valenti coll. (4, RJRC); New Castle Co., Newark, 21 May 1983, C. Sanford coll. ex: *Liroden-dron tulipifera* (1, UDCC); Sussex Co., Redden State Forest, HQ Tract, 24 April1998, M. A. Valenti coll. (1, RJRC).

Hypothenemus crudiae (Panzer)

Distribution.—Africa, Asia, South America; USA: AL, AR, DC, FL, GA, IN, KS, KY, LA, MD, MS, NJ, NY, NC, PA, SC, TN, TX, VA, WV. DELAWARE: Sussex Co., Redden State Forest, Owens Tract, 24 June 1998, M. A. Valenti coll. ex: Lindgren funnel trap with ethanol and yellow poplar branch (1, RJRC).

Hypothenemus dissimilis (Zimmermann)

Distribution.—USA: AL, CT, DC, FL, GA, IL, IN, LA, KY, MD, MN, MS, MO, NJ, NY, NC, OH, PA, SC, TN, TX, VA, WV. DELAWARE: New Castle Co., Newark, 21 May 1983, C. Sanford coll. ex: *Lirodendron tulipifera* (1, UDCC).

Hypothenemus eruditus Westwood

Distribution.—Africa, Asia, Australia, Europe, South America; USA: AL, AR, CA, DC, FL, GA, IL, LA, MD, MI, MS, NH, NJ, NY, NC, PA, SC, TN, TX, VA, WV. DELAWARE: New Castle Co., Newark, 15 May 1906 (1, UDCC).

Conophthorus coniperda (Schwarz)

Distribution.—USA: ME, MD, MA, MI, MN, NH, NJ, NY, NC, PA, VA, WV, WI. DELAWARE: New Castle Co., Wilmington, 6 May 1993, J. Plummer coll. ex: Ipslure-baited funnel trap (1, RJRC).

Corthylus columbianus Hopkins

Distribution.—USA: DC, FL, GA, IN, KS, MD, MA, MO, NJ, NC, SC, TN, VT, VA, WV. DELAWARE: Kent Co., Dover, 15 April 1998, Del Dept of Ag. coll. ex: Ipslure-baited trap (1, RJRC); New Castle Co., Iron Hill County Park, 24 August 1998, M. A. Valenti coll. (1, RJRC); Sussex Co., Redden State Forest, Owens Tract, 26 May 1998, M. A. Valenti coll. (1, RJRC).

Gnathotrichus materiarius (Fitch)

Distribution.—Europe; USA: AL, AR, DC, FL, GA, LA, ME, MD, MA, MI, MN, MS, MO, NE, NH, NJ, NY, NC, OK, PA, SC, TX, VA, VT, WV, WI. DELAWARE: Kent Co., Little Creek Wildlife Area, 22 April 1998, M. A. Valenti coll. (1, RJRC); Sussex Co., Redden State Forest, HQ Tract, 24 April 1998, M. A. Valenti coll. (2, RJRC).

Monarthrum fasciatum (Say)

Distribution.—USA: AR, CT, DC, FL, GA, IL, IN, IL, KS, KY, LA, MD, MA, MI, MS, MO, NJ, NY, NC, OH, PA, SC, TN, TX, VA, WV, WI. DELAWARE: Kent Co., NG Wilder Wildlife Area, 22 April 1998, M. A. Valenti coll. (2, RJRC); New Castle Co., Newark, 20 April 1912 (17, UDCC).

Monarthrum mali (Fitch)

Distribution.—USA: AL, AR, CA, CT, DC, FL, IL, IN, IL, IA, KY, LA, ME, MD, MA, MI, MN, MS, NJ, NY, NC, OH, PA, TN, TX, VA, VT, WV, WI. DELAWARE: New Castle Co., Newark, 20 May 1907 (1, UDCC).

Pityophthorus cariniceps LeConte

Distribution.—USA: CT, IN, KY, ME, MD, MA, MI, MN, NH, NY, NC, OH, PA, SC, VA, WI. DELAWARE: New Castle Co., Blackbird State Forest, 27 May 1997, M. A. Valenti coll. (3, RJRC).

Pityophthorus confusus Blandford

Distribution.—USA: AL, AR, FL, GA, LA, MD, MS, NC, PA, SC, TX, VA, WV, DE: New Castle Co., Wilmington, 16 August 1993 (1, RJRC); Sussex Co., Redden State Forest, HQ Tract, 1 May 1997, M. A. Valenti coll. (2, RJRC).

Pityophthorus liquidambarus Blackman

Distribution.—USA: AR, CT, DC, FL, GA, IL, IN, IA, LA, MD, MS, NC, WV, DE: Sussex Co., Redden State Forest, HQ Tract, 28 July 1997, M. A. Valenti coll. (1, RJRC).

Pityophthorus opaculus LeConte

Distribution.—USA: AK, AZ, CA, CO, ID, ME, MD, MI, MN, NV, NH, NM, NY, PA, SD, UT, WV, WY, DE: New Castle Co., Wilmington, 9 June 1993, Del Dept of Ag coll. ex. pinene-baited trap (1, RJRC).

Pityophthorus puberulus (LeConte)

Distribution.—USA: DC, IN, KS, KY, ME, MD, MA, MI, MN, NH, IA, NJ, NY, NC, OH, PA, RI, VA, WV, WI, DE: New Castle Co., Wilmington, 28 April 1998, Del Dept of Ag coll. ex. pinene-baited trap (1, RJRC); Sussex Co., Redden State Forest, Owens Tract, 24 June 1998, M. A. Valenti coll. (1, RJRC).

Pityophthorus scriptor Blackman

Distribution.—USA: GA, MS, NC, OK, TN, TX. DELAWARE: Kent Co., Blackburn Wildlife Area, 23 April 1998, M. A. Valenti coll. (2, RJRC).

Pseudopityophthorus minutissimus (Zimmermann)

Distribution.—USA: AR, DC, FL, GA, IL, IA, KS, LA, ME, MD, MS, MA, MI, NH, NJ, NY, NC, PA, SC, VA, WV, WI, DE: New Castle Co., Newark, 9 February 1984, D. F. Bray coll. ex: oak firewood (12, UDCC).

Pseudopityophthorus pubescens Blackman

Distribution.—USA: MD, NC, OK, VA, DE: New Castle Co., Iron Hill County Park, 21 April 1998, M. A. Valenti coll. (1, RJRC).

List of Delaware Scolytidae

a = Species newly reported in Delaware
b = Exotic species found in Delaware

Hylesininae

Hylastini

Hylastes porculus Erichson—a
Hylastes salebrosus Eichhoff—a
Hylastes tenuis Eichhoff—a
Hylurgops rugipennis pinifex (Fitch)—a

Hylesinini

Hylesinus aculeatus Say—a

Tomicini

Dendroctonus frontalis (Zimmermann)—a
Dendroctonus terebrans (Olivier)
Dendroctonus valens LeConte—a
Hylurgopinus rufipes (Eichhoff)

Bothrosternini

Cnesinus strigicollis LeConte—a

Phloeotribini

Phloeotribus liminaris (Harris)—a

Phloeosinini

Chramesus hicoriae LeConte
Phloeosinus dentatus (Say)—a

Polygraphini

Carphoborus bifurcus Eichhoff—a

Scolytinae

Scolytini

Scolytus multistriatus (Marsham)—b
Scolytus quadrispinosus (Say)
Scolytus rugulosus (Muller)—b

Micracini

Hylocurus rudis (LeConte)—a
Hylocurus flaglerensis Blackman—a
Micracisella opacicollis (LeConte)—a
Thysanoes fimbricornis LeConte—a

Ipini

Ips calligraphus (Germar)
Ips grandicollis (Eichhoff)—a
Ips pini (Say)—a
Orthotomicus caelatus (Eichhoff)—a
Pityogenes hopkinsi Swaine—a

Dryocoetini

Dryocoetes autographus (Ratzburg)—a
Dryocoetes granicollis (LeConte)—a
Dryoxylon onoharaensum (Murayama)—a
Lymantor decipiens (LeConte)—a

Xyloterini

Xyloterinus politus Say—a

Xyleborini

Ambrosiodmus obliquus (LeConte)—a
Ambrosiodmus rubricollis (Eichhoff)—a, b
Ambrosiodmus tachygraphus (Zimmermann)—a
Euwallacea validus (Eichhoff)—a, b
Xyleborinus saxeseni (Ratzeburg)—b
Xyleborus affinis Eichhoff
Xyleborus atratus Eichhoff—a, b
Xyleborus californicus Wood—b
Xyleborus celsus Eichhoff—a
Xyleborus ferrugineus (Fabricius)—a
Xyleborus pelliculosus Eichhoff—a, b

Xyleborus pubescens Zimmermann—a
Xyleborus sayi (Hopkins)—a
Xylosandrus crassiusculus (Motschulsky)—a, b
Xylosandrus germanus (Blandford)—a, b

Cryphalini

Hypothenemus crudiae (Panzer)—a, b
Hypothenemus dissimilis (Zimmermann)—a
Hypothenemus eruditus Westwood—a, b
Hypothenemus seriatus (Eichhoff)—b

Corthylini

Conophthorus coniperda (Schwarz)—a
Corthylus columbianus Hopkins—a
Gnathotrichus materiarius (Fitch)—a
Monarthrum fasciatum (Say)—a
Monarthrum mali (Fitch)—a
Pityophthorus cariniceps LeConte—a
Pityophthorus confusus Blandford—a
Pityophthorus liquidambarus Blackman—a
Pityophthorus opaculus LeConte—a
Pityophthorus puberulus (LeConte)—a
Pityophthorus pulicarius (Zimmermann)
Pityophthorus scriptor Blackman—a
Pseudopityophthorus minutissimus (Zimmermann)—a
Pseudopityophthorus pubescens Blackman—a

ACKNOWLEDGMENTS

Donald E. Bright identified or verified the identity of many of the specimens, his help is greatly appreciated. We also thank Charles Bartlett, University of Delaware, for the loan of specimens and the Delaware Department of Agriculture, Plant Industries Section, for providing specimens from their USDA Cooperative Agricultural Pest Survey. Funding was provided through a USDA, Forest Service Focus Funding Grant.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 320–330

SUBGENERA OF *CLADONOTA* STÅL (HEMIPTERA: MEMBRACIDAE), WITH TWO NEW SPECIES FROM MEXICO

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Abstract.—The subgenera of *Cladonota* Stål (Hemiptera: Membracidae: Hysoprorini) are reviewed. The subgenus *Acanthonota* Buckton is a **new synonym** of the subgenus *Lobocladisca* Stål, and the subgenus *Lecythifera* Fowler is reinstated. A key to subgenera of *Cladonota* and a checklist of the 47 valid species are provided. Twenty-four species are referred to different subgenera. Two new species of *Cladonota* are described and illustrated from Mexico: ***C. bulbosa*** and ***C. yucatanensis.***

Abstracta.—Se repasa los subgéneros de *Cladonota* Stål (Hemiptera: Membracidae: Hysoprorini). El subgénero *Acanthonota* Buckton es sinónimo con el subgénero *Lobocladisca* Stål y el subgénero *Lecythifera* Fowler está reinstalado como válido. Se encuentra una clave para los subgéneros de *Cladonota* junto con una lista de las 47 espécies válidas. No hay combinaciones nuevas sino 24 espécies están referidas subgéneros diferentes. Dos nuevas especies de *Cladonota* de México están descritas e ilustradas: ***C. bulbosa*** y ***C. yucatanensis.***

Key Words: Membracidae, *Cladonota,* subgeneric key, Mexico, new species, treehoppers

Members of the membracid genus *Cladonota* Stål (1869c) are among the most ornate of earth's creatures (Figs. 1–6). The genus includes the largest number of species of the Tribe Hypsprorini (Membracinae) yet almost nothing is known of their biology. Funkhouser (1951a) stated the trilobed head (clypeus and two subantennal lobes), ocelli on an imaginary line through the middle of eyes, and free forewings as distinctive generic characters. Peláez (1945a) did a generic study of *Cladonota* (then known as *Sphongophorus* Fairmaire 1846a) for Mexico. McKamey (1998) listed 46 valid species in his catalogue. These species were placed in the genus *Sphongophorus* until McKamey (1997) found *Sphongophorus* to be a junior objective synonym of *Hypsauchenia* Germar (1835a), and McKamey (1997) elevated the subgenus *Cladonota* Stål (1869c) to generic status to accommodate the numerous New World species incorrectly placed in *Sphongophorus.* Fifteeen species of *Cladonota* had never been placed in subgenera (McKamey 1998). The inclusion of the two new species, described below, increases the number of valid species in *Cladonota* to 47.

Three characters appear to be useful for delimiting subgenera within *Cladonota*: (1) the presence or absence of a thorn or knob extension on the posterior margin of the anterior process—10 of the 47 species have a tubercle or thorn on the posterior margin of the anterior process (*Lobocladisca* Stål) as in Figs. 3, 37 species do not (as in Fig. 2); (2) the presence or absence of an intermediate process; 42 of the 47 species have an intermediate process (as in Fig. 4), five do not (*Falculifera* McKamey) as in Fig. 1; (3) the length of the anterior process when an intermediate process is present; 32 species have an intermediate process and the posterior margin of the anterior process is entire. In sixteen, the anterior process surpasses the intermediate process (*Cladonota* Stål); and in 16 it does not (*Lecythifera* Fowler). Although no subgenus is distinguished by one feature by itself, these distinctions are useful, at least until a cladistic analysis of the species is undertaken.

Goding (1928e) synonymized the subgenus *Lecythifera* Fowler (1894c) with the subgenus *Cladonota* (as *Sphongophorus*) Stål (1869c). Fowler (1894c) had separated *Lecythifera* Fowler from *Cladonota* Stål by the length of the anterior process when an intermediate process is present: in *Cladonota* the anterior process surpasses the intermediate process; in *Lecythifera* Fowler the anterior process does not surpass the intermediate process. The aforementioned features delimit two distinct subgeneric groups. I therefore propose reinstating *Lecythifera* Fowler as a valid subgenus.

Buckton (1903a) created a new subgenus *Acanthonota* to accommodate one new species, *Cladonota livida*. The spatulate anterior process is the only character that separates *livida* from species of the subgenus *Lobocladisca* Stål. I therefore propose *Acanthonota* Buckton (1903a) as a **new synonym** of *Lobocladisca* Stål (1869c).

KEY TO SUBGENERA OF *CLADONOTA* (MODIFIED FROM FOWLER (1894c), BUCKTON (1903a))

1. Pronotum with erect process present at approximately mid length ("intermediate process") in the form of a ball, knobbed extension or erect horn (Fig. 3) 2
– Pronotum without intermediate process (Fig. 1) . . . . *Falculifera* McKamey
2. Posterior margin of anterior process with small tooth-like extension (Fig. 3) . . . *Lobocladisca* Stål
– Anterior process entire, lacking process on posterior margin (Fig. 2) 3
3. Anterior process does not surpass the intermediate process (Fig. 4) . . . . *Lecythifera* Fowler
– Anterior process surpasses the intermediate process (Fig. 2) . . . . *Cladonota* Stål

The following are descriptions of two new species of *Cladonota* (*Lecythifera*) from Mexico. As for most species in the genus, host plant data are lacking for these species.

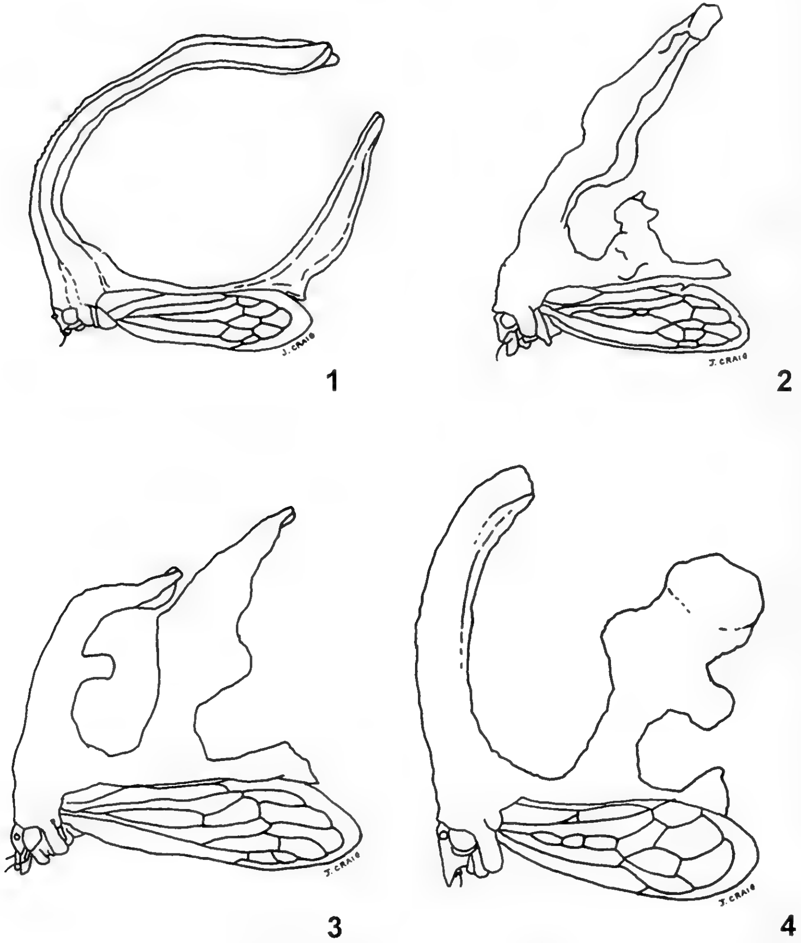
Cladonota (*Lecythifera*) *bulbosa* Flynn, new species

(Figs. 5–7)

Type locality.—MEXICO. Jalisco, 7 km N. Malacque.

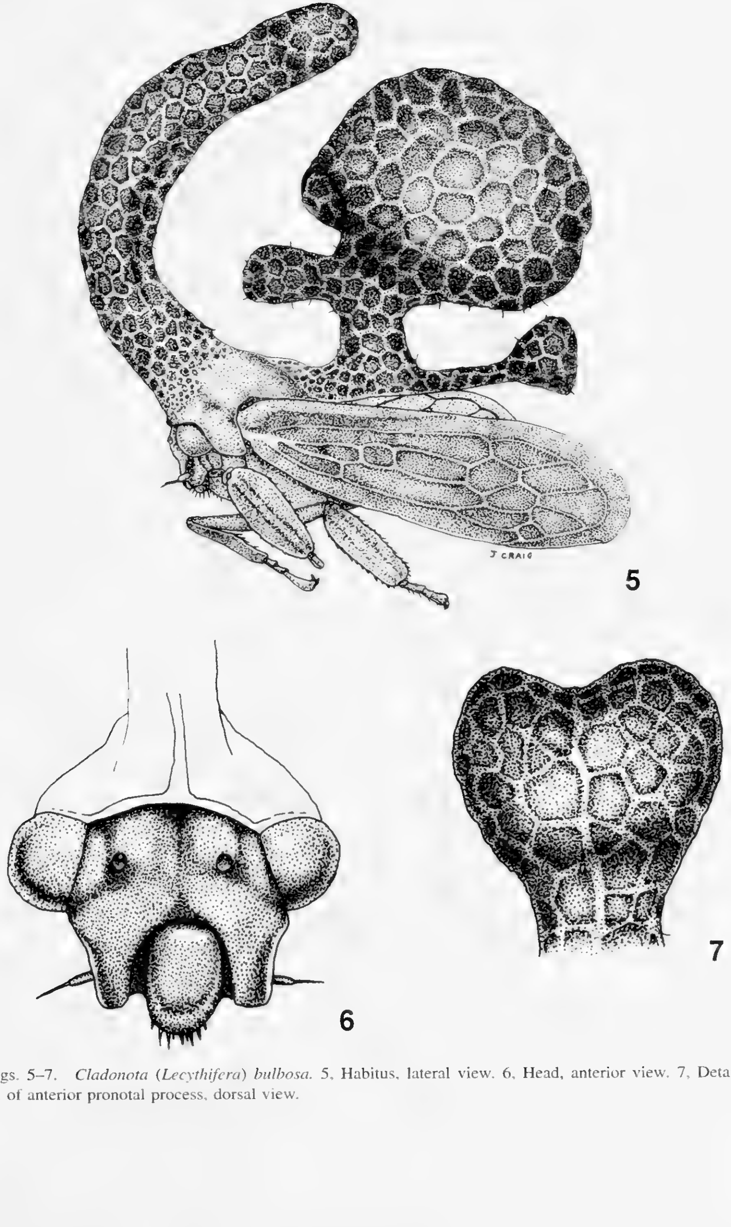
Diagnosis.—*Cladonota bulbosa* is the only species in the genus with a large bulb attached to a stalked intermediate process.

Description.—Female: Unknown. Male: *Head* (Fig. 6): Ocelli closer to eyes than to each other, bisected by an imaginary line that passes through center of eyes; supra antennal lobes elongate, rounded, not attaining apex of clypeus; clypeus nearly twice as long as wide, clypeus apex rounded and pilose. *Thorax:* Pronotum with anterior process arching posteriorly, extending above and nearly touching top of large pronotal bulb of intermediate process, slightly compressed at mid length on posterior face of anterior pronotal process, apex heart shaped and glabrous (Fig. 7); intermediate process with three pronotal bulbs in one plane (Fig. 5): small bulb directed anteriorly, large subspherical bulb directed dorsoposteriorly and a small bulb formed by a constriction on anterior face of large bulb; large bulb approximately 3 times longer (in lateral view) and about 20 times the volume than small basal anteriorly directed bulb of intermediate process; midline of large bulb defined by thin, narrow groove; pronotal surface cancellate—reticulate; humeral angles blunt and obtuse; sparse erect setae on pronotum longer on large posterior pronotal bulb; posterior pronotal process ends in bulb nearly equal in size to small basal posteriorly directed bulb of intermediate process, not attaining apex of forewing. *Forewing:* Coriaceous with broad apical limbus.



Figs. 1–4. 1, *Cladonota* (*Falculifera*) *apicalis*, habitus, lateral view (*Sphongophorus ballista* redrawn from Peláez 1945a). 2, *C.* (*Cladonota*) *latifrons*, habitus, lateral view (redrawn from Peláez 1945a). 3, *C.* (*Lobocladisca*) *biclavatus*, habitus, lateral view (redrawn from Strümpel 1973a). 4, *C.* (*Lecythifera*) *yucatanensis*, habitus, lateral view.

Color: Head with frontoclypeus reddish brown, frequently covered with white tomentose; eyes brownish yellow. Thorax with anterior pronotal process from metopidium to half length of anterior process brownish yellow; remainder of anterior process to apex and posterior process (posterad of intermediate process) reddish brown; large bulb with sunken surface dark red brown, raised surface black. Fore-



Figs. 5–7. *Cladonota* (*Lecythifera*) *bulbosa*. 5, Habitus, lateral view. 6, Head, anterior view. 7, Detail of apex of anterior pronotal process, dorsal view.

wing reddish brown. Legs: Tibiae brownish yellow; tarsi yellowish. Abdomen: Reddish brown.

Dimensions (mm): Length from anterior margin of eyes to apex of forewing in repose: 5.5–6.5 (holotype: 6.5); height from dorsal margin of eyes to apex of anterior process: 6.0–7.0 (holotype: 7.0); height from posterolateral margin of pronotum to dorsal margin of intermediate process: 4.5–4.9 (holotype: 4.9); width of large pronotal bulb (with small constricted bulb in lateral view): 3.5–4.0 (holotype: 4.0)

Material examined.—Holotype (♂) and three paratypes (♂) from the University of Georgia Entomological Collection are labeled: "MEX. Jalisco 7/km N. Malacque/ 16, 19 July 1990/J. E. Wappes." Holotype male additionally labeled "HOLOTYPE/ Cladonota/bulbosa Flynn" deposited in National Museum of Natural History, Smithsonian Institution, Washington, DC; two paratypes (♂) additionally labeled "PARATYPE/Cladonota/bulbosa Flynn" deposited in University of Georgia Entomological Collection and one paratype male deposited in author's collection. All type placements are with permission of the University of Georgia Entomological collections.

Distribution.—Mexico.

Discussion.—This new species is closely allied to *Cladonota inflata* (Peláez) and *Cladonota plummeri* (Peláez), each of which also have a large bulb on the pronotal posterior process. *Cladonota bulbosa* differs from the aforementioned species in having the bulbs attached to a stalked vertical process as opposed to lying directly on, or being an extension of, the pronotal posterior process. *Cladontoa bulbosa* is named for the large diagnostic bulb on the intermediate process of the species.

Cladonota (*Lecythifera*) *yucatanensis* Flynn, new species

(Figs. 8–10)

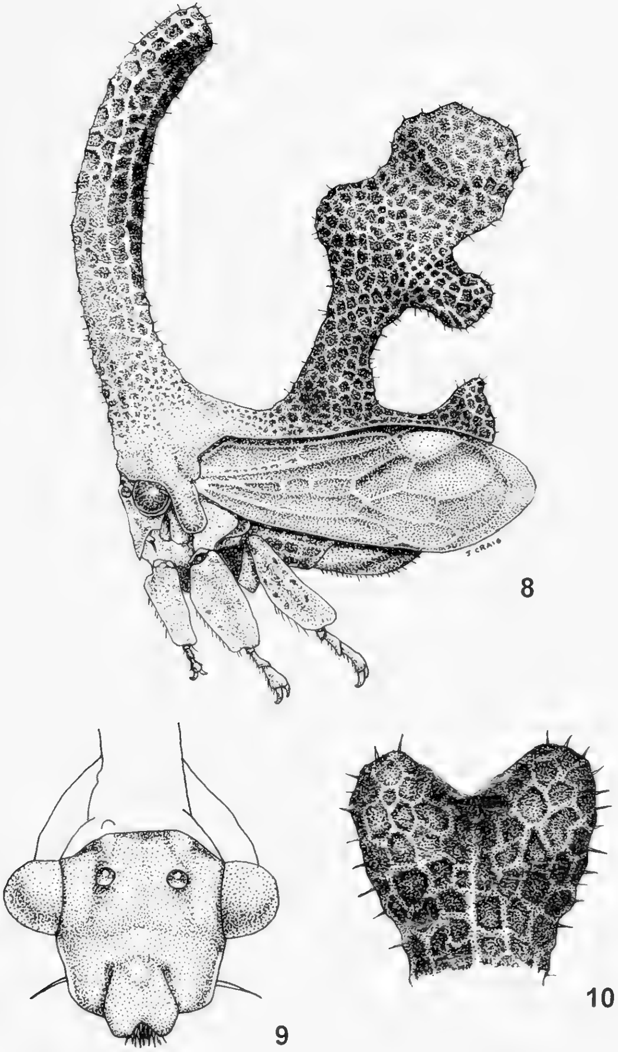
Type locality.—MEXICO: Yucatán, 2 km E. Chichén Itzá.

Diagnosis.—*Cladonota yucatanensis* is distinguished by an anterior pronotal process that does not arch posteriorly as far as the base of an intermediate process that has three lobes.

Description.—Male: Unknown. Female: *Head* (Fig. 9): Ocelli on bases directed laterad toward eyes, closer to eyes than each other, situated on an imaginary line that passes through center of eyes; supra-antennal lobes elongate, rounded, not attaining apex of clypeus; clypeus apex truncate, pilose with white tomentose on the underside. *Thorax:* Pronotum with anterior process weakly recurved with trilobed posteriorly directed intermediate process (Fig. 8); base of anterior process tubular with raised cancellate-reticulate surfaces prominent; apex of anterior process expanded, heart-shaped with center deeply cleft (Fig. 10); intermediate process almost equal to height of anterior process with three lobes: one small lobe directed dorsoanteriorly, one small lobe directed ventroposteriorly and large lobe directed dorsoposterorly; lobes cancellate reticulate; pronotal surface cancellate reticulate; humeral angles blunt and obtuse; pronotum covered with short, erect setae on pronotum longer along inferior margin of pronotum; posterior process ends in bulb, raised vertically over half distance to ventroposterorly directed intermediate process bulb, bifurcate on top, not attaining tip of forewings. *Forewing:* Coriaceous with clear cell below knob at tip of posterior process.

Color: Head with frontoclypeus reddish brown grading to dark brown toward metopidium, becoming lighter toward clypeus; ocelli yellowish; eyes brownish yellow with outermost facets reddish. Thorax with pronotum reddish brown, covered in white tomentum; intermediate process darker; raised surfaces reddish brown with deeper surfaces black; tip of anterior pronotal process black. Forewing: Dark reddish brown. Legs: Tibiae brownish yellow; tarsi darker. Abdomen reddish brown with white tomentum.

Dimensions (*mm*): Length from anterior



Figs. 8–10. *Cladonota (Lecythifera) yucatanensis.* 8, Habitus, lateral view. 9, Head, anterior view. 10, Detail of apex of anterior pronotal process, lateral view.

edge of eyes to tip of the forewing: 6.0; height from top of eyes to apex of anterior pronotal process: 7.0; height from posterolateral margin of pronotum to dorsal margin of intermediate process: 5.6; width across eyes: 1.5.

Material examined.—Holotype (♀) from the University of Georgia Entomological Collection labeled: "MEXICO: Yucatan/2 km E. Chitzen Itza/16 June 1990/R. Turnbow" and additionally labeled: "HOLOTYPE/Cladonota/yucatanensis Flynn," deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC with permission of the University of Georgia Entomological collections.

Distribution.—Mexico.

Discussion.—*Cladonota yucatanensis* most resembles *Cladonota hoffmanni* (Peláez) but differs in having (1) the apex of the anterior process anterior to, rather than above, the intermediate process and (2) an intermediate process with three lobes (*Cladonota hoffmanni* has four). *Cladonota yucatanensis* is named after the state of the type location.

List of Species of *Cladonota*

The letter suffixes following citation dates are those used in the major bibliographic references for the Membracoidea based on year of citation: Prior to 1956: Metcalf and Wade (1965a); 1956–1980: Deitz and Kopp (1987a); 1981–1987: Deitz (1989a); 1988–1998: McKamey (1998). Synonomies are given for each species, citing the first usage of a name combination. All the subgenera have unique combinations of the features mentioned in the subgeneric review. If each of these features evolved once, some of the subgenera may eventually become synonyms. In the absence of a cladistic estimate for the genus, the subgeneric classification and placements proposed here are expected to be stable. An asterisk (*) indicates species with new subgeneric assignment.

Subgenus *Lobocladisca* Stål (1869c)

bennetti (Kirby). Venezuela, Trinidad.
  Sphongophorus (*Lobocladisca*) *bennetti* Kirby 1829a: 20.
  Cladonota (*Lobocladisca*) *bennetti* (Kirby); McKamey 1997a: 192.

biclavata (Westwood). Mexico to Panama.
  Sphongophorus (*Lobocladisca*) *biclavatus* Westwood 1840a: 432.
  Centrotus (*Lobocladisca*) *biclavatus* Westwood; Duncan 1843a: 286.
  Sphongophorus (*Lobocladisca*) *guerinii* Fairmaire 1846a: 262.
  Sphongophorus spatulatus Fairmaire 1846a: 262.
  Hysauchenia spatulata Fairmaire 1846c: 13.
  Hypsauchenia guerinii Fairmaire 1846c: 13.
  Sphongophorus bivexilliffer Costa 1862: 150; Funkhouser 1951a: 53.
  Lobocladisca guerinii Fairmaire; Buckton 1903a: 82.
  Lobocladisca bivexilliffer Costa; Buckton 1903a: 82.
  Sphongophorus (*Lobocladisca*) *dorsalis* Buckton 1903a: 80.
  Sphongophorus parvulus Buckton 1903a: 80.
  Spongophorus [sic] *guerini* [sic] Fairmaire; Comstock 1940a: 404.
  Cladonota (*Lobocladisca*) *biclavata* (Westwood); McKamey 1997a: 193.

clavaria (Fairmaire). Brazil, Ecuador.
  Hypsauchenia clavaria Fairmaire 1846c: 13.
  Sphongophorus (*Lobocladisca*) *clavarius* Fairmaire; Stål 1869c: 275.
  Lobocladisca clavaria Fairmaire; Buckton 1903a: 82.
  Sphongophorus clavaria Fairmaire; Funhouser 1927f: 67.
  Cladonota (*Lobocladisca*) *clavaria* (Fairmaire) McKamey 1997a: 193.

**livida* (Buckton). Brazil, Peru.
  Sphongophorus (*Acanthonota*) *lividus* Buckton 1903a: 81.

Cladonota livida (Buckton); McKamey 1997a: 190.

lobulata (Stål). Colombia.

Sphongophorus (*Lobocladisca*) *lobulatus* Stål 1869c: 276.

Lobocladisca lobulatus Stål; Buckton 1903a: 82.

Cladonota (*Lobocladisca*) *lobulata* (Stål); McKamey 1997a: 193.

**occidentalis* (Strümpel). Colombia.

Sphongophorus occidentalis Strümpel 1973a: 335.

Cladonota occidentalis (Strümpel); McKamey 1997a: 189.

**orientalis* (Strümpel). Colombia.

Sphongophorus orientalis Strümpel 1973a: 338.

Cladonota orientalis (Strümpel); McKamey 1997a: 189.

rigida (Stål). Colombia.

Sphongophorus (*Lobocladisca*) *rigidus* Stål 1869c: 275.

Lobocladisca rigidus Stål; Buckton 1903a: 82.

Cladonota (*Lobocladisca*) *rigida* (Stål); McKamey 1997a: 193.

spatulata (Fairmaire). Brazil.

Sphongophorus spatulatus Fairmaire 1846a: 262.

Hysauchenia spatulata Fairmaire 1846c: 13.

Spongophorus [sic] *spatulatus* Fairmaire; Funkhouser 1927f: 67.

Sphongophorus (*Lobocladisca*) *spatulatus* Fairmaire; Stål 1869c: 275.

Cladonota (*Lobocladisca*) *spatulata* (Fairmaire); McKamey 1997a: 193.

vexillifera (Goding). St. Vincent Island, W.I.

Sphongophorus (*Lobocladisca*) *vexillifera* Goding 1893b: 53.

Sphongophorus intermedius Buckton 1903a: 80.

Lobocladisca vexillifera Goding; Buckton 1903a: 82.

Sphongophorus (*Lobocladisca*) *vexilliferus* Goding; Metcalf & Wade 1965a: 1384.

Cladonota (*Lobocladisca*) *vexillifera* (Goding); McKamey 1997a: 193.

Subgenus *Falculifera* McKamey (1997)

apicalis (Stål 1869c). Mexico to Panama.

Hypsauchenia balista Amyot & Serville 1843a: 535.

Sphongophorus ballista Amyot & Serville; Fairmaire 1846a: 261.

Sphongophorus (*Sphongophorus*) *balista* [sic] Amyot & Serville; Goding 1930b: 8.

Spongophorus (*Sphongophorus*) *apicalis* Stål 1869c: 273.

Spongophorus (*Sphongophorus*) *amyoti* Metcalf & Wade 1965: 1368 [error].

Cladonota (*Falculifera*) *apicalis* Stål; McKamey 1997a: 192.

**bolivari* (Peláez 1945a). Mexico.

Sphongophorus bolivari Peláez 1945a: 66.

Cladonota bolivari Peláez; McKamey 1997a: 189.

clavigera (Stål 1864a). Mexico to Costa Rica.

Sphongophorus (*Sphongophorus*) *claviger* Stål 1864a: 68.

Sphongophorus (*Sphongophorus*) *clavigerus* Stål; Goding 1893a: 467.

Cladonota clavigera Stål; McKamey 1997a: 192.

**luctuosa* (Peláez 1945a). Mexico.

Sphongophorus luctuosus Peláez 1945a: 68.

Cladonota luctuosa Peláez; McKamey 1997a: 189.

**zeledoni* (Peláez 1967a). Costa Rica.

Sphongophorus zeledoni Peláez 1967a: 209.

Cladonota zeledoni Peláez; McKamey 1997a: 190.

Subgenus *Lecythifera* Fowler (1894c)

**affinis* (Fowler 1894c). Guatemala.

Sphongophorus (*Lecythifera*) *affinis* Fowler 1894c: 29.

Sphongophorus (*Cladonota*) *affinis*

Fowler; Metcalf & Wade 1965a: 1372.

Cladonota (*Cladonota*) *affinis* Fowler; McKamey 1997a: 190.

**brunnea* (Fallou 1890a). Brazil.

Sphongophorus brunneus Fallou 1890a: 354.

Cladonota brunnea Fallou; McKamey 1997a: 189.

bulbosa Flynn, **n. sp.** Mexico.

**championi* (Fowler 1894c). Mexico, Guatemala.

Sphongophorus (*Lecythifera*) *championi* Fowler 1894c: 28.

Sphongophorus (*Cladonota*) *championi* Fowler; Metcalf & Wade 1965a: 1373.

Cladonota (*Cladonota*) *championi* Fowler; McKamey 1997a: 190.

**costata* (Buckton 1903a). St. Vincent Island., W.I.

Hypsoprora costata Buckton 1903a: 61.

Sphongophorus costata Buckton; Funkhouser 1927f: 67.

Sphongophorus (*Cladonota*) *costatus* Fowler; Goding 1928e: 228.

Cladonota (*Cladonota*) *costata* Buckton; McKamey 1997a: 191.

**falleni* (Stål 1862e). Brazil.

Sphongophorus (*Cladonota*) *falleni* Stål 1862e: 24.

Cladonota falleni Stål; Buckton 1903a: 83.

**gonzaloi* (Peláez 1945a). Mexico.

Sphongophorus gonzaloi Peláez 1945a: 68.

Cladonota gonzaloi Peláez; McKamey 1997a: 189.

**hoffmanni* (Peláez 1940a). Mexico.

Sphongophorus hoffmanni Peláez 1940a: 285.

Cladonota hoffmanni Peláez; McKamey 1997a: 189.

**inflata* (Fowler 1894c). Guatemala to Panama.

Sphongophorus (*Lecythifera*) *inflatus* Fowler 1894c: 30.

Sphongophorus (*Cladonota*) *inflatus* Fowler; Metcalf & Wade 1965a: 1374.

Cladonota (*Cladonota*) *inflata* Fowler; McKamey 1997a: 191.

**locomotiva* (Breddin 1901a). Ecuador.

Sphongophorus locomotiva Breddin 1901a: 201.

Sphongophorus (*Cladonota*) *locomotivus* Breddin; Goding 1928e: 228.

Cladonota (*Cladonota*) *locomotiva* Breddin; McKamey 1997a: 191.

**machinula* (Breddin 1901a). Ecuador.

Sphongophorus machinula Breddin 1901a: 201.

Sphongophorus (*Lobocladisca*) *machinulus* Breddin; Goding 1928e: 229.

Cladonota (*Lobocladisca*) *machinula* Breddin; McKamey 1997a: 193.

**pieltaini* (Peláez 1945a). Mexico.

Sphongophorus pieltaini Peláez 1945a: 68.

Cladonota pieltaini Peláez; McKamey 1997a: 189.

**plummeri* (Peláez 1945a). Mexico, Guatemala.

Sphongophorus plummeri Peláez 1945a: 67.

Cladonota plummeri Peláez; McKamey 1997a: 189.

**robustula* (Fowler 1894c). Guatemala to Panama.

Sphongophorus (*Lecythifera*) *robustulus* Fowler 1894c: 29.

Sphongophorus (*Cladonota*) *robustulus* Fowler; Metcalf & Wade 1965a: 1378.

Cladonota (*Cladonota*) *robustula* Fowler; McKamey 1997a: 192.

**siparuna* (Strümpel 1973a). Colombia.

Sphongophorus siparuna Strümpel 1973a: 344.

Cladonota siparuna Strümpel; McKamey 1997a: 190.

yucatanensis Flynn, **n. sp.** Mexico.

Subgenus *Cladonota* Stål (1869c)

albofasciata (Goding 1893b). St. Vincent Island, W.I.

Sphongophorus (*Cladonota*) *albofasciata* Goding 1893b: 54.
Sphongophorus (*Cladonota*) *albofasciatus* Goding 1893a: 467.
Cladonota albofasciata Goding; Buckton 1903a: 83.
Cladonota (*Cladonota*) *albofasciata* Goding; McKamey 1997a: 190.

amazonica (Andrade 1978a). Brazil.
Sphongophorus (*Cladonota*) *amazonicus* Andrade 1978a: 1.
Cladonota (*Cladonota*) *amazonica* Andrade; McKamey 1997a: 190.

atrata (Fonesca 1936a). Brazil.
Sphongophorus (*Cladonota*) *atratus* Fonesca 1936a: 162.
Cladonota (*Cladonota*) *atrata* Fonesca; McKamey 1997a: 190.

cinerea (Fonesca 1933a). Brazil.
Sphongophorus (*Cladonota*) *cinereus* Fonesca 1933a: 445.
Cladonota (*Cladonota*) *cinerea* Fonesca; McKamey 1997a: 191.

crassepunctata (Sakikabara 1971b). Brazil.
Sphongophorus (*Cladonota*) *crassepunctatus* Sakikabara 1971b: 185.
Cladonota (*Cladonota*) *crassecpuntata* Sakikabara; McKamey 1997a: 191.

foliata (Funkhouser 1922a). Brazil.
Sphongophorus (*Cladonota*) *foliatus* Funkhouser 1922a: 1.
Cladonota (*Cladonota*) *foliata* Funkhouser; McKamey 1997a: 191.

**fritzi* (Sakikabara 1976e). Brazil.
Sphongophorus fritzi Sakikabara 1976e: 159.
Cladonota fritzi Sakikabara; McKamey 1997a: 189.

gracilis (Sakikabara 1971b). Brazil.
Sphongophorus (*Cladonota*) *gracilis* Sakikabara 1971b: 187.
Cladonota (*Cladonota*) *gracilis* Sakikabara; McKamey 1997a: 191.

**guimaraesi* (Sakikabara 1981b). Brazil.
Sphongophorus guimaraesi Sakikabara 1981a: 85.
Cladonota guimaraesi Sakikabara; McKamey 1997a: 189.

latifrons (Stål 1869c). Mexico, Guatemala, Brazil.
Sphongophorus (*Cladonota*) *latifrons* Stål 1869c: 274.
Sphongophorus (*Cladonota*) *nodosus* Buckton 1903a: 79.
Sphongophorus inelegans Buckton 1903a: 82.
Sphongophorus nodosis [sic] Buckton; Funkhouser1951a: 54.
Cladonota (*Cladonota*) *latifrons* Stål; McKamey 1997a: 191.

**lopezi* (Strümpel 1973a). Colombia.
Sphongophorus lopezi Strümpel 1973a: 346.
Cladonota lopezi Strümpel; McKamey 1997a: 189.

mirabilis (Fairmaire 1846a). Trinidad, Venezuela, Brazil.
Sphongophorus mirabilis Fairmaire 1846a: 261.
Hypsauchenia mirabilis Fairmaire 1846a: 13.
Sphongophorus (*Cladonota*) *mirabilis* Fairmaire; Stål 1869c: 273.
Cladonota mirabilis Fairmaire; Buckton 1903a: 82.
Cladonota (*Cladonota*) *mirabilis* Fairmaire; McKamey 1997a: 191.

paradoxa (Germar 1821a). Ecuador, Bolivia, Brazil, Argentina.
Membracis paradoxa Germar 1821a: 26.
Hypsauchenia paradoxa Germar 1835a: 231.
Sphongophorus paradoxa Germar; Fairmaire 1846a: 261.
Sphongophorus (*Cladonota*) *paradoxus* Germar; Stål 1869c: 273.
Sphongophorus (*Cladonota*) *facetus* Walker 1858a: 64; Funkhouser 1927f: 67.
Cladonota acetus Buckton 1903a: 82.
Cladonota (*Cladonota*) *paradoxa* Germar; McKamey 1997a: 191.

ridicula (Walker 1858a). Mexico, Brazil.
Sphongophorus ridiculus Walker 1858a: 64.

Sphongophorus (*Cladonota*) *ridiculus* Walker; Stål 1869c: 273.

Cladonota (*Cladonota*) *ridicula* Walker; McKamey 1997a: 191.

rufescens (Fonesca 1933a). Brazil.

Sphongophorus rufescens Fonesca 1933a: 444.

Sphongophorus (*Cladonota*) *rufescens* Fonesca; Metcalf & Wade 1965a: 1378.

Cladonota (*Cladonota*) *rufescens* Fonesca; McKamey 1997a: 192.

**trilobosa* (Fonesca and Diringshofen 1969a). Argentina.

Sphongophorus trilobosa Fonesca and Diringshofen 1969a: 151.

Cladonota trilobosa Fonesca and Diringshofen; McKamey 1997a: 190.

undulata (Walker 1851a). Brazil, Ecuador, Mexico.

Sphongophorus (*Cladonota*) *undulatus* Walker 1851a: 498.

Sphongophorus ludicrus Walker; Stål 1869c: 273.

Cladonota undulatus Walker; Buckton 1901a: 82.

Cladonota ludicrous Walker; Buckton 1901a: 83.

ACKNOWLEDGMENTS

I thank Cecil Smith of the University of Georgia Entomological Collections, Athens, GA, for loaning membracid specimens for identification, yielding two new species. I also thank Jim Craig of the Schiele Museum, Gastonia, NC, for illustrating the new species; Lewis Deitz of North Carolina State University and Stuart McKamey of the Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington, DC, for helpful suggestions on the manuscript; and Ken Davis for the Spanish abstract translation.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 331–347

RE-EVALUATION OF THE *ELAPHRIA FESTIVOIDES* (GUENÉE) SPECIES COMPLEX (LEPIDOPTERA: NOCTUIDAE)

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Abstract.—***Elaphria alapallida*, new species,** is described and illustrated. *Elaphria festivoides* (Guenée) is re-evaluated and distinguished from *E. alapallida* by the structures of the male vesica and female appendix bursa. In the male genitalia of *E. festivoides*, the cornuti in the vesica are larger and more numerous than in *E. alapallida*. In the female genitalia of *E. festivoides*, the appendix bursa is curved behind the corpus bursae, and in *E. alapallida* it projects vertically from lateral margin of corpus bursae. The distribution of collecting dates suggests *E. festivoides* is at least double brooded and *E. alapallida* is single brooded.

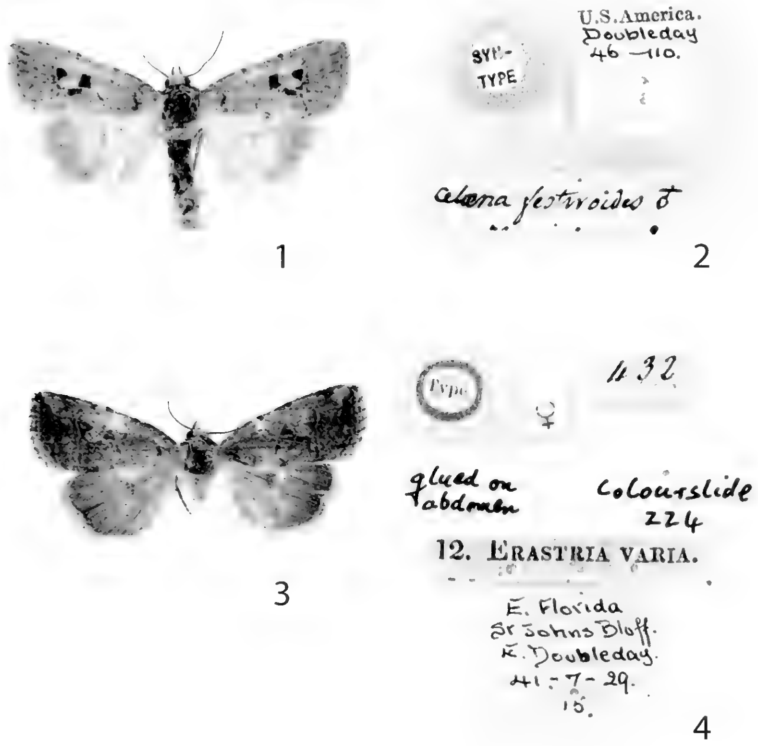
Key Words: *Elaphria alapallida, Elaphria festivoides,* taxonomy, distribution

The *Elaphria festivoides* (Guenée 1852) species complex was evaluated in a previous paper (Saluke and Pogue 2000) and at that time a new species, *E. cornutinis* Saluke and Pogue was described. After studying additional material and re-evaluating what Saluke and Pogue (2000) recognized as *E. festivoides,* we determined that an additional species is present. In this paper, we establish the identity of *E. festivoides* based on type comparison and describe a third species in the *festivoides* complex.

Elaphria festivoides (Guenée)
(Figs. 1, 3, 5–8, 13–14, 17, 20)

Celaena festivoides Guenée *in* Boisduval and Guenée 1852: 220.
Erastria varia Walker 1857: 808.—Draudt 1926: 220.
Oligia festivoides: Smith 1889: 147.—Butler 1891: 240.—Smith 1891: 43.—Dyar 1902: 112.
Monodes festivoides: Hampson 1909: 483.—Barnes and McDunnough 1917: 68.—Draudt 1926: 268.
Elaphria festivoides: Kimball 1965: 99.—Franclemont and Todd 1983: 141.—Poole 1989: 351.—Poole and Gentili 1996: 739.—Saluke and Pogue 2000: 234, 235 (fig. 2)

Diagnosis.—The forewing size is slightly larger in *festivoides* than in *alapallida,* which is evident when comparing a series of both species as there is overlap in the absolute measurements. The overall coloration of the forewing is more drab in *festivoides* than in *alapallida* because of the lack of rufous and white scales in *festivoides,* though some specimens of *alapallida* also lack the brighter scales. Markings of the forewings are generally less defined in *festivoides* than in *alapallida,* for example, the claviform spot is indistinct to absent in *festivoides* and is well developed in *alapallida.* The hindwing in *festivoides* is darker than in *alapallida.* In the male genitalia the



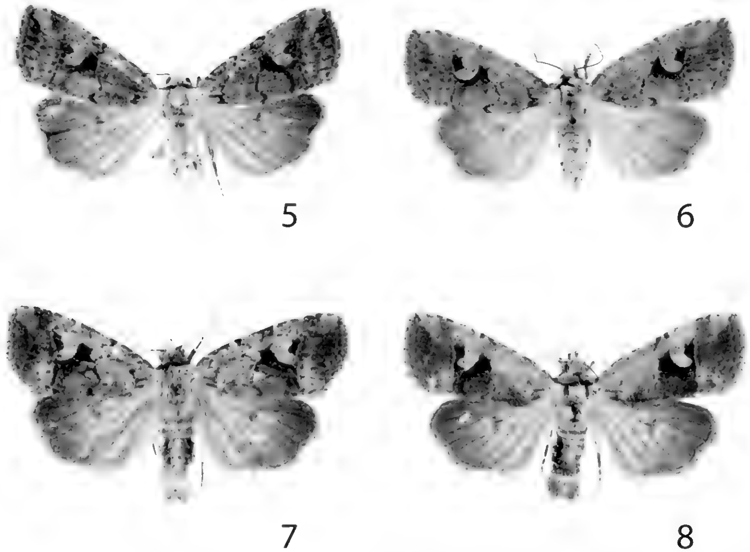
Figs. 1–4. Type specimens. 1, ♂ Holotype of *Celaena festivoides* Guenée. 2, Labels from holotype of *Celaena festivoides* Guenée. 3, ♀ Holotype of *Erastria varia* Walker. 4, Labels from holotype of *Erastria varia* Walker.

number and size of cornuti is diagnostic. In *festivoides* there are more (range 35–50, mean = 42.4, n = 7) cornuti and the longest cornutus is longer than in *alapallida* (range 0.45–0.70 mm, mean = 0.579 mm, n = 7). In *alapallida* the cornuti are fewer (range 21–35, mean = 27.0, n = 7) and the longest cornutus is shorter than in *festivoides* (range 0.35–0.50 mm, mean = 0.393 mm, n = 7). In the female genitalia, the appendix bursae curves around to the dorsal side of corpus bursae in *festivoides*; in *alapallida* the appendix bursae projects vertically and is not curved around the corpus bursae.

Description.—*Male: Head:* Labial palp with basal and median segments dark gray to black with ventral margin and interior cream, dorsal apex of median segment cream, apical segment cream with a few black and/or rufous scales. Frons with closely appressed scales cream, longer dorsal scales pale rufous to rufous with a varying amount of black scales forming a spot on eye margin where appressed and longer scales meet. Vertex concolorous with longer scales of frons. Antennal scape white ventrally, with varying amounts of black and rufous dorsally; flagellum gray to black. *Thorax:* Patagium pale rufous to brown mixed with varying amounts of white with a few darker scales. Tegula white with a few darker scales. Dorsal tuft between patagia with cephalic half brown to dark rufous extending laterally to form a margin on tegula, rest white. Mesothorax tan. Metathorax tan with gray apex. Foreleg with femur gray speckled with white; tibia black with median band cream to pale rufous, this lighter medial area can vary in amounts of lighter colored scales; tarsi black with apical rings cream to cream mixed with pink. Midleg with femur white speckled with brown scales; tibia with longer narrower scales in basal two-thirds cream mixed with gray to pale rufous, shorter scales in basal third black with white apical ring; tarsi black with white apical rings. Hindleg with femur and tibia mostly white mixed with gray scales; tarsi gray with white apical rings. *Forewing:* Length 10.5–14 mm (n = 11). Basal third of wing ground color very light brown; basal line black (indistinct to absent); antemedial line black, sinnuate (indistinct); orbicular spot, indistinct to very faint, round, a few darker scales in center, bordered by black scales nearest reniform spot; claviform spot absent; median line black, borders reniform spot to postmedian line; a trapezoidal area between orbicular and reniform spots may be completely filled with black; area between antemedial and postmedian lines and below orbicular and reniform spots light brown to brown, some specimens with a dark rufous patch; reniform spot very light brown with darker scales internally; postmedial line straight, indistinct, pale, with black scales along proximal border; basal third very light brown to brown; veins outlined with black and white for a short distance from postmedian line; gray along outer margin; fringe with basal half gray and apical half light brown. *Hindwing:* Ground color gray; fringe white with darker basal line. *Abdomen:* Dorsal tuft on first abdominal segment absent; dorsum gray with an indistinct basal border of white scales; venter a mixture of white and gray scales. *Genitalia* (Figs. 13–14): Uncus curved, widest at proximal end, narrowing after curve to a hooked apex. Tegumen with an enlarged penicillum bearing an elongate, dense peniculum; a shorter, less sparse peniculum at inner base of penicillum. Pleurite C-shaped with a small muscle plate. Valve elbow shaped, curved, vertical, apex round; ampulla arising from near base of valve, curved, constricted medially, apex pointed, a small triangular process just proximal to medial constriction. Juxta rectangulate with proximal margin produced medially into a pointed projection, chevron-shaped. Vinculum V-shaped. Aedoeagus straight, wider at base than at apex; with an elongate, pointed, ventro-distal projection. Vesica intially curves ventrad then curves back around itself and ends dorsal to the apex of the aedoeagus; cornuti arranged in two parallel rows, a dorsal row runs along edge of vesica then curves off this edge apically, a second semicircular lateral row with fewer cornuti; cornuti numerous (range 35–50, mean = 42.4, n = 7), with longest cornutus (range 0.45–0.70 mm, mean = 0.579 mm, n = 7).

Female: As in male except forewing length 11.0–14.0 mm (n = 10). Hindwing slightly darker. *Genitalia* (Fig. 17): Papillae anales with round apex. Ventral plate of ostium bursae an elongate rectangle; distal margin straight. Ductus bursae short, straight, sclerotized; wall invaginated; spiculate; basal projection prominent. Appendix bursae curved behind corpus bursae (Fig. 17). Corpus bursae ovate, narrowest at apex. Signum absent.

Type material.—*Celaena festivoides* Guenée (Figs. 1–2). The ♂ holotype [BMNH] is labeled: 1) Syn-type, 2) U.S. America. [printed], Doubleday, 46–110.



Figs. 5–8. Adults of *Elaphria festivoides.* 5, ♀, Florida, Highlands Co., Archbold Biol. Sta., 12 Mar. 1997, M. G. Pogue, USNMENT 00063105. 6, ♀, Florida, Putnam Co., Welaka, University Conservation Reserve, 12 Mar. 1962, D. C. Ferguson, USNMENT 63150. 7, ♂, North Carolina, New Hanover Co., MOTSU Buffer, Peter's Point, 13 Sep. 1994, J. B. Sullivan, R. Broadwell, B. Smith. 8, ♂, Alabama, Baldwin Co., Bon Secour NWR, 15 Oct. 1986, T. L. Schiefer, USNM 00063680.

[handwritten], 3) Celaena festivoides ♂ [handwritten].

Erastria varia Walker (Figs. 3–4). The ♀ holotype [BMNH] is labeled: 1) Type, 2) ♀, 3) 432 [handwritten, yellow label], 4) glued on abdomen [handwritten], 5) colour slide, 224 [hand written], 6) 12. Erastria varia.[printed], 7) E. Florida, St Johns Bluff., E. Doubleday., 41.-7–29., 15 [handwritten].

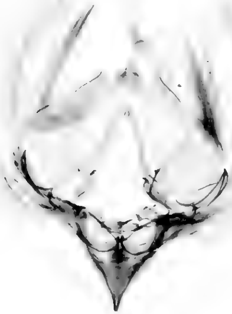
Distribution (Fig. 20).—This species has principally a southeastern United States distribution. The collection localities range from southeastern Kansas and central Missouri, south to southern Texas, east to Florida, and north to North Carolina.

Material examined.—137 ♂ and 184 ♀. **U.S.A.:** ALABAMA: BALDWIN CO., 1 mi E Oyster Bay, T9S, R4E, sec 6, sand dunes, 10–14 Mar. 1990 (4 ♂, 5 ♀), Brown ?, genitalia slide MGP 1140; 1 mi E Oyster Bay, T9S, R4E, sec 7 NW, 13 Oct. 1990 (1 ♂), Brown; Bon Secour NWR, 1 Apr. 1994 (1 ♂), 17 Apr. 1994 (1 ♂), Pollock, 14 May 1994 (1 ♀), Seymour; Bon Secour NWR, foredunes, 17 Apr. 1993 (1 ♀), Brown, 15 Oct. 1996 (7 ♂, 3 ♀), Bon Secour NWR, hind dunes, 2 Apr. 1994 (1 ♂, 1 ♀), Pollock; Bon Secour NWR, T9S, R2E, Sec. 24, 11 Mar. 1990 (1 ♀), Brown, 12–14 Oct. 1991 (1 ♀), Brown and Pollock; Bon Secour NWR, T9S, R2E, Sec. 25, 14 Oct. 1990 (2 ♂, 2 ♀), Brown; Bon Secour NWR, T9S, R2E, Sec. 25N, 11 Oct. 1991 (1 ♂, 3 ♀), Brown and Pollock; Bon Secour NWR, T9S, R2E, Sec. 25S, 12–16 Oct. 1991 (9 ♂, 4 ♀), Brown and Pollock; Bon Secour NWR, T9S, R2E, Sec. 25S, dunes, 12–16 Oct. 1991 (1 ♂, 1 ♀), Brown and Pollock; Bon Secour NWR, T9S, R3E, Sec.

19NW, 11–15 Oct. 1991 (1 ♀), Brown and Pollock; nr. Bon Secour NWR, oak-pine forest, 17 Apr. 1993 (1 ♀), Brown and Pollock. DEKALB CO., DeSoto St. Pk., T6S, R10E, Sec. 19SE–20SW, 1,360–1,460 ft., 19 May 1990 (1 ♀), Brown and Pollock; DeSoto St. Pk., T6S, R10E, Sec. 31SW, 1,240 ft., 20–24 May 1990 (1 ♂, 1 ♀), Brown and MacGown; DeSoto St. Pk., 25–29 Sep. 1992 (1 ♂, 1 ♀), Brown and Pollock. LEE CO., 2.5 mi E I-85 & Hwy 29, 4 May 1995 (1 ♂), Brown and Vogt. JEFFERSON CO., Pinson, 30 Mar. 1986 (1 ♀), Brown. MONROE CO., Haines Island Park, 4–5 Apr. 1995 (2 ♂, 2 ♀), MacGown. ARKANSAS: LOGAN CO., Cove Lake, T7N, R25W, sec. 35SE, 1,020 ft., 14–20 May 1989 (1 ♀), Brown. FLORIDA: [no locality], (1 ♂, 2 ♀), ♀ genitalia slide JFG 1757. DUVAL CO., St. Johns Bluff, 20 Apr. 1962 (1 ♂, 1 ♀), 21 Apr. 1962 (1 ♀), Ferguson. HAMILTON CO., Suwannee River St. Pk., 10 Apr. 1987 (2 ♀), Steiner. HIGHLANDS CO., Archbold Biological Station, 12 Mar. 1997 (1 ♂, 12 ♀), ♀genitalia slide USNM 46658, Pogue, 25 Mar. 1962 (1 ♀), Ferguson; Archbold Biological Station, Lake Placid, 17 Feb. 1985 (2 ♂), 18 Feb. 1985 (1 ♀), 19 Feb. 1985 (1 ♀), 20 Feb. 1985 (1 ♂), 21 Feb. 1985 (1 ♂), 22 Feb. 1985 (2 ♀), 25 Feb. 1985 (1 ♂), 28 Mar. 1962 (1 ♂), Ferguson. INDIAN RIVER CO., Vero Beach, Dec. (1 ♀), Mallock. LEON CO., Tall Timbers Research Station, 26–27 Sep. 1972 (1 ♀), Todd. MARTIN CO., Jonathan Dickinson State Park, 20 Mar. 1963 (1 ♀), Covell. PUTNAM CO., University Conservation Reserve, Welaka, 10 Mar. 1962 (1 ♀), 12 Mar. 1962 (1 ♂, 1 ♀), 15 Mar. 1962 (2 ♂), 21 Mar. 1962 (1 ♂), Ferguson; University Reserve, Welaka, 8 Apr. 1962 (1 ♂), 9 Apr. 1962 (1 ♂), 10 Apr. 1962 (1 ♂, 1 ♀), ♂ genitalia slide USNM 46243, ♀ genitalia slide USNM 46244, 12 Apr. 1962 (2 ♀), 15 Apr. 1962 (1 ♀), 19 Apr. 1962 (1 ♀), Ferguson. VOLUSIA CO., Cassadega, 24 Mar. 1965 (1 ♀), Fuller. WAKULLA CO., Ochlockonee River State Park, 10 Oct. 1983 (1 ♂, 1 ♀), Miller. GEORGIA: CHARLTON CO., Okefenokee National Wildlife Refuge, 20 Apr. 1962 (1 ♀), 21 June 1991 (1 ♀), 20 May 1991 (1 ♀), Ferguson; Okefenokee Refuge Headquarters, nr. Folkston, 2 May 1981 (1 ♀), 3 May 1981 (1 ♂), Ferguson. KANSAS: CRAWFORD CO., 4 mi E Pittsburg, 1–15 Sep. 1972 (1 ♂, 1 ♀), ♂ genitalia slide USNM 46260, Todd. DOUGLAS CO., Kansas University, 25 July 1937 (1 ♂), Fritz. LABETTE CO., Oswego, 2 Sep. 1965 (1 ♀), Hevel. KENTUCKY: CALLOWAY CO., Kenlake St. Pk., 16 Sep. 1979 (2 ♀), 17 Sep. 1979 (1 ♀), Cornett. MCCRAKEN CO., vic. Paducah, 24 July 1976 (1 ♀), Covell. LOUISIANA: BOSSIER PARISH: Barksdale Air Force Base, 18 Apr. 1996 (1 ♂), 24 Apr. 1996 (1 ♂), Pollock; Barksdale Air Force Base, calcareous prairie, 9 May 1996 (1 ♀), 14 Sep. 1996 (1 ♂), Pollock; Barksdale Air Force Base, shortleaf-pine forest, 24 Apr. 1996 (1 ♂), 1 May 1996 (1 ♂), 6 May 1996 (1 ♂, 1 ♀), 15 May 1996 (1 ♂), Pollock. MISSISSIPPI: FRANKLIN CO., Trib. of McGehee Crk., T6N, R4E, Sec. 26 SW, 8 Apr. 1992 (1 ♀), MacGown and Schiefer; GEORGE CO., 4.5 mi NNW Lucedale, T1S, R6W, Sec. 6 SE, 11 Mar. 1991 (1 ♀), Pollock, 29–30 Oct. 1989 (1 ♂, 4 ♀), Schiefer. HARRISON CO., Long Beach, 16 Oct. 1990 (1 ♀), 21 Oct. 1992 (1 ♂), Kergosien. HINDS CO., Clinton, 12 Apr. 1992 (1 ♂), Roshore, 23 Apr. 1966 (1 ♂), Mather; Jackson, 18 Mar. 1961 (1 ♀). JACKSON CO., 1 mi W Hwy 90 & 57, T7S, R8W, Sec. 25, 15 Apr. 1989 (1 ♂), Brown. LEE CO., Tombigee State Park, 1–23 Apr. 1993 (1 ♂, 2 ♀), 24 Apr.–7 May 1993 (1 ♀), Kergosien. LOWNOES CO., T19N, R16E, Sec. 30 SE, 17 Apr. 1991 (1 ♂), Pollock. OKTIBBEHA CO., Starkville, 13 May 1983 (1 ♂), Porter, 6 mi SW Starkville, 25 Apr. 1985 (1 ♀), 30 Apr. 1987 (1 ♀), Brown; A & M College, 29 Apr. 1931 (1 ♂), 18 June 1931 (1 ♀), Hutchins; T18N, R14E, Sec. 23, 18 Sep. 1987 (1 ♂), Brown. STONE CO., Sweetbay Bogs, T2S, R13W, Sec. 34 SW; 12 Mar. 1991 (1 ♀), Pollock. TISHOMINGO CO.,

Figs. 9–12. Adults of *Elaphria alapallida*. 9, ♂, Connecticut, New Haven Co., West Rock Park, 24 May 1986, D. C. Ferguson, USNMENT 00063085. 10, ♀, Connecticut, New Haven Co., Hamden, 14 June 1967, D. C. Ferguson, USNMENT 00063074. 11, ♂, Nova Scotia, Halifax Co., West Dover, 28 May 1955, D. C. Ferguson, USNMENT 00063370. 12, ♀, North Carolina, Ashe Co., Mt. Jefferson State Park, 4,150 ft., hairpin turn, 1 June 2000, J. B. Sullivan, USNMENT 00164817.

Tishomingo State Park, 11–12 Apr. 1986 (1 ♀), MacDonald. NORTH CAROLINA: BLADEN CO., Doe Island at Duck Pond (Bayfields), near White Oak, 9 Apr. 1994 (1 ♂), Broadwell. BRUNSWICK CO., 1 mi S Pretty Pond, Boiling Springs Lakes, 19 Apr. 1994 (2 ♂), Sullivan, Broadwell, Smith; Green Swamp, 29 Sep. 1994 (1 ♂, 1 ♀), Sullivan, Broadwell, Smith. CARTERET CO., Fort Macon State Park, brackish marsh, 5 Apr. 1997 (1 ♂), ♂ genitalia slide MGP 1135, Sullivan; Fort Macon State Park, hardwoods, 2 May 1996 (1 ♀), ♀ genitalia slide MGP 1136, Sullivan; Fort Macon State Park, brackish marsh, 13 Sep. 1996 (1 ♀), 14 Oct. 1996 (1 ♂), ♂ genitalia slide MGP 1139, Sullivan. COLUMBUS CO., Lake Waccamaw, 10 May 1985 (1 ♀), Steiner, Gerberich. DARE CO., 18 May 1977 (1 ♀), Gifford. MOORE CO., Weymouth Woods Natural Area, 4 Apr. 2000 (2 ♀), Hartley, Helms, Hall; Niagara, 24 Apr. 1954 (1 ♀), 25 Apr. 1954 (1 ♀), 30 Apr. 1954 (2 ♀); Southern Pines, 8 May 1986 (1 ♂), Steiner. NEW HANOVER CO., Carolina Beach State Park, E of Dow Rd., coastal fringe sandhill, 28 Apr. 1994 (1 ♂), Sullivan, Broadwell, Smith; Carolina Beach State Park, Limesink Area, coastal fringe sandhill, 23 Mar. 1994 (1 ♂), ♂ genitalia slide MGP 1133, 20 Sep. 1995 (1 ♂, 1 ♀), Sullivan, Broadwell, Smith; Fort Fisher Maritime Forest, coastal fringe evergreen forest, 13 Sep. 1994 (1 ♂), ♂ genitalia slide MGP 1138; MOTSU Buffer, Peter's Point, coastal fringe sandhills, 7 Mar. 1995 (1 ♂), ♂ genitalia slide MGP 1134, 20 Apr. 1994 (1 ♀), ♀ genitalia slide MGP 1137; 13 Sep. 1994 (1 ♂), 22 Sep. 1994 (1 ♂), 27 Sep. 1994 (1 ♀), Sullivan, Broadwell, Smith. ONSLOW CO., Camp Lejune, Corn Landing, *Juncus* march, 2 May 1996 (1 ♀), Sullivan. POLK CO., Tryon, 30 Apr. 1904 (1 ♀), 21 May (1 ♀), Fiske Coll.



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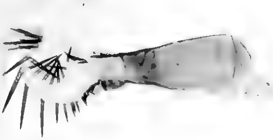

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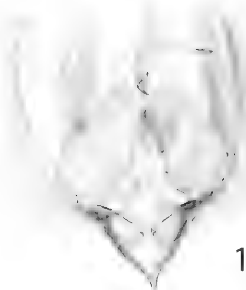

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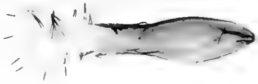

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Figs. 13–16. *Elaphria* species, ♂ genitalia. 13, *E. festivoides,* North Carolina, Carteret Co., Fort Macon State Park, maritime shrub, 14 Oct. 1996, J. B. Sullivan, genitalia slide MGP 1139. 14, aedoeagus and vesica of same specimen. 15, *E. alapallida,* West Virginia, Hardy Co., Lost River State Park, 29 June 1968, J. F. G. Clarke, USNM genitalia slide 46626. 16, aedoeagus and vesica of same specimen.

OKLAHOMA: SEQUIA CO., Lake Tenkiller, 2 mi NW Blackgum, 25–29 Aug. 1982 (1 ♂, 3 ♀), ♂ genitalia slide USNM 46684, 14–16 July 1983 (1 ♀), Davis. SOUTH CAROLINA: CHARLESTON CO., Wedge Plantation, McClellanville, 26 Apr. 1980 (3 ♂, 2 ♀), ♂ genitalia slide USNM 46261, Ferguson; Charleston, 28 Apr. 1962 (1 ♀), Ferguson. HORRY CO., Myrtle Beach, 21 Sep. 1940 (1 ♀), McElvare, 28 Sep. 1954 (1 ♀), McEvans, 30 Sep. 1953 (1 ♂). TEXAS: [no specific locality], (3 ♂, 3 ♀), ♂ genitalia slide JGF 1758. ANDERSON CO., Tennessee Colony, 5 Mar. 1967 (1 ♂, 1 ♀), ♂ genitalia slide USNM 46680, 12 Mar. 1962 (1 ♀), Blanchard. BASTROP CO., Bastrop State Park, 27 Feb. 1965 (1 ♂), ♂ genitalia slide AB 666, 28 Feb. 1965 (1 ♂, 1 ♀), ♂ genitalia slide USNM 46679, Blanchard. BLANCO CO., Pedernales Falls State Park, 4 May 1973 (1 ♂), Blanchard. BOSQUE CO., Clifton, (1 ♂), Belfrage; Laguna Park, 24 Sep. 1970 (3 ♂, 2 ♀), ♂ genitalia slide USNM 46677, Blanchard. BOWIE CO., 5 mi N New Boston, 17 Sep. 1972 (1 ♂), Todd; 10 mi NW New Boston, 18 Sep. 1972 (1 ♂), Todd. BRAZOS CO., College Station, June (1 ♀), ♀ genitalia slide USNM 46661, Glick, 10–17 Aug. (1 ♀), Sep. (1 ♀). BROWN CO., Lake Brownwood State Park, 7 Sep. 1963 (1 ♂, 1 ♀), Blanchard. CAMERON CO., Brownsville, 1–7 Mar. (1 ♂), 8–15 Mar. (1 ♂),16 Mar. 1923 (1 ♂), 16–23 Mar. (2 ♂). CHAMBERS CO., Black Jack Springs, (1 ♂). COMAL CO., Guadalupe River, nr. New Braunfels, 12 Mar. 1972 (1 ♂), Blanchard. DALLAS CO., Dallas, (1 ♀), vic. Irving, 29 Mar. 1997 (1 ♂), 14 Apr. 1981 (1 ♀), 12 Sep. 1981 (1 ♀), 20 Sep. 1981 (1 ♂, 1 ♀), ♂ genitalia slide USNM 46659, Rahn. HARRIS CO., Houston, (1 ♀), Doll; Spring, 9 Mar. 1965 (1 ♂), Blanchard. HAYS CO., Freeman Ranch, 6 km NW San Marcos, 13 Mar. 1995 (1 ♀), ♀ genitalia slide USNM 46660, Steiner, Swearingen, Ott, Silverfine. JASPER CO., Town Bluff (Dam B), 10 Mar. 1965 (1 ♂), ♂ genitalia slide USNM 46239, Blanchard. KERR CO., Kerrville, 8 Mar. (1 ♀), ♀ genitalia slide JGF 1759, Lacy, (4 ♀), ♀ genitalia slide JGF 1761, Sep. 1902 (1 ♂), ♂ genitalia slide JGF 1760, Lacy, (5 ♂), ♂ genitalia slide USNM 46264. KIMBLE CO., Junction, 16 June 1972 (1 ♀), 17 June 1972 (1 ♀), 18 June 1972 (1 ♂, 2 ♀), Ferguson, 18 Sep. 1968 (1 ♀), Blanchard. LAMPASAS CO., 6.5 mi E Lampasas, 12 Mar. 1982 (8 ♂, 23 ♀), 2 ♂ genitalia slides USNM 46263, 46678, Poole. SAN SABA CO., Bend, 11 Mar. 1982 (5 ♂, 2 ♀), ♂ genitalia slide USNM 46682, Poole. ST. AUGUSTINE CO., 2 mi SW Broaddus Lake Sam Rayburn, 20 Sep. 1972 (1 ♂, 3 ♀), Todd. TARRANT CO., Fort Worth, 9 Sep. 1963 (1 ♀), 30 Sep. 1963 (3 ♀), Jackh. TRAVIS CO., Bee Cave, 14 Apr. 1964 (2 ♀), ♀ genitalia slide USNM 46240, Blanchard. UVALDE CO., Sabinal, Mar. 1910 (1 ♀), 10 May 1910 (1 ♂), 1 ♂ genitalia slide USNM 46683, Pratt.

Discussion.—*Elaphria festivoides* and *E. alapallida* are difficult to separate from localities where both occur unless comparing large series. In the extreme south (Florida and Alabama), only *festivoides* occurs and in the north (Pennsylvania north) only *alapallida.* In other areas of the south and mid-Atlantic region both occur however, in North Carolina *festivoides* is found in xeric, sandy areas along the coast and inland to the sandhills and has multiple broods (principally April–May and September–October). *Elaphria alapallida* is in hardwood habitats from 2,000–6,000 feet and is single brooded (late April–June). Whether these habitat preferences hold true across the entire range of either species is yet to be determined.

The collection dates (Fig. 19) show that *E. festivoides* is principally double brooded. Dates indicate that the first brood occurs from mid-February to the end of May with the second brood from late August to the end of October. The data shown are from the entire geographic range of *E. festivoides.* These broods are certainly more defined if viewed from a more restricted range. For example, the dates in Florida range from mid-February to mid-April for the first brood and the only records are early October for the second brood. In Alabama the first brood is from mid-March to the end of May and the second brood is from the end of September to mid-October. In North Carolina the first brood is from end of March to mid-May and the second brood is from mid-September to mid-October.

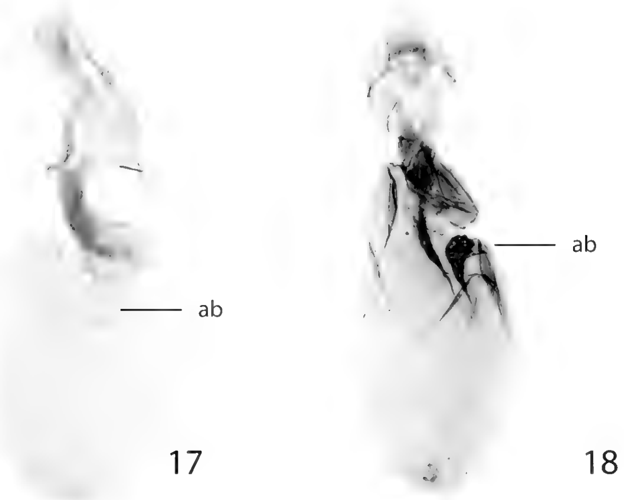
Elaphria alapallida Pogue and Sullivan, new species

(Figs. 9–12, 15–16, 18, 21)

Elaphria festivoides: Rockburne and Lafontaine 1976: 83 [misidentification].—Covell 1984: 135 [misidentification].—Rings et al. 1992: 100 (fig. 30, 35) [misidentification].—Saluke and Pogue 2000: 235 (figs. 1, 3–4), 237 (fig. 9), 238 (figs. 11–13), 239 (figs. 17–18), 240 (figs. 21–22), 241 (figs. 25, 27) [misidentification].

Diagnosis.—See the previous diagnosis section regarding the differences between *E. alapallida* and *E. festivoides.*

Description.—*Male: Head:* Labial palp with basal and median segments black with a few scattered rufous scales, ventral margin and interior cream, apical segment



Figs. 17–18. *Elaphria* species, ♀ genitalia. 17, *E. festivoides*, Missouri, Benton Co., 4 mi NW Warsaw, along MO State UU, 7 May 1970, J. R. Heitzman, USNM genitalia slide 46699. 18, *E. alapallida*, West Virginia, Tucker Co., Blackwater Falls State Park, 24 June 1968, J. F. G. Clarke, USNM genitalia slide 46272.

cream with a few black and/or rufous scales. Frons with closely appressed scales cream, longer dorsal scales pale rufous to rufous with a varying amount of black scales forming a spot on eye margin where appressed and longer scales meet. Vertex concolorous with longer scales of frons. Antennal scape white ventrally, varying amounts of black and rufous dorsally; flagellum gray to black. *Thorax:* Patagium variable, can be rufous, brown, or light brown and mixed with varying amounts of black scales. Tegula white with a few darker scales. Dorsal tuft between patagia with cephalic half black to brown extending laterally to form a margin on tegula, rest white. Mesothorax very light brown. Metathorax very light brown with brown to gray apex. Foreleg with femur gray speckled with white; tibia gray with median band or spot cream to rufous, this lighter medial area may vary in amounts of lighter colored scales; tarsi gray with apical rings cream to cream mixed with pink. Midleg with femur white speckled with brown scales; tibia with longer narrower scales in basal two-thirds cream mixed with pale rufous to pink, shorter scales in basal third black with white apical ring; tarsi black with white apical rings. Hindleg with femur and tibia mostly white mixed with gray scales; tarsi gray with white apical rings. *Forewing:* Length 10–13 mm (n = 15). Basal third ground color white; basal line black (indistinct to absent); antemedial line white, sinnuate; orbicular spot, round, a few darker scales in center, bordered by black scales nearest reniform spot; claviform spot white to cream variably bordered by a few black scales; median line black, borders reniform spot to postmedian line; a trapezoidal area between orbicular and reniform spots can be completely filled with black; area between antemedial and postmedian lines and below orbicular and reniform spots a varying mixture of rufous, light brown, and gray

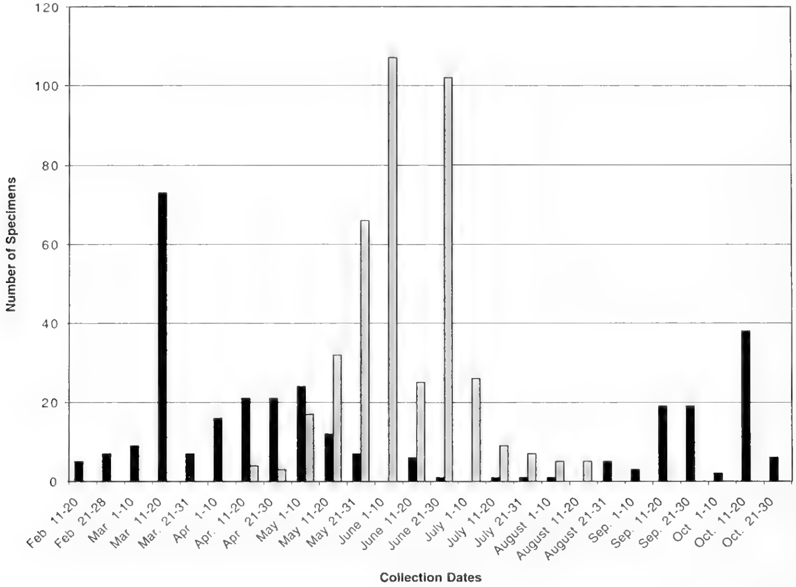


Fig. 19. Distribution of collecting dates of *Elaphria festivoides* and *E. alapallida* from the material examined.

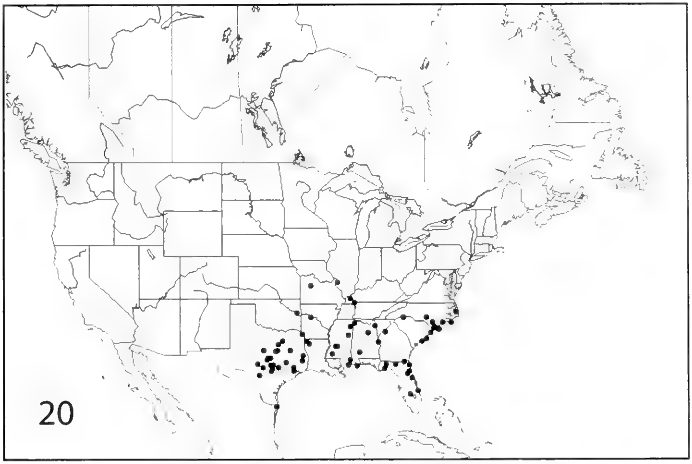
scales patches; reniform spot white with darker scales internally; postmedial line straight, white, with a few black scales along proximal border; basal third with an irregular white area bordering postmedian line and posterior margin; a white apical patch; gray along outer margin and rest with scattered rufous scales; fringe gray. *Hindwing:* Ground color white with indistinct pale gray margin; fringe white with darker basal line. *Abdomen:* Dorsal tuft on first abdominal segment absent; dorsum gray with an indistinct basal border of white scales; venter a mixture of white and gray scales. *Genitalia* (Figs. 15–16): Essentially same as *E. festivoides* except: cornuti fewer (range 21–35, mean = 27.0, n = 7), longest cornutus (range 0.35–0.50 mm, mean = 0.393 mm, n = 7).

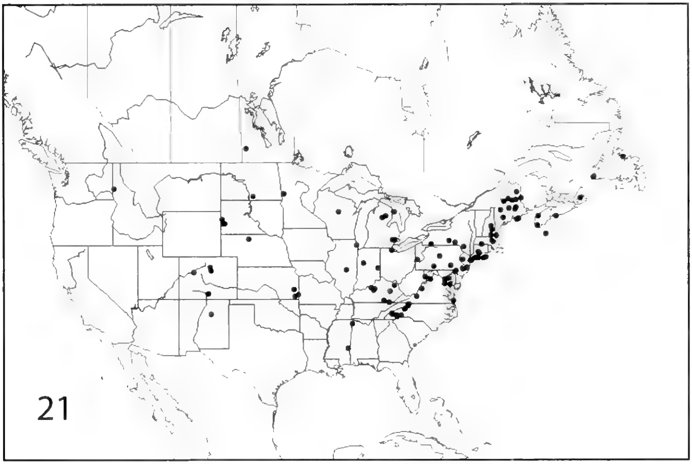
Female: As in male except forewing length 10–13 mm (n = 15). *Genitalia* (Fig. 18): Essentially the same as *festivoides* except: appendix bursae projects vertically from lateral margin of corpus bursae.

Type material.—The ♂ holotype [USNM] is labeled: 1) Hamden, New Haven Co., CONNECTICUT; 4. VI. 1966; D. C. Ferguson; 2) USNM ENT 00063094; 3) Holotype; *Elaphria alapallida;* Pogue and Sullivan. Paratypes: 265 ♂ and 188 ♀. CANADA: BRITISH COLUMBIA: Kaslo Creek, (1 ♂), ♂ genitalia slide JGF 1764, Dyar. MANITOBA: Miniota, (1 ♂), Gibbon. NEWFOUNDLAND: South Branch, 4 July 1949 (1 ♂), ♂ genitalia slide USNM 46311, Krogerus. NOVA SCOTIA: Baddock, Cape Breton Is., 30 July 1970 (2 ♂), Ferguson; Digby, (1 ♂), ♂ genitalia slide JGF 1762, 18 June 1908 (1 ♀), 25 June 1908 (1 ♀), 26 June 1908 (1 ♀), ♀ genitalia slide JGF 1763, Russell. ANNAPOLIS CO., South Milford, 23 June 1950 (1 ♀), Ferguson. HALIFAX CO., Bog E of Big Indian Lake, Halifax Watershed, 24 June

1962 (2 ♂), 24 June 1963 (1 ♂), 24 June 1968 (1 ♂), 26 June 1968 (1 ♀); Boulderwood, 26 June 1959 (1 ♂), 26 July 1959 (1 ♂); Halifax Watershed Area, 2 June 1955 (1 ♂), 5 June 1955 (1 ♂), ♂ genitalia slide USNM 46259, Ferguson; near Big Indian Lake, Halifax watershed, 24 June 1963 (1 ♂), Ferguson; Peggy's Cove, 11 July 1953 (1 ♀), Ferguson; Purcell's Cove, 6 June 1960 (1 ♀), 12 July 1962 (1 ♂), Ferguson; West Dover, 28 June 1955 (2 ♂), ♂ genitalia slide USNM 46258, 30 June 1968 (1 ♂), Ferguson. KINGS CO., Aylesford, 29 June 1962 (1 ♂), Ferguson; cattail swamp near Aylesford, 20 June 1963 (1 ♂), Ferguson; top of North Mt., near Garland, 11 June 1954 (1 ♀), Ferguson. LUNEN CO., Green Bay, 1 July 1956 (1 ♀), Ferguson. QUEENS CO., Lake Kejimukujik, 27 May 1958 (1 ♂), 17 June 1957 (1 ♂, 1 ♀), 3 July 1968 (1 ♂), Ferguson. YARMOUTH CO., Argyle, 7 June 1954 (1 ♂), Ferguson. ONTARIO: Hymers, 1–7 Aug. (1 ♂). U.S.A.: COLORADO: Vermeyjo R., 25 June (1 ♀), Packard. BOULDER CO., Mt. Flagstaff, 2,280 m, 20 June 1988 (1 ♂, 1 ♀), Peigler and Weissman. GARFIELD CO., Glenwood Springs, 16–23 July (1 ♂), ♂ genitalia slide USNM 46252. JEFFERSON CO., Chimney Gulch, 16 June 1920 (1 ♂), Oslar; Clear Creek, Oslar. CONNECTICUT: NEW HAVEN CO., Bethany, 17 May 1968, (1 ♀), Ferguson; Bethany Center, 17 June 1967 (1 ♂, 1 ♀), Ferguson; Hamden, 4 June 1967, (2 ♂), 9 June 1967 (1 ♂), 14 June 1967 (1 ♀), Ferguson; West Rock Park, 24 May 1966 (15 ♂, 1 ♀), Ferguson; Yale Preserve, 9 May 1964 (2 ♂), 21 May 1964 (1 ♂), 7 June 1964 (2 ♂, 1 ♀), ♂ genitalia slide USNM 46247, ♀ genitalia slide USNM 46248. DISTRICT OF COLUMBIA: (1 ♀), 30 June (1 ♀). DELAWARE: NEW CASTLE CO., Newark, 30 May 1983 (1 ♀), Bray. ILLINOIS: COOK CO., Evanston, 27 May 1895 (1 ♀). MACON CO., Decatur, 8 May 1915, (1 ♂). INDIANA: TIPPECANOE CO., Lafayette, 15 May 1916 (1 ♀), 9 Aug. 1915 (1 ♀), 13 Aug. 1915 (1 ♀). KENTUCKY: BELL CO., Pine Mountain State Park, 3 May 1974 (1 ♂), 13 May 1980 (1 ♂), Cornett. BULLITT CO., Bernheim Forest, 17 Apr. 1977 (2 ♂, 1 ♀), Brownell; 20 May 1999 (1 ♀), 21 May 1999 (1 ♂, 1 ♀), Vanderpool. Mt. Washington, 23 May 1966 (1 ♀), 28 July 1988 (2 ♂), Covell. CARTER CO., Carter Caves, 29 Apr. 1972 (1 ♀), Covell. JEFFERSON CO., Valley Station, 9 May 1974 (1 ♀), 15 May 1974 (1 ♂, 1 ♀), 25 May 1974 (1 ♀), 9 Aug. 1974 (1 ♀), 19 Aug. 1974 (1 ♀), Scholz. POWELL CO., Tunnel Ridge Rd., 21 May 1988 (1 ♂), Covell. RUSSELL CO., Lake Cumberland State Park, 18 July 1972 (1 ♀), Cornett. WHITLEY CO., Cumberland Falls State Park, 16 May 1980 (1 ♂), Cornett. MASSACHUSETTS: [County unknown], Beverly Farms, 10 June 1913 (1 ♂), Reiff; HAMPDEN CO., Chicopee, 2 June 1899 (1 ♀), Knab. MIDDLESEX CO., Auburndale, 13 June 1974 (1 ♂), Covell; Concord, 3 June 1913 (1 ♀), Reiff. MARYLAND: ANNE ARUNDEL CO., Southaven, 17 May 1991 (1 ♀), Stevenson. CALVERT CO., Camp Bay Breeze, nr Lusby, 8 June 1963 (1 ♀), Flint; Flag Ponds, 9 May 1991 (1 ♀), Stevenson. CECIL CO., Elkton, 29 May 1983 (1 ♀), Bray. PRINCE GEORGE'S CO., Patuxent National Wildlife Research Center, 12 May 1979 (1 ♂), ♂ genitalia slide USNM 46267, Ferguson. MAINE: [no county], Oguossoc, 6 July (1 ♀); top Mt. Bigelow, 7 July 1937 (1 ♀). AROOSTOOK CO., Ashland, 3 July 1943 (1 ♀); Houlton, 10 July 1945 (1 ♂). HANCOCK CO., Bar Harbor, 7 June 1937 (2 ♂), Brower, 22 June 1933 (1 ♀), 28 June 1933 (1 ♂), 1 July 1934 (1 ♂), Brower, 4 July 1934 (1 ♂), 10 July 1935 (1 ♀), Brower, 17 July 1933 (1 ♀), Brower, 19 July 1934 (1 ♂), 24 July 1933 (1 ♀), Brower; Mt. Desert Is., 13 June 1932 (1 ♂), 23 June 1932 (1 ♀). KENNEBEC CO., Mt. Vernon, 10 June 1967 (1 ♀), Dearborn. PENOBSCOT CO., Lincoln, 5 July (1 ♀), 6 July (1 ♀), 7 July 1935 (2 ♂), 10 July 1935 (1 ♂, 1 ♀), 18 July 1937 (1 ♂); Passadumkeag, 1 June 1936 (1 ♂), ♂ genitalia slide

USNM 46253, 18 June 1938 (1 ♂); Patten, 26 July (1 ♀). PISCATAQUIS CO., Chesuncook, 13 July (1 ♀); Mt. Katahdin, 9 July 1939 (1 ♀); Sebec Lake, 24 June 1930 (3 ♂, 2 ♀), 16 June 1923 (1 ♂). SOMERSET CO., Pittston Farm, 9 July (1 ♂). MICHIGAN: CRAWFORD CO., 5 mi W of Roscommon, 19 May 1938 (2 ♂), 29 May 1938 (5 ♂). MONTGOMERY CO., Atlanta, 31 May 1936 (1 ♂, 1 ♀), 31 May 1938 (1 ♂), McAlpine. OAKLAND CO., Franklin, 24 May 1936 (1 ♂, 1 ♀), ♂ genitalia slide USNM 46252, 2 June 1934 (1 ♂, 1 ♀), 2 June 1932 (1 ♀), 4 June 1937 (1 ♂), McAlpine; Royal Oak, 14 May 1915 (1 ♂), McAlpine. OSCODA CO., Luzerne, 4 June 1944 (1 ♂), Rawson. NORTH CAROLINA: ALLEGHANY CO., 7 mi. N. Sparta, 2,700 ft., 10 June 1974 (1 ♂, 1 ♀), Sullivan; New River State Park, Oliver Farm, 2,600 ft., 1–4 June 2000 (2 ♂, 2 ♀), Sullivan. ASHE CO., Mt. Jefferson State Park, hairpin turn, 4,150 ft., 1 June 2000 (14 ♂, 7 ♀), Sullivan; Mt. Jefferson State Park, park offices, 3,080 ft., 2–3 May 2000 (6 ♂, 1 ♀), 1 June 2000 (3 ♂), Sullivan; Mt. Jefferson State Park, summit, 4,600 ft., 1 June 2000 (18 ♂, 8 ♀), Sullivan. AVERY CO., Grandfather Mountain, 4,850–5,150 ft., 30–31 May 2000 (1 ♂, 1 ♀), Sullivan; Grandfather Mountain, Visitor Ctr., 5,150 ft., 25–27 June 2000 (1 ♂), Sullivan; Moore Mt. 4,000 ft., 30–31 May 2000 (3 ♂, 2 ♀), Sullivan. HAYWOOD CO., Wagon Gap, 4533 ft., 20 May 2001 (10 ♂), 26–27 June 2001 (6 ♂, 5 ♀), Sullivan; Black Balsam Mt., 5,800 ft., 26–27 June 2001 (5 ♂), Sullivan; mile post 415, Blue Ridge Pkwy. 4,800 ft., 27 June 2001 (2 ♂, 2 ♀), Sullivan; 155 Mt. Pisgah Rd., 2,900 ft., 20 May 2001 (2 ♂), 25 June 2001 (2 ♂), Sullivan and Deutschman; US 276 below Wagon Gap Rd., 3,776 ft, 23 April 2001 (2 ♂), 20 May 2001 (1 ♂, 3 ♀), 26–27 June 2001 (5 ♂, 3 ♀), Sullivan and Deutschman; Wagon Gap Rd. on US 276, 20 May 2001 (4 ♂, 5 ♀), 23 June 2001 (5 ♂, 2 ♀), 26–27 June 2001 (2 ♀), Sullivan and Deutschman. HENDERSON CO., Bat Cave, 26 May 1970 (1 ♀), Covell. SWAIN CO., Cherokee, Big Cove Road, Great Smoky Mountains National Park, 2,062 ft., 21 May 2001 (2 ♀), Sullivan and Deutschmann, 30 May 2001 (1 ♀), Sullivan; Thomas Divide trailhead, Great Smoky Mountains National Park, 4,580 ft., 21 May 2001 (4 ♂), Sullivan; Great Smoky Mountains National Park, Big Cove Rd., 2,064 ft., 30 May 2001 (1 ♀), Sullivan and Deutschman. NORTH DAKOTA: EMMONS CO., 16 mi E Linton, 20 June 1975 (3 ♂), Lago. NORTH CASS CO., Red River, Fargo, 9 June 1961 (1 ♂), Poole. NEBRASKA: CHERRY CO., Fort Niobrara, 14 June 1983 (1 ♂), Ferguson; Hackberry Lake, Valentine NWR, 18 June 1983 (1 ♂), Ferguson. NEW HAMPSHIRE: Squam Lake, July 1925 (1 ♀), Allen. BELKNAP CO., Center Harbor, (1 ♂). HILLSBOROUGH CO., Manchester, (1 ♀). ROCKINGHAM CO., Hampton, 3 June 1902 (1 ♂), 4 June 1940 (1 ♂), 21 June 1931 (1 ♀), Shaw. NEW JERSEY: BURLINGTON CO., Medford Township, Lake Pine, 7 June 1973 (3 ♂, 2 ♀), 16 Aug. 1974 (1 ♀), Rentz. HUNTERDON CO., Woodglen, 13 June 1971 (1 ♀), 22 June 1971 (1 ♀). OCEAN CO., Lakehurst, (1 ♂), May 1929 (1 ♂, 1 ♀), Lenmer, May 1925 (1 ♀); Wrangle Brook Rd., Lakehurst, 30 May 1956 (1 ♂, 3 ♀), 2 ♀ genitalia slides USNM 46268, 46271, 31 May 1956 (2 ♂, 3 ♀), 3 June 1956 (4 ♂, 2 ♀), ♂ genitalia slide USNM 46250, 7 June 1956 (2 ♂), 8 June 1956 (2 ♂, 3 ♀), Ferguson. NEW MEXICO: SAN MIGUEL CO., Las Vegas, (2 ♂), ♂ genitalia slide USNM 46255. NEW YORK: [no specific locality], (2 ♂, 3 ♀), ♀ genitalia slide JGF 1756. Centre, 21 May 1877 (1 ♂), ♂ genitalia slide JGF 1755, Hill. CATTARAUGUS CO., Allegany State Park, 10 Sep. 1940 (1 ♀), Shadle. CHENANGO CO., Greene, 2500 ft., (1 ♂), June (2 ♂), Howard. KINGS CO., Brooklyn, 18 June 1902 (1 ♂), 20 June 1901 (1 ♂), ♂ genitalia slide USNM 46265. QUEENS CO., Woodhaven, Long Island, (1 ♂). SUFFOLK CO., Amagansett, Long Island, 30 May 1913 (1 ♀), Englehardt; East, Long





Figs. 20–21. Collecting localities. 20, *Elephria festivoides*. 21, *E. alapallida*.

Island, 14 May 1902 (1 ♀), 22 May 1902 (1 ♀), 5 June 1900 (2 ♀), Weeks, 5 June 1901 (1 ♂), Weeks; Eatons Neck, Long Island, 10 June 1971 (1 ♀), Jackh; Penniquid Barrens, Coram, Long Island, 20 Aug. 1920 (1 ♀). SULLIVAN CO., Debruce, 9 July 1916 (1 ♂). TOMPKINS CO., Ithaca, 22 May 1965 (2 ♂), Ferguson; McLean Bogs Reserve, 15 June 1957 (1 ♀), Davis. OHIO: ATHENS CO., Waterloo Township, Sec. 33, at a beaver dam, 23 May 1981 (1 ♀), Metzler. LUCAS CO., Holland, 10 May 1936 (1 ♂), Rawson. PENNSYLVANIA: BEAVER CO., New Brighton, 25 May

1902 (1 ♀), 31 May 1902 (1 ♀), 1 June 1902 (2 ♂, 1 ♀), 2 June 1918 (1 ♂), 11 June 1901 (1 ♂), Merrick. CENTRE CO., Howard, 31 May 1979 (1 ♀), Haas. LANCASTER CO., Lititz, Aug. 1924 (1 ♂), ♂ genitalia slide JGF 1765, Heiserman. SOUTH DAKOTA: LAWRENCE CO., Cheyenne Crossing, 5,600 ft., 1 July 1997 (1 ♂), Rahn. PENNINGTON CO., Hill City, 5 July 1964 (1 ♂, 1 ♀), Ferguson; Slate Creek, 9 mi NW of Hill City, Black Hills, 6,000 ft., 4 July 1964 (1 ♂, 2 ♀), Ferguson; Upper Spring Creek, near Hill City, Black Hills, 27 June 1964 (2 ♂, 5 ♀), ♀ genitalia slide USNM 46246, 28 June 1964 (5 ♂, 2 ♀), ♂ genitalia slide USNM 46245, Ferguson. VIRGINIA: [no specific locality], (1 ♂). BATH CO., 2.6 mi E of Warm Springs, 8 June 1956 (1 ♀), Hevel. FAIRFAX CO., Alexandria (Rose Hill), 24 July 1976 (1 ♂), Opler. MONTGOMERY CO., Brush Mountain, 14 May 1963 (1 ♂), 18 May 1963 (1 ♂), Covell. CITY OF VIRGINIA BEACH, Seashore State Park, 1–4 June 1975 (3 ♂), Davis. WISCONSIN: MARATHON CO., Township of Stettin, 4 June 1975 (1 ♂), 17 June 1975 (1 ♀), Rahn. WEST VIRGINIA: TUCKER CO., Blackwater Falls State Park, 23 June 1968 (1 ♂, 9 ♀), 24 June 1968 (4 ♂, 22 ♀), ♂ genitalia slide USNM 46262, ♀ genitalia slide USNM 46272, Clarke. HARDY CO., Lost River State Park, 29 June 1968 (1 ♂), ♂ genitalia slide USNM 46626, Clarke; near Lost River State Park, 4–6 July 1980 (1 ♂), Miller. MORGAN CO., 4 mi SW Grand Cacapon, 19 Aug. 1989 (1 ♀), Clarke, McIntyre. Paratypes were deposited in the following institutions: American Museum of Natural History, New York, NY; The Natural History Museum, London, Great Britain; Field Museum of Natural History, Chicago, IL; Los Angeles County Museum of Natural History, Los Angeles, CA; Mississippi State University, Mississippi State, MS.

Distribution (Fig. 21).—Most records are from the northeastern U.S. and Nova Scotia, Canada. It extends as far south as the mountains of North Carolina and west to western British Columbia and south to Colorado and New Mexico.

Discussion.—*Elaphria alapallida* has been masquerading as *E. festivoides* in the North American literature (Rockburne and Lafontaine 1976, Covell 1984, Rings et al. 1992). After examination of the types of *festivoides* and *varia* and comparing these with similar Florida specimens it was determined that the southern species was *E. festivoides* and the more northern species was *E. alapallida.*

The collection dates (Fig. 19) show that *E. alapallida* is single brooded. Dates range from the end of April to mid-August across its geographical distribution. The data shown are from the entire geographic range of *E. alapallida.* These broods are certainly better defined if viewed from a more restricted range. For example, the dates in North Carolina are from late April to the end of June, in Connecticut from mid-May to mid-June, in Maine from early June to the end of July, and in Nova Scotia from the end of May to the end of July.

Etymology.—The specific epithet, *alapallida,* refers to the pale hindwing with the Latin terms *ala* referring to the hindwing and *pallida* referring to the pale coloration as compared to the darker hindwing of *E. festivoides.*

CONCLUSIONS

With the recognition of *alapallida* the *festivoides* complex of the genus *Elaphria* consists of three very similar species. Accurate determination of the three species by maculation is extremely difficult without a known series of each species. However, males are easily placed by dissection of the genitalia. *Elaphria cornutinis* is the only species of the complex with ventral abdominal pouches and coremata (Saluke and Pogue 2000). Males of the remaining two species can be distinguished by forewing size and the number and size of the cornuti on the inflated vesica. They can also be separated by the color of the hindwing which is whitish in *alapallida* and gray in *festivoides*. The hindwing of *cornutinis* is intermediate but closer to gray. The female of *festivoides* is distinguished by the longer appendix bursa. Females of *alapallida* and *cornutinis* are extremely difficult to separate on characters of the genitalia. However, the female of *alapallida* has a lighter hindwing color and the female forewing of *cornutinis* has a more mottled pattern. In North Carolina, the three species are largely allopatric. *Elaphria festivoides* is limited to xeric, white sand habitats in eastern North Carolina where it occurs with such uncommon species as *Catocala jair* Strecker, *Zale declarens* (Walker) (Noctuidae) and *Heterocampa varia* Walker (Notodontidae). It is common in the early spring and late fall with stragglers throughout the summer. It overlaps *E. cornutinis* in the sandhills, where both occur at Weymouth Woods Natural Area in Moore County. There *festivoides* is in the dryer, sandy habitats and *cornutinis* is in mesic woodlands. *Elaphria cornutinis* is common in mesic woodlands across the piedmont of North Carolina and up to an elevation of about 2,200 feet in the mountains. There it overlaps with *E. alapallida,* but the species appear to be in different habitats. *Elaphria cornutinis* is in the more xeric woodlands where *Vaccinium* species are common. At altitudes below 2,500 feet *E. alapallida* is infrequent but becomes abundant from 3,000–5,000 feet throughout the montane forests of the state and has been collected as high as 5,800 feet. *Elaphria alapallida* is single brooded in the spring while *E. cornutinis* has multiple broods beginning in April–May with a strong flight and showing straglers throughout the summer but no strong fall flight.

The food plant of *E. alapallida* was reported to be *Acer negundo* Linnaeus by Rockburne and Lafontaine (1976) but the distribution of that plant species does not coincide with the distribution of *alapallida* in North Carolina (Radford et al. 1968). It does match the distribution of *E. cornutinis* but that species does not reach Canada, the origin of the food plant record. The food plants of species of *Elaphria* in the eastern U.S. are poorly known in spite of the abundance of adults. Wagner et al. (1997) reared *E. versicolor* on algal layers on tree bark. If this feeding strategy occurs in other species of the genus, it may explain why larvae are seldom located.

The genus *Elaphria* as currently conceived, contains 127 species (Poole 1989, Saluke and Pogue 2000, and *E. alapallida* added here). The genus is largely Neotropical but one species occurs in Europe, one in Africa, one in China, three in India, and 14 in North America. The genus has never been revised nor delineated in any detail although Forbes (1954) briefly describes generic characters. Dissections of some 25 species from the Americas indicate that the genus is polyphyletic. The type species is *E. grata* (Hübner), which appears to have rather typical and unspecialized genitalia. The genitalia of the species in the *festivoides* complex are somewhat specialized, particularly the two parallel rows of cornuti in the sinnuate vesica in the male and the short ductus bursae in the female. Perhaps the closest relative to the complex is *E. agrotina* which has a similar maculation, abdominal pockets and coremata, two short rows of cornuti on a sinnuate vesica and a short sclerotized ductus bursae.

Saluke and Pogue (2000) suggested that the presence of abdominal pockets and coremata in *E. cornutinis* could indicate that this species reveals conspecifics chemically by the use of pre-mating pheromones. The geographic range of *E. cornutinis* largely divides *E. festivoides* from *E. alapallida.* The distribution of abdominal pockets and coremata is sporatic in *Elaphria* species and may represent a pattern of expression rather than absolute genetic gain or loss of a complex character (Poole 1995). It may be involved in rapid speciation, perhaps even sympatric speciation. The presence or absence of such a pheromone system is also found in other very closely related species pairs of noctuids (*Euagrotis, Lacinipolia* and probably others). One can imagine alleles at very low frequencies which allow the expression in males of the pheromone apparatus or the reception of the pheromone in females. In time, the occurrence of the alleles in individuals of both sexes may occur at a single locality producing offspring which could utilize the pheromone system as an isolating mechnism, and over time allow for habitat specialization to avoid direct competition in the larval stages. The *festivoides* complex may offer a convenient model for the study of rapid speciation and pheromone dependency.

ACKNOWLEDGMENTS

For critically reviewing a draft of this mauscript, we thank Terry L. Erwin, Department of Systematic Biology, Smithsonian Institution, Washington, DC, and N. J. Vandenberg and D. R. Smith, Systematic Entomology Laboratory, U.S.D.A., Washington, DC. We are grateful to James Adams, Dalton, GA, R. L. Brown, Mississippi State University, Mississippi State, MS, and Bryant Mather, Clinton, MS, Charles V. Covell, Jr., University of Louisville, Louisville, KY, Steve Hall, North Carolina Heritage Program, Raleigh, NC, Don DeFoe and Keith Langdon, Great Smoky Mountains National Park, Gatlinburg, TN, for allowing us to borrow, examine, and dissect specimens from their collections. For loaning us the types of *E. festivoides* and *E. varia,* we thank Ian J. Kitching of The Natural History Museum, London, United Kingdom. For permission to collect Lepidoptera in restricted areas we thank the following: Vic French and Randall C. Wilson, North Carolina Wildlife Resources Commission; A. Este Stiefel, The Nature Conservancy; Steve Miller, Grandfather Mountain Preserve; Keith Langdon, Great Smokey Mountain National Park; Chris Ulrey, Blue Ridge Parkway National Park; Erich L. Hoffman, Ft. Bragg Military Reservation; John Townsend, Camp Lejune Military Reservation; Scott Hartley, Jody Merritt, Tommy Wagoner, and Jay Wild, North Carolina Department of Environmental Resources.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 348–351

THE DISCOVERY OF THE GENUS *ECNOMIOS* MASON (HYMENOPTERA: BRACONIDAE) IN CHINA, WITH DESCRIPTION OF A NEW SPECIES

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Abstract.—A **new species** of braconid wasp, ***Ecnomios flavus***, is described. It represents the first record of the genus *Ecnomios* Mason as well as the subfamily Ecnomiinae in China.

Key Words: *Ecnomios,* new species, Braconidae, China

The rare genus *Ecnomios* was first described by Mason (1979) from Papua New Guinea with the type species *E. papuensis* Mason 1979. Thirteen years later a second species of this genus was described from Australia by Austin and Wharton (1992) and, in 1993, another two species were reported from Vietnam by Belokobylskij (1993). Achterberg (1995) provided a key to the species of *Ecnomios* with descriptions of an additional three species from Indonesia. Currently seven species of the genus have been described with an obvious Indo-Australian distribution before this study.

When the first author visited the Shanghai Institute of Entomology, Academia Sinica in 2000, a female specimen of *Ecnomios* was encountered, and further examination proved it to be a new species. It represents the first record of the genus *Ecnomios* Mason as well as of the subfamily Ecnomiinae in China.

The subfamily Ecnomiinae was erected by Achterberg (1985) to hold the aberrant genus *Ecnomios.* A second genus, *Korecnomios* Park and Achterberg 1994, of this subfamily was reported from Korea, with only the type species known (Park and Achterberg 1994). The biology of the subfamily is unknown.

Mason (1979) originally placed his new genus *Ecnomios* in the tribe Orgilini Foerster 1862 (now subfamily Orgilinae), although more recent research suggests it may belong to the "microgastroid lineage" (Quicke and Achterberg 1990). The most prominent shared character with this lineage is the large plical cell of the hind wing, with a distinct cleft distally. A large plical cell appears to be plesiomorphic within the Hymenoptera (Quicke and van Achterberg 1990), but in phylogenetic analysis within Braconidae (Quicke and van Achterberg 1990, Wharton et al. 1992), its presence appears as a reversal. Other possible synapomorphies with the microgastroid lineage are the shape of the first discal cell of fore wing, the comparatively long fore spur, the absence of the lateral carina of the mesoscutum, and the position of vein SR1 of the fore wing. The vertical position of vein r, the oblique vein 1-CU1, the comparatively slender first discal cell and the reduced vein

2-1A of the fore wing suggest some relationship to the subfamily Dirrhopinae within the microgastroid lineage. Autoapomorphies of the Ecnomiinae within the microgastroid lineage are the anteriorly wide pronotum, the short labial palp (in comparison with the maxillary palp), and the sinuate vein 2-M of hind wing. It is to be hoped that suitable material of this group will become available to allow analysis of DNA sequence data, to test these possible relationships further in the context of expanding understanding of braconid, especially microgastroid, phylogeny (Whitfield 1997, Belshaw et al. 1998, Dowton and Austin 1998, Whitfield 2002).

The morphological (including wing vein) terminology used in this paper follows Achterberg (1993).

Ecnomios flavus Chen and Whitfield, new species

(Figs. 1–4)

Female.—Body length 2.7 mm, fore wing length 2.4 mm.

Color: Brownish yellow, metasoma after first tergite light brown; palp pale yellow; antenna brownish yellow, apical half darker; legs yellowish; pterostigma brown, pale basally; veins unpigmented.

Head: Antennal segments 24, length of first flagellar segment 1.5 times second flagellar segment, first, second and penultimate flagellar segments 2.3, 1.7 and 1.6 times their width, respectively, apical segment with a spine; occipital carina complete; length of maxillary palp 0.7 times height of head; length of eye in dorsal view 1.7 times temple; temple strongly and rounded behind eyes, smooth; OOL: OD: POL = 10:10:11; frons smooth and slightly concave medially; face with a wide medio-longitudinal ridge, nearly smooth with long setae, its width 1.7 times its height, as long as height of eye; clypeus distinctly convex, smooth, its width about 2 times its height; length of malar space 1.7 times basal width of mandible.

Mesosoma: Length of mesosoma 2.0 times its height; side of pronotum coarsely crenulate anteriorly and posteriorly, rest almost smooth; precoxal sulcus narrow, crenulate-rugose, anteriorly absent, rest of mesopleuron smooth, shiny; metapleuron coarsely rugose; notauli shallow but distinct, rugose, joining in a broad, distinct and rugose area posteriorly before scutellar suture, with a medio-longitudinal carina in this rugose area; mesoscutum other than notauli largely smooth with setae; scutellar suture with 5 carinae; scutellum flat and smooth, glabrous, without lateral carina; propodeum completely rugose with a distinct transverse carina in posterior half, forming a pair of latero-posterior tubercles.

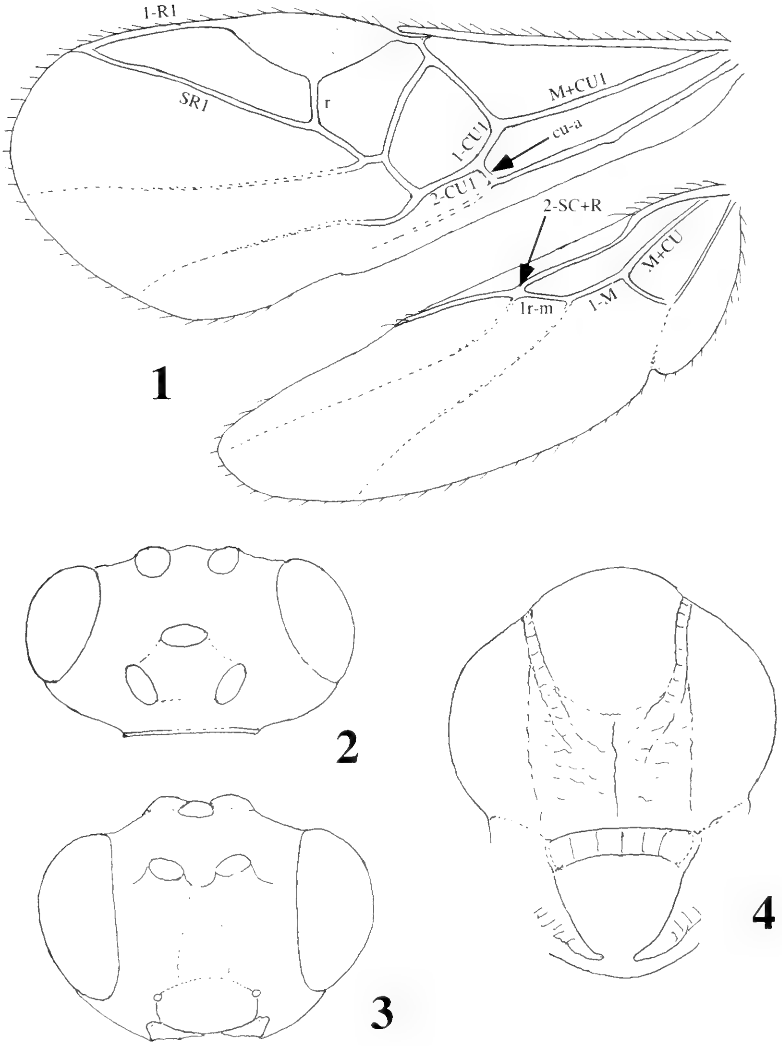
Wings: Fore wing: length of pterostigma 1.2 times vein 1-R1, 2.5 times its width; r: 3-SR+SR1: 2-SR: m-cu = 14:73:18:17; 2-CU1 much lower than M+CU1; SR1 sinuate; 1-CU1: 2-CU1 = 13:20, 1-CU1:cu-a = 13:6. Hind wing: M+CU: 1-M: 1r-m = 36:18:15; base of SR unsclerotised; 2-SC+R much shorter than 1r-m, nearly quadrate.

Legs: Hind coxa with some distinct carinae anteriorly, rest largely smooth; all tarsal claws simple and rather slender; length of femur and basitarsus of hind leg 4.3 and 5.6 times their width, respectively; length of hind tibia 1.25 times hind tarsus; length of hind tibial spurs 0.57 and 0.39 times hind basitarsus; basitarus and second tarsal segment with a distinct ventral carina.

Metasoma: Length of first tergite 0.8 times its apical width, distinctly and linearly widened apically, its surface coarsely rugose, weaker near apical margin where is almost smooth, its dorsal carina absent; second and following tergites smooth; second suture absent; length of ovipositor sheath 0.8 times hind basitarsus, 0.08 times fore wing; ovipositor sheath glabrous.

Male.—Unknown.

Material examined.—Holotype, ♀, China: Yunnan, Hekou, Xiaonanxi, 1956.vi.7, Huang Keren, kept in Shanghai Institute of Entomology, Academia Sinica, Shanghai.



Figs. 1–4. *Ecnomios flavus,* holotype. 1, Wings. 2, Head, dorsal view. 3, Head, frontal view. 4, Mesoscutum, dorsal view.

Etymology.—The specific name "*flavus*" refers to the body color of the new species being almost completely yellowish.

Notes.—This new species runs to couplet 6 in the key of Achterberg (1995), but can be separated from the most closely similar species, *Ecnomios caophongi* Belokobylskij 1993 in having the vein 1-CU1 of fore wing much longer, almost 2.2 times vein cu-a (1.2 times in *E. caophongi*); vein 2-SC+R of hind wing shorter, nearly quadrate (distinctly longitudinal in *E. caophongi*); notauli more distinct with a broad joining area posteriorly (notauli very shallow and rugulose, joining in a small and weakly reticulo-puctate area posteriorly in *E. caophongi*), face smooth with a broad medio-longitudinal ridge (this area much narrower in *E. caophongi*), and hind femur more slender, 4.3 times as long as wide (3.5 times in *E. caophongi*).

ACKNOWLEDGMENTS

The first author thanks Dr. Haisheng Ying for his hospitality during his stay at the Shanghai Institute of Entomology, Shanghai, and for the loan of the specimen. We thank C. van Achterberg (Leiden, the Netherlands) and S. A. Belokobylskij (St. Petersburg, Russia) for reviewing the first draft. The project was partly supported by the National Scientific Foundation of China (NSFC number: 39970099) to the first author.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 352–361

FIVE NEW SPECIES OF *XANTHINA* ALDRICH (DIPTERA: DOLICHOPODIDAE) FROM MEXICO AND CENTRAL AMERICA

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Abstract.—Five new species of *Xanthina* are described from Mexico and Costa Rica, ***X. squamifera*, *X. flagellifera*, *X. schildi*, *X. turrialbae***, and ***X. attenuata***, showing various distinctive antennal or palpal forms. The large palpal scales of *X. squamifera* and the flagelliform palpal setae in *X. flagellifera* are particularly noted.

Key Words: *Xanthina*, new species, Dolichopodidae, Mexico, Costa Rica, palpi, ESEM

Xanthina Aldrich is an American genus credited in the Neotropical Catalogue (Robinson 1970) with four species, *X. flavus* (Aldrich) and *X. plumicauda* Aldrich from the Lesser Antilles, and *X. nigromaculata* Van Duzee and *X. subcurva* Van Duzee from Panama. Four species were described by Robinson (1975) from Dominica in the Lesser Antilles, *X. acuticornis, X. dominicensis, X. persetosa,* and *X. rubromarginata.* Another supposedly undescribed species was mentioned in Robinson (1975) from Puerto Rico, that has been reexamined and seems to be a minor variant of *X. persetosa.* At the time of the Dominica treatment, at least one additional remarkable species already was collected from Mexico, and representatives of four other Central American species, collected from the Turrialba area of Costa Rica in 1922 or ca. 1922 by Pablo Schild, had been sorted out of the Melander collections at the National Museum of Natural History, Smithsonian Institution (USNM). It is these Mexican and Central American species that are the topic of the present paper, especially the remarkable Mexican species with large scales on its palpi.

Like the more temperate *Achalcus* Loew, *Xanthina* is distinctive in its yellowish color with mostly black bristles, and in having the scape of the antenna bare above, the posterior slope of the mesoscutum somewhat flattened, and the wings with the vein M usually scarcely deflected at the crossvein dm-cu, and vein R_{4+5} often becoming subparallel with M more distally. However, the femora of *Xanthina* lack true anterodorsal preapical bristles. In the Catalogue, Robinson (1970) states,"The genus seems very close to *Achalcus* except for the lack of true preapical bristles on the femora. The palpi are often highly developed and ornate." The palpus character is especially true of some species described below, but it seems that the labella are also often interestingly modified. In one new species, *X. turrialbae,* modified labella occur in both sexes.

The new species with scales on the palpi, *Xanthina squamifera,* and a related new species with narrow trichomes on the palpi, *X. flagellifera,* share a distinctive short abdomen with the fifth tergite hiding the hypopygium. The two species have the first flagellomere deeply notched at the apex, unlike most *Xanthina*; a smaller less distinct notch is seen in one of the other new species, *X. schildi.* Establishment of a new subgenus for the two most discordant species has been considered, but decided against at this time.

For illustration of the new species, the new Philips XL30 ESEM Scope of the National Museum of Natural History, that allows imaging without metallic coating, has been used. This has allowed highly detailed imaging that includes some substructure of the scales of *Xanthina squamifera.*

In the course of the study, material of two probable additional species has been seen, including one from North Carolina. Such material is too limited or too damaged for description at this time, however. The new species described here are based on limited material, each with only one male and often with no female. As a result, no effort has been made to dissect out hidden genital capsules, and some legs and wings were not available for description. Still, each of the species described below has at least one unquestionably distinctive feature by which the males, and in one case the females, can be easily identified.

Xanthina squamifera H. Robinson, new species

(Fig. 1)

Male.—Length 2.2 mm; wing 2.7 by 0.8 mm. Setae mostly black.

Eyes nearly contiguous at lower ⅓ of face, facial triangles brown pollinose with pale reflections; front dark brown, scarcely dulled with sparse pollen. Palpus (Fig. 1B) narrowly ovate, acute, at midlength with numerous large stipitate white scales with dark bases, with flattened whitish setae nearer tips. Labella tonglike, pale yellow; long-acute at front, narrowed to apical peg. Antenna dark yellow, first flagellomere darker distally, oblong, with broad deep apical notch to ⅖ of length (Fig. 1A), longer lobe below notch; arista from middle of notch.

Thorax yellow; 6 or 7 pairs of acrostichals; 6 pairs of distinct dorsocentrals.

Legs yellow. Fore coxa with pale hairs anteriorly, with small black bristles along apical margin; femora not distorted, without highly modified setae; middle femur with slightly longer posteroventral hairs in distal ⅓. Tibia II with anterodorsals near ⅙, ½, posterodorsal near ⅙, 3 apicals; tibia III with anterodorsals near ⅙, ⅓, ⅗, posterodorsals at ⅙, ⅖, ⅔, ventrals at ⅖, ⅗, and 3 apicals. Lengths of tibiae and tarsomeres as follows: tibia I: 0.6 mm, tarsi: 0.47, 0.22, 0.16, 0.08, 0.08 mm; tibia II: 1.11 mm, tarsi: 0.36, 0.28, 0.19, 0.14, 0.11 mm; tibia III: 1.55 mm, tarsi: 0.22, 0.30, 0.25, 0.14, 0.11 mm.

Wing narrowly oval, slightly fuscous. Vein M scarcely bent at crossvein dm-cu; vein dm-cu nearly as long as CuA$_1$; tip of CuA$_1$ ending slightly before margin. Knob of haltere pale brownish.

Abdomen brown on tergites, yellow below. Tergites 1–5 exposed, with black bristles, longer near margins. Genital capsule mostly hidden in tergite 5, brown, rounded apex with small black bristles; cercus pale, small, ovate to subquadrate.

Female.—Unknown.

Holotype.—♂. Mexico: Oaxaca, above Valle Nacional, 16 May 1963, Robinson (USNM).

Remarks.—Males of *Xanthina squamifera* and the following species are unusual for the genus by the deep apical notch in each first flagellomere, the elaborated trichomes of each palpus, only five visible tergites of the abdomen, and the short cerci of their genital capsules. In neither case has any effort been made to dissect the genital capsules of the single males of each species. Perhaps more material will provide structural details that will justify a separate subgeneric status for the two species.

The present species has been noted by the author since the time of its collection because of the large scales on the palpi, but the description has awaited a fitting method of illustration. The new Philips XL30 ESEM Scope of the Museum has proven perfect, requiring neither coating with metal nor notable moistening of the specimens.

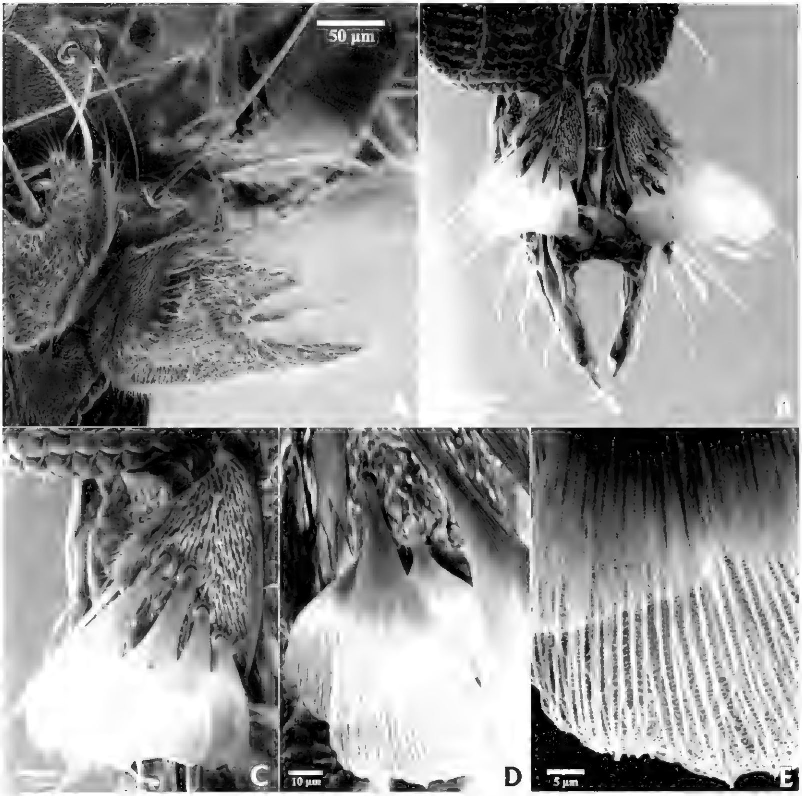

Fig. 1. *Xanthina squamifera.* A, First flagellomeres of antennae with deep apical sinuses. B, Frontal view of proboscis showing acute palpi with broad and narrow scales, and showing prolonged, tong-like tips of labella. C, Enlarged palpus with broad scales. D, Palpal scale showing some substructure. E, Edge of palpal scale with structural details.

Scales or scalelike structures occur in some other Dolichopodidae such as the Sciapodinae, along the costa of the wing or along tibiae or basitarsi. The scales of the present species, however, are the largest seen in the family (Figs. 1B–E). In the SEM scans the scales show some transparency, and high magnification shows some of the reticulate substructure. Such structure is slightly reminiscent of that in the scales of Lepidoptera, but it is not nearly as intricate. The flattened bristles on the more distal parts of the palpi are evidently scales that are scarcely broadened. The labella of the proboscis also seem rather odd in their tonglike form and their peglike tips.

Xanthina flagellifera H. Robinson, new species
(Fig. 2)

Male.—Length ca. 2 mm; wings broken near base. Setae mostly black.

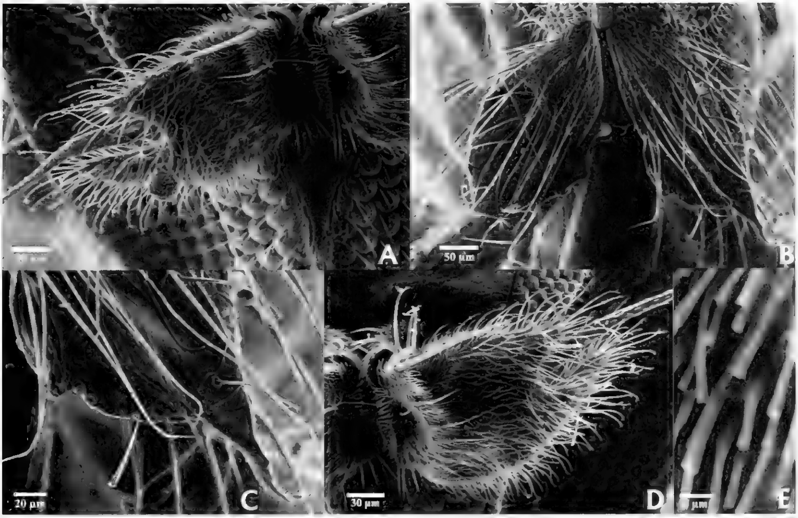

Fig. 2. *Xanthina flagellifera.* A, Inside view of first flagellomere of right antenna showing deep apical sinus B, Palpi and labella showing flagelliform setae of palpi and acuminate tips of labella. C, Enlarged nearly glabrous distal half of one labellum showing acuminate tip. D, Inside view of first flagellomere of left antenna showing apical sinus. E, Enlarged minute setulae of palpus showing truncated tips.

Eyes nearly contiguous at lower ⅓ of face, facial triangles brownish pollinose; front dark brownish, not or scarcely dulled. Palpus (Fig. 2B) brownish, triangular with oblique tip, with many long bristles having flagelliform tips, with many small peglike hairs; labella (Figs. 2B, C) pale yellow, very thin, nearly glabrous, with slender acuminate tip. Antenna yellowish, first flagellomere slightly darker at tips, oblong, apical notch to ⅓ of length (Figs. 2A, D), lower lobe longer.

Thorax yellow; 6 or 7 pairs of acrostichals, 6 pairs of distinct dorsocentrals.

Legs yellow. Fore coxa with pale hairs anteriorly, with small black bristles along apical margin. Femora without distortions or unusual bristles. Tibia II with anterodorsals at ⅙, ⅗; posterodorsal at ⅕, apicals 3; tibia III with anterodorsals at ⅙, ⅓, ⅗, posterodorsals at ⅕, ½, ¾, ventral near ½, ⅗, ca. 4 erect ventral hairs in 2nd ¼, apicals 3. Lengths of tibia and tarsomeres as follows: tibia I: 0.6 mm, tarsi: 0.38, 0.2, 0.16, 0.1, 0.1 mm; tibia II: 0.88 mm, tarsi: 0.36, 0.2, 0.16, 0.12, 0.12 mm; tibia III: 1.28 mm, tarsi: 0.5, 0.24, 0.22, 0.16, 0.12 mm.

Wings slightly fuscous, broken near base. Knob of haltere yellow.

Abdomen brown on tergites, yellow below. Tergites 1–5 exposed, with black bristles, longer near margins. Genital capsule mostly hidden by tergite 5, brown, cylindrical, with short black hairs; cercus whitish, thin, short, ovate, with black hairs.

Female.—Length ca. 3 mm; wings 2.8 mm long, ca. 1 mm wide.

First flagellomere ovate, not notched, arista subapical on outer surface. Palpus brownish-yellow, with black hairs; labella plain, without pointed tip.

Tibia II with anterodorsals at ¼, ⅗, posterodorsal at ⅓, apicals 3; tibia III antero-

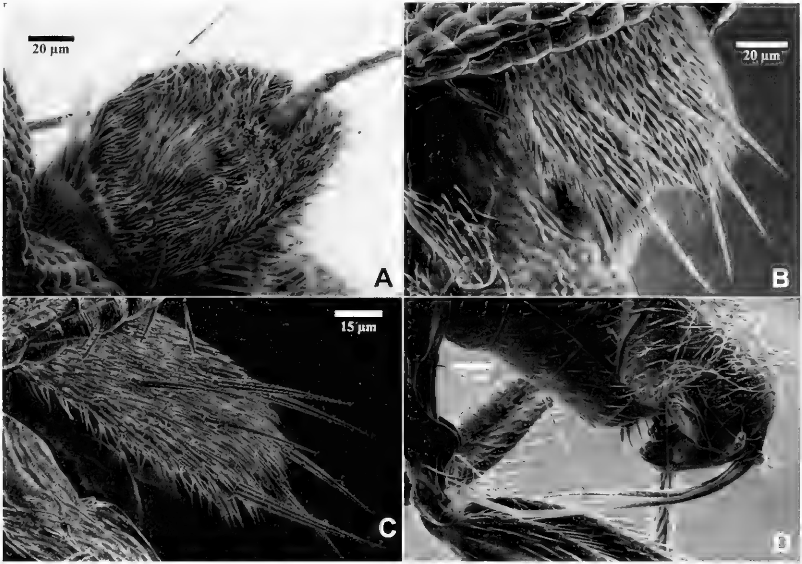

Fig. 3. *Xanthina schildi.* A, First flagellomere of antenna showing small apical sinus. B, C, Palpi showing two sizes of setae. D, Abdomen with genital capsule and cerci, showing comb of blunt setae of hind margin of 5th sternite.

dorsals at ¼, ½, ¾, posterodorsals at ⅕, ¾, apicals 3.

Abdominal tergites more yellowish on sides.

Wing slightly fuscous; vein M scarcely bent at crossvein CuA; R_{4+5} curving back to become subparallel with vein M.

Holotype.—♂. Costa Rica: Cartago. La Suiza de Turrialba, Aug 1922?, Pablo Schild (USNM, from Melander Collection). Paratypes; ♀. Costa Rica: Higuito, San Mateo, s.d., 1922?, Schild (USNM); ♀, Cartago, Suiza de Turrialba, July 1922?, Schild (USNM).

Remarks.—*Xanthina flagellifera* shares with *X. squamifera* the genital capsule mostly enclosed in the 5th tergite, the short cerci, and the deeply notched first flagellomere of the antenna, and the two are evidently closely related. They also share unique forms of trichomes on their palpi. In the present case (Fig. 2B) the trichomes are slender flagellate bristles whose ends reach to the margin of the labella. At the highest magnification the flagellate tips show minute appendages, a detail recalling the minute substructure of the scales in *X. squamifera.*

The identity of the females is based on similar chaetotaxy of the legs and the pale knobs of the halteres, but the females are somewhat larger with larger bristles on the tibiae. The females lack the pointed tips of the labella seen in the male.

Xanthina schildi H. Robinson, new species

(Fig. 3)

Male.—Length ca. 1.5 mm; wing ca. 1.6 mm long, torn behind R_{4-5}. Setae mostly black. Eyes contiguous in lower ⅓, facial triangles brown pollinose, lower triangle almost absent; front blackish, not dulled. Palpus (Figs. 3B, C) brownish, small, with black bristles and minute hairs; labella of proboscis brownish, small. Antenna yellowish, darker distally; first flagellomere ovate, subacute, with easily overlooked small apical notch bearing arista.

Thorax brownish above, yellowish on sides; 6 or 7 pairs of acrostichals, 6 pairs of distinct dorsocentrals.

Legs yellow. Fore coxa with mostly pale hairs, with 1 black bristle on distal margin. Fore and middle femora plain, hind femur with ventral row of more erect black bristles, longest near distal $\frac{1}{3}$ of femur, $\frac{1}{3}$ as long as width of femur. Tibia II with anterodorsals at $\frac{1}{5}$, $\frac{1}{2}$, no posterodorsals, apicals 3; tibia III with small anterodorsal at $\frac{1}{7}$, larger at $\frac{3}{7}$, $\frac{3}{4}$; posterodorsal near $\frac{1}{7}$; apicals 3. Lengths of tibiae and tarsomeres as follows: tibia I: 0.5 mm, tarsi: 0.3, 0.14, 0.08, 0.06, 0.06 mm; tibia II: 0.65 mm, tarsi: 0.28, 0.14, 0.1, 0.07, 0.08 mm; tibia III: 0.9 mm, tarsi: 0.15, 0.2, 0.14, 0.09, 0.09 mm.

Wing slightly fuscous, torn, missing behind R_{4-5}. Knob of haltere brown.

Abdomen with tergites brown, sternites yellow. Tergites 1–6 exposed, bristles dark with pale reflections. Genital capsule (Fig. 3D) pale brownish, facing a comb of stiff, curved, blunt bristles apparently borne on a preceding sternite; cercus as long as abdomen, filiform.

Female.—Unknown.

Holotype.—♂, Costa Rica: Cartago. La Suiza de Turrialba, July 1922?, Pablo Schild (USNM) from the Melander Collection.

Remarks.—*Xanthina schildi* is more like West Indian members of the genus, with six tergites exposed in the abdomen, a more exposed genital capsule, and long cerci. The first flagellomere of the antenna also looks more like the typical West Indian type that has no apical notch, but the present species does have a small notch (Fig. 3A). A comb of stiff sternal bristles facing the genital capsule, of the type seen in *X. schildi,* has thus far not been seen in any other member of the genus. The cerci are the longest and narrowest thus far seen in the genus.

Xanthina turrialbae H. Robinson, new species

(Figs. 4–5)

Male.—Length 2.3 mm; wing 2.65 by 1.0 mm. Setae mostly black.

Eyes nearly contiguous in lower $\frac{1}{2}$ to $\frac{1}{3}$ of face, facial triangles yellowish pollinose; front brown, scarcely dulled with pollen. Palpus (Fig. 4D) brownish, oval, with black bristles; labella with slender attenuate tips. Antenna with first flagellomere brownish yellow, oblong, slightly emarginate at tip (Figs. 4A, B); arista nearly twice as long as face, at lower magnification appearing glabrous throughout, thicker in basal $\frac{1}{2}$ with cover of minute hairs (Fig. 4C), becoming very slender distally with sparse minute fimbriae (Fig. 4E).

Thorax yellow; 6 or 7 pairs of acrostichals, 6 pairs of dorsocentrals.

Legs yellow. Fore coxa with black hairs anteriorly, with black setae along distal margin. Femora without distortions or unusual bristles. Tibia I with anterodorsal at $\frac{1}{3}$; tibia II broken; tibia III with bristles strong, anterodorsals at $\frac{1}{7}$, $\frac{1}{3}$, $\frac{3}{5}$; posterodorsals at ca. $\frac{1}{5}$, $\frac{1}{2}$, $\frac{3}{4}$, smaller ventrals at $\frac{1}{2}$, $\frac{2}{3}$; few erect posteroventral hairs in basal $\frac{1}{4}$–$\frac{1}{3}$; apicals 3. Lengths of tibiae and tarsomeres as follows: tibia I: 0.83 mm; tarsi: 0.4, 0.23, 0.2, 0.13, 0.12 mm; tibia II and tarsi missing; tibia III: 1.57 mm; tarsi: 0.27, 0.37 mm, other tarsi broken.

Wing slightly fuscous; vein M scarcely bent at dm-cu, R_{4-5} bent distally and becoming subparallel with M, dm-cu as long as last of CuA_1, CuA_1 fading before margin. Knob of haltere. brownish-yellow.

Abdomen brown on tergites, yellow on sternites; five tergites exposed, with marginal bristles long, black, others black with yellowish reflections. Genital capsule mostly hidden by tergite 5, brownish with small black hairs; cercus short.

Female.—Length ca. 2.7 mm; wing 3 by 1 mm.

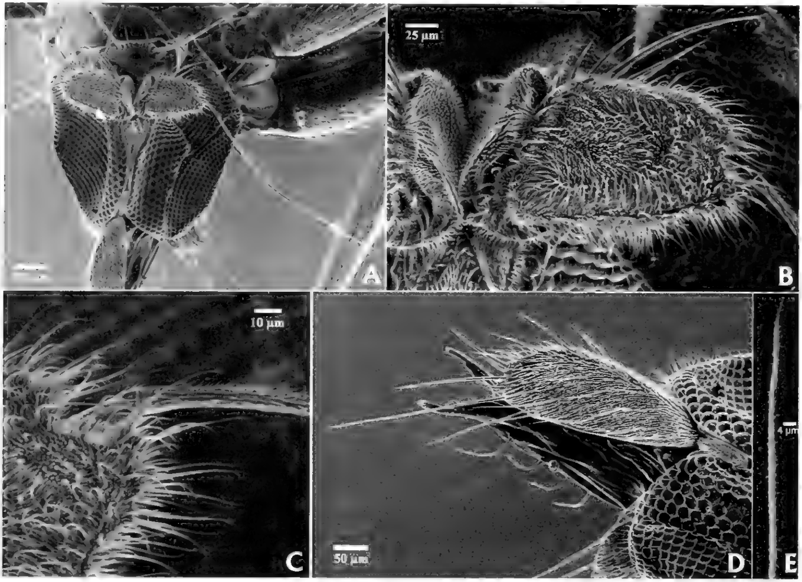

Fig. 4. *Xanthina turrialbae*, male. A, View of head showing antennae, face, and base of proboscis. B, First flagellomere of antennae. C, Tip of first flagellomere showing slight sinus and base of minutely haired arista. D, Proboscis with right palpus, part of laterally directed left palpus, and pointed tips of labella. E, Arista showing nearly hairless appearance.

Eyes contiguous. Palpus smaller but mostly as in male (Fig. 5A); labella pointed as in male. First flagellomere shorter than high, slightly emarginate at apex; arista about 1.5 times as long as face, hairy (Fig. 5B).

Tibia I with no dorsal; tibia II with anterodorsals at $^1/_5$, $^1/_2$; posterodorsal at $^1/_5$; tibia III with bristles large, anterodorsals at $^1/_7$, $^1/_3$, $^1/_2$; posterodorsals at $^1/_6$, $^2/_5$, $^2/_3$, apicals 3. Lengths of tibiae and tarsomeres as follows: tibia I: 0.77 mm; tarsi: 0.37, 0.23, 0.2, 0.13, 0.17 mm; tibia II: 1.1 mm; tarsi: 0.43, 0.27, 0.2, 0.15, 0.1 mm; tibia III: 1.57 mm; basitarsus: 0.27 mm, other tarsi broken.

Holotype.—♂, Costa Rica: Cartago, La Suiza, Apr 1922, Schild (USNM). Allotype ♀, Costa Rica: Cartago, La Suiza de Turrialba, Aug 1922, Schild (USNM). Both from the Melander Collection.

Remarks.—*Xanthina turrialbae* differs generally by its large size, the larger bristles on its hind tibiae, and the black rather than pale hairs on the front surfaces of the fore coxae. Of more particular interest are the nearly bare aristae of the male antennae and the pointed labella of both the male and the female probosci. The species has the abdomen with only five visible abdominal tergites, the nearly hidden genital capsule, and the short cerci of the group of species including *X. squamifera* and *X. flagellifera*, but the first flagellomere of the antenna does not have the large apical notch and the palpi do not have strikingly distinctive setae or scales like those found in the two species described above.

Xanthina attenuata H. Robinson, new species

(Fig. 6)

Male.—Length 1.8 mm; wings broken. Setae mostly black.

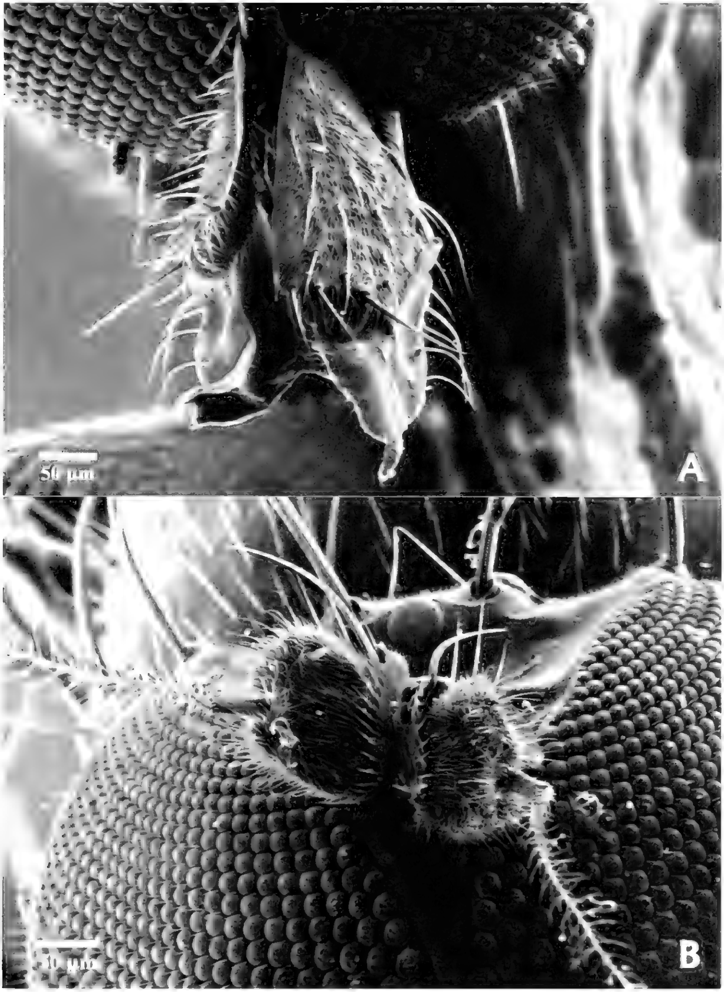

Fig. 5. *Xanthina turrialbae* female. A, Proboscis showing short palpi and pointed labella. B, Antennae showing reduced first flagellomeres with small apical sinuses and pubescent aristae.

Eyes contiguous in lower ⅓ of face; facial triangles mostly pale brownish pollinose; front blackish brown scarcely dulled with pale brownish pollen. Palpus very thin, pale, broadly obdeltoid (Fig. 6B), with scattered pale hairs; labella broad, thin, pale, obtusely pointed with minute apiculus (Fig. 6B). Antenna mostly yellowish; first

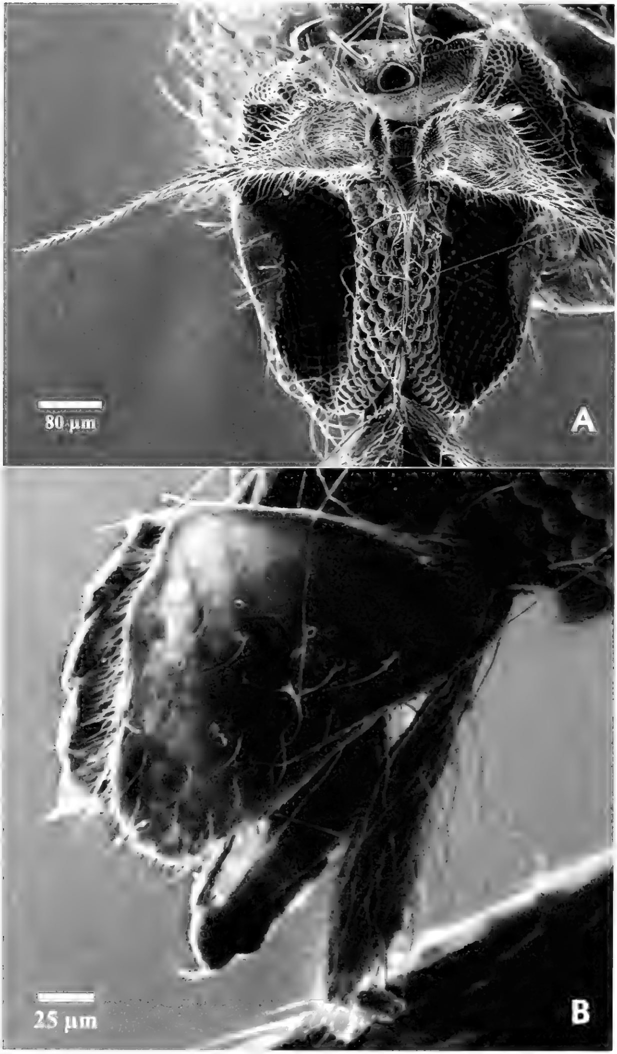

Fig. 6. *Xanthina attenuata.* A, View of head showing triangular first flagellomeres of antennae with single acuminate tips. B, Proboscis with face view of right palpus in center and edge view of left palpus to right, labella showing short-apiculate tips.

flagellomere darker distally, with obtuse angle above near basal ⅓ (Fig. 6A), with long, slender, hairy, attenuate tip below; arista from distal ⅓ of upper margin, slightly longer than first flagellomere, hairy.

Thorax yellow, 6 or 7 pairs of acrostichals, 6 pairs of dorsocentrals.

Legs yellow. Fore coxa with pale hairs anteriorly, with black bristles distally; femur I plain; femur II with row of erect, fine hairs ventrally, some as long as ⅓ width of femur, small black apical on midanterior surface; hind femora missing. Tibia II with anterodorsals at ⅙, ⅗, small posterodorsal at ⅕, 3 apicals. Lengths of tibiae and tarsomeres as follows: tibia I: 0.5 mm, tarsi: 0.33, 0.14, 0.1, 0.09, 0.063 mm; tibia II: 0.8 mm; basitarsus: 0.3 mm, other tarsi broken. Hind tibiae and tarsi missing.

Wings broken near base. Knob of haltere dark yellow.

Abdomen brown above on most tergites, yellow on most of 1st tergite, sides of most other tergites and on sternites. Tergites 1–6 showing, with black bristles, marginal bristles longer. Genital capsule mostly hidden, brownish; cercus appearing small.

Female.—Unknown.

Holotype.—♂, Costa Rica: Cartago, La Suiza de Turrialba, Aug 1922?, Schild (USNM) from the Melander Collection.

Remarks.—*Xanthina attenuata* is distinct among the species with dorsally inserted aristae by the greater length versus width and more tenuous tip of the first flagellomere. Relationship may be closest to *X. dominicensis* H. Rob. of the Lesser Antilles because of the row of erect hairs or setae ventrally on the middle femur and the short form of the cerci. The palpi of the new species are very thin and totally lack any brownish or blackish setae.

ACKNOWLEDGMENTS

The Philips XL30 ESEM Scope was operated by Scott Whitaker, manager of the National Museum of Natural History SEM laboratory. Marjorie Knowles, Technician in Botany, is thanked for work with the specimens and illustrations.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 362–372

A NEW GENUS AND NEW SPECIES OF COLPURINI (HETEROPTERA: COREIDAE) FROM NEW GUINEA

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Abstract.—The new genus ***Ullrihygia*** and five new species ***Ullrihygia iriana***, ***Heisshygia tafa***, ***Lothygia sordida***, ***Lothygia consocia***, and ***Sciophyroides splendidula*** collected in New Guinea are described in the tribe Colpurini (Coreidae). Dorsal habitus illustrations and drawings of the head, male genital capsule, and female genital plates are provided to distinguish each species. A key to the *Lothygia* species is given.

Key Words: Insecta, Heteroptera, Coreidae, Colpurini, new genus, new species, New Guinea

The island of New Guinea contains a remarkable and highly endemic assemblage of genera and species in the tribe Colpurini, many of which are still undescribed.

The tribe Colpurini is represented by a number of species that show various bizarre morphological specializations. The most striking features of these genera are the remarkable reduction of the hemelytra, the development of the head including the eyes and tylus, and the shape of male genital capsule and female genital plates (Brailovsky 1996, 2000).

The current paper is a further contribution to this study. Provided are descriptions for one new genus and five new species and a key to the species belonging to the genus *Lothygia* Brailovsky.

The following abbreviations are used for the institutions cited in this paper: AMNH (The American Museum of Natural History, New York); BPBM (Bernice P. Bishop Museum, Honolulu, Hawaii); BMNH (The Natural History Museum, London, England); UNAM (Instituto de Biología, Universidad Nacional Autónoma de México); WUCO (Wolfgang Ullrich collection, Germany); ZSM (Zoologische Staatssammlung, München, Germany).

All measurements are given in millimeters.

Ullrihygia Brailovsky and Barrera, new genus

Diagnosis.—*Ullrihygia* is related to *Baumannhygia* Brailovsky (1996), *Nishihygia* Brailovsky (2000), and *Wygohygia* Brailovsky (1993a). Similar to *Baumannhygia* without ocelli, head quadrangular and wider than long, antenniferous tubercle armed with long robust spine, eyes small and globular, buccula with sharp projection, femora unarmed, micropterous, abdomen elliptical, and connexivum higher than terga. *Baumannhygia* known only from the Philippine Republic, is recognized by having the tylus unarmed, the postocular tubercle protuberant, antennal segment I longer than III and shorter than maximum length of the head, humeral angles rounded and not raised, and scutellum apically acute. In *Ullrihygia*, recorded from Irian Jaya, the tylus is apically acute and upturned to form a median horn, the postocular tubercle is absent, the length of antennal segment I is equal than III, and equal than maximum length of head, the humeral angles are raised, and the scutellum is apically rounded. This new genus resembles *Nishihygia* in having the tylus apically acute, antenniferous tubercle armed, ocelli absent, eyes globular, humeral angles slightly raised, femora unarmed, micropterous, apex of scutellum rounded, abdomen elliptical, and connexivum higher than terga. In *Nishihygia,* the frontal angles are rounded and not exposed, the posterior lobe of pronotum depressed, postocular tubercle moderately protuberant, and buccula rounded, without sharp acute projection. *Wygohygia* is like *Ullrihygia* with the eyes small and protrudent on short stalks, head quadrate, buccula with sharp projection, antenniferous tubercle armed, and frontal angles produced forward as rounded lobes. *Wygohygia* is recognized by the following combination of characters: head longer than wide, tylus apically globose, ocelli present, postocular tubercle protuberant, femora armed, apex of scutellum acute, and submacropterous reaching the posterior third of abdominal segment VI.

Nishihygia and *Wygohygia* are recorded from New Guinea.

Generic description.—*Head:* Wider than long, quadrangular, and dorsally slightly convex; tylus apically upturned to form a subacute median horn, extending anteriorly to and laterally higher than juga; juga unarmed, thickened, and apically barely acute; antenniferous tubercle armed with long robust spine; antennal segment I stout, thickest, slightly curved outward and equal than maximum length of head; segments II and III cylindrical and slender; segment IV fusiform; antennal segment II longest, IV shortest, and I equal to III; ocelli absent; preocellar pit deep, circular; eye small, globular, and protruding on short stalk; postocular tubercle absent; buccula rounded, short, not projecting beyond antenniferous tubercle, with sharp middle projection; rostrum reaching anterior margin of abdominal sternite III; mandibular plate absent.

Thorax: Pronotum wider than long, trapeziform, bilobed, and non declivent; anterior lobe slightly longer than posterior lobe, and each margin convexly rounded; collar weakly apparent; frontal angles produced forward as conical lobe; humeral angles rounded, raised, and directed upward; posterolateral borders and posterior border straight; calli weakly convex. Anterior lobe of metathoracic peritreme reniform, posterior lobe sharp, small.

Legs: Unarmed; tibiae cylindrical and sulcate.

Scutellum: Wider than long, flat, moderately rectangular; apex rounded.

Hemelytron: Micropterous, reaching anterior third of abdominal segment I; wings reduced to small pads, widely separated; clavus and corium fused, and abdomen exposed mesially; membrane absent.

Abdomen: Conspicuously elliptical; connexivum higher than terga; connexival margin entire, with posterior angle of each segment not extending on a short spine; terga II to VI barely convex.

Integument: Body surface dull, almost glabrous; antennal segments and legs with long erect setae; head with circular, grayish white farinose punctures; pronotum, scutellum, hemelytron, abdominal segments, thorax, and abdominal sterna strongly punctate; connexivum and upper margin of pleural abdominal sterna smooth.

Male genitalia: Posteroventral edge of genital capsule strongly produced forward as robust conical projection (Figs. 7–8).

Female, unknown.

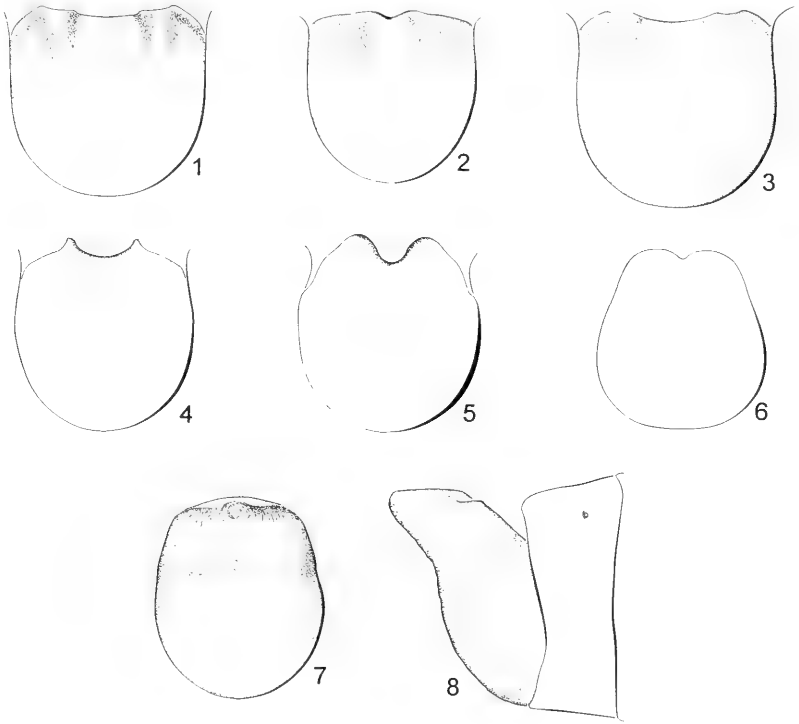
Etymology.—Named after Wolfgang Ullrich, a distinguished German entomologist. Gender feminine.

Type species.—*Ullrihygia iriana* Brailovsky, new species.

Ullrihygia iriana Brailovsky and Barrera, new species

(Figs. 7–8, 18)

Description.—*Measurements:* Male: Head length 1.48; width across eyes 1.84; interocular space 1.32; preocular distance



Figs. 1–8. 1–6, *Lothygia* spp., male genital capsule in caudal view. 1, *L. papuana*. 2, *L. cordigera*. 3, *L. enarotadi*. 4, *L. consocia*. 5, *L. sordida*. 6, *L. sandaracine* Brailovsky. 7–8, *Ullrihygia iriana*, male genital capsule. 7, Caudal view. 8, Lateral view.

1.34; length antennal segments: I, 1.48; II, 2.02; III, 1.48; IV, 1.08. Pronotum: Total length of anterior lobe 0.94; total length of posterior lobe 0.89; total width of anterior lobe 2.02; total width of posterior lobe 2.92. Scutellar length 0.40; width 1.32. Maximum width of abdomen 4.80. Body length 8.95.

Dorsal coloration: Head black; antennal segments I to III reddish brown, with basal joint of III ochre orange; antennal segment IV dark chestnut orange with basal third reddish brown; anterior lobe of pronotum black and posterior lobe reddish brown; anterolateral margin and upper margin of humeral angles ochre orange; scutellum reddish brown with wide ochre-orange longitudinal stripe at middle third; hemelytron and abdominal segments reddish brown; connexivum reddish brown with posterior margin of connexival segments V and VI dark orange. *Ventral coloration:* Head black; rostral segments dark yellow; thorax, abdominal sterna, and genital capsule dark orange yellow with punctures reddish brown to black; coxae black; trochanters yellow; femora yellow with apical third and few and scattered discoidal spots reddish brown; tibiae reddish brown with two yellow rings one subbasal, the other one near middle third; tarsi chestnut orange.

Type material.—Holotype: ♂, Indonesia: Irian Jaya, Paniai Province, N Mulia Trail to Dowome, 2,200–2,500 m, 8 July 1994, A. Riedel (Ent. Expl. New Guinea, 1990–1994) (WUCO). Paratype: 1 ♂, same label data as holotype (UNAM).

Etymology.—The name is derived from the type locality.

Heisshygia tafa **Brailovsky and Barrera, new species**

(Figs. 14, 16)

Description.—*Measurements:* Male: Head length 1.60; width across eyes 1.56; interocular space 0.94; interocellar space 0.32; preocular distance 1.04; length antennal segments: I, 1.20; II, 1.80; III, 1.24; IV, 0.88. Pronotum: Length 1.32; width across frontal angles 1.60; width across humeral angles 2.76. Scutellar length 0.88; width 0.96. Maximum width of abdomen 4.39. Body length 8.85. Female: Head length 1.60; width across eyes 1.60; interocular space 0.96; interocellar space 0.34; preocular distance 1.09; length antennal segments: I, 1.28; II, 2.00; III, 1.40; IV, 0.92. Pronotum: Length 1.60; width across frontal angles 1.68; width across humeral angles 2.76. Scutellar length 0.84; width 1.06. Maximum width of abdomen 5.30. Body length 10.00.

Male: *Head:* Pentagonal, longer than wide; antenniferous tubercle barely diverging anteriorly; ocelli obscure; rostrum reaching anterior border of abdominal sternite VI (Fig. 16).

Thorax: Pronotal disc flat, with posterior median depression.

Scutellum: Wider than long, with apex rounded.

Hemelytron: Micropterous, reaching posterior third of abdominal segment I; clavus and corium fused into coriaceous pad, and wings widely separated from each other, leaving abdomen totally exposed mesally; membrane represented by small flap.

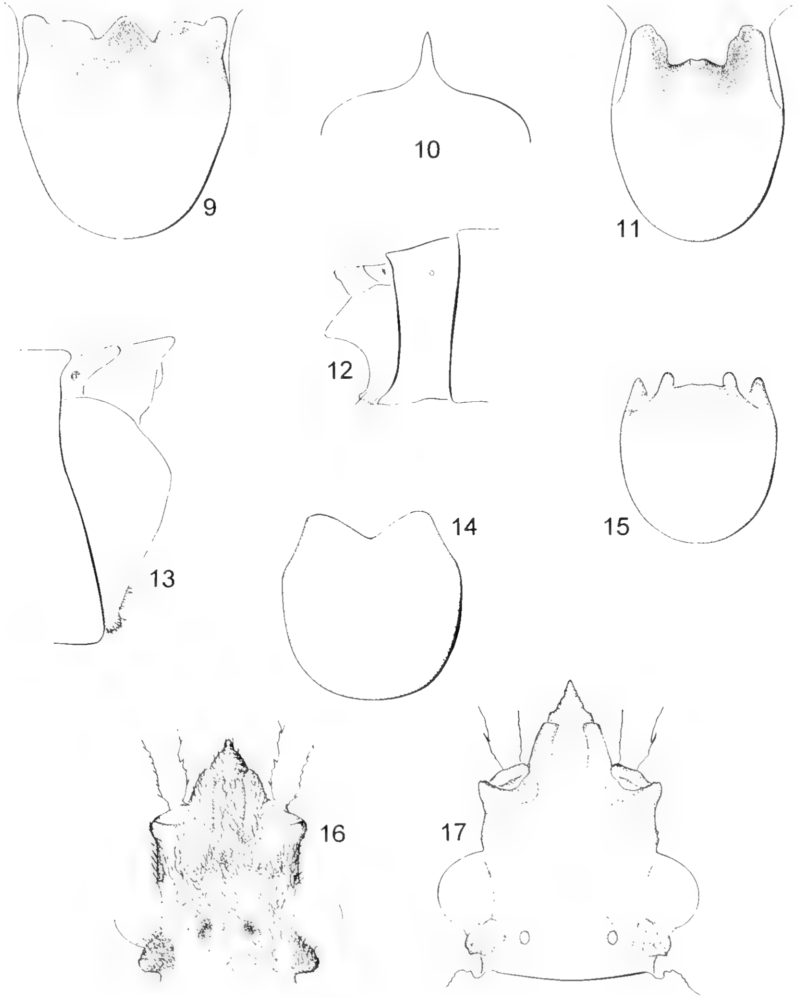
Genital capsule: Posteroventral edge with open and deep "V" concavity, enclosed by two broad rounded lobes (Fig. 14).

Coloration: Ground color bright reddish orange with head darker; antennal segments I to III bright reddish orange, and IV orange yellow with basal third bright reddish orange; apex of scutellum dark yellow; upper margin of connexivum and rostral segments I to IV pale chestnut orange; posterior margin of acetabulae yellow; coxae, trochanters, and fore and middle femora pale orange yellow; hind femur dark chestnut orange with two yellow rings, one basal, the other one near middle third; tibiae pale chestnut orange with two yellow rings, one subbasal, the other one near middle third; tarsi chestnut orange; anterior lobe of metathoracic peritreme pale yellow, and posterior lobe reddish orange.

Female: Head as longer as wide; rostrum reaching posterior third of abdominal sternite V. Coloration: similar to male. Connexival segments VIII and IX, dorsal abdominal segments VIII and IX, and genital plates bright reddish orange.

Type material.—Holotype ♂, Papua New Guinea: Mt. Tafa, 8,500′, February 1934, L. E. Cheesman (BMNH). Paratypes: 1 ♂, 1 ♀, same data as for holotype (BMNH, UNAM).

Discussion.—Among New Guinea *Heisshygia* species (Brailovsky 1995), *H. tafa,* is superficially most similar to *H. novoguinensis* Brailovsky (1993b), but may be separated by the following characters: In *H. tafa,* the posteroventral edge of the male genital capsule has an open and deep V-shaped concavity, enclosed by two broad rounded lobes (Fig. 14), the rostrum reach the posterior third of abdominal sternite V or anterior border of VI, the antenniferous tubercle are unarmed, and the hemelytra reaching the posterior third of abdominal segment I. In *H. novoguinensis* (Fig. 17), the posteroventral edge of male genital capsule has two short lateral projections, surrounding a broad middle plate (Fig. 15), the



Figs. 9–17. 9–13, *Sciophyroides* spp. 9–11, Male genital capsule in caudal view. 9, *S. splendidula.* 10, *S. acuminatus.* 11, *S. pumilus.* 12–13, Female genital plates in lateral view. 12, *S. acuminatus.* 13, *S. splendidula.* 14–17, *Heisshygia* spp. 14–15, Male genital capsule in caudal view. 14, *H. tafa.* 15, *H. novoguinensis.* 16–17, Head in dorsal view. 16, *H. tafa.* 17, *H. novoguinensis.*

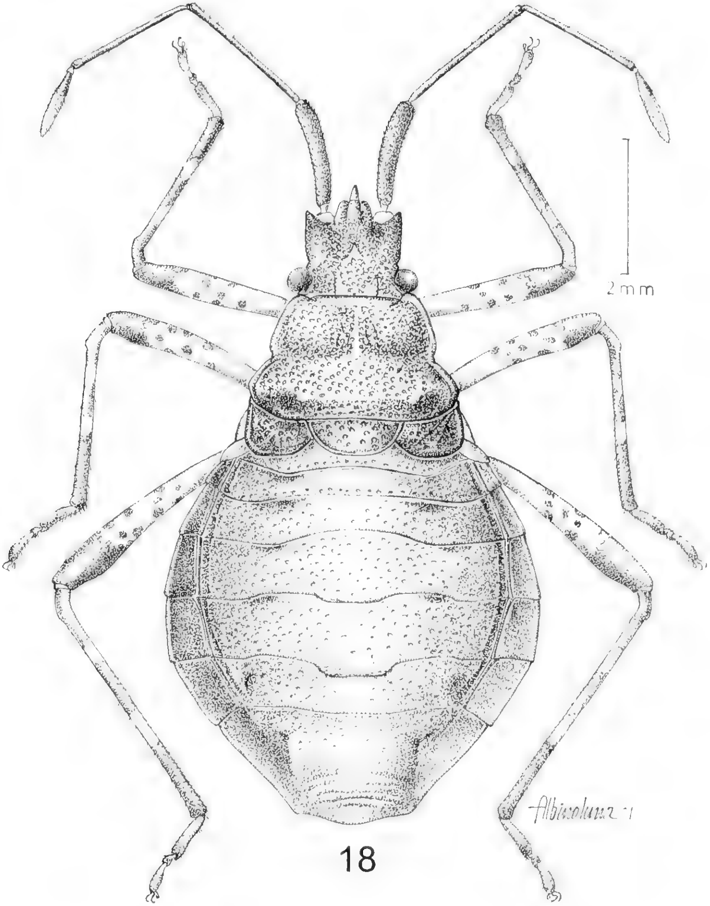


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Fig. 18. Dorsal view of *Ullrihygia iriana,* male.

rostrum reach the anterior third of abdominal sternite V, the antenniferous tubercle is armed, and each lobe raised and diverging anteriorly, and the hemelytra reaching the posterior third of abdominal segment II.

Etymology.—This species is named for its occurrence in the Tafa mountains.

Lothygia sordida
Brailovsky and Barrera, new species
(Figs. 5, 19)

Description.—*Measurements:* Male: Head length 1.96; width across eyes 1.84; interocular space 1.04; interocellar space 0.48; preocular distance 1.28; length antennal segments: I, 1.40; II, 2.08; III, 1.36; IV, 1.42. Pronotum: Length 2.12; width across frontal angles 1.56; width across humeral angles 3.80. Scutellar length 1.48; width 1.60. Body length 10.95. Female: Head length 2.16; width across eyes 2.00; interocular space 1.16; interocellar space 0.52; preocular distance 1.48; length antennal segments: I, 1.52; II, 2.16; III, 1.40; IV, 1.44. Pronotum: Length 2.44; width across frontal angles 1.68; width across humeral angles 4.16. Scutellar length 1.64; width 1.96. Body length 12.30.

Male: *Head:* Longer than wide; tylus apically truncated; antenniferous tubercle with small lobelike projection; eyes spherical, elevated, and protruding on short stalks; postocular tubercle protuberant, and acutely expanded; rostrum reaching middle third of abdominal sternite VII.

Thorax: Pronotum wider than long; frontal angles produced forward as conical teeth; humeral angles rounded, not exposed.

Hemelytron: Macropterous, reaching apex of last abdominal segment.

Genital capsule: Posteroventral edge laterally produced on a short blunt lobes, and between them a deep "U" concavity (Fig. 5).

Dorsal coloration: Head shiny black with tylus bright reddish brown; antennal segment I bright reddish brown; segments II to IV dark chestnut orange; dorsal face of postocular tubercle dark yellow; anterior lobe of pronotum black, and posterior lobe dark reddish brown; scutellum dark reddish brown; clavus and corium pale reddish brown; hemelytral membrane dark brown; connexivum pale orange yellow with posterior third or posterior border of segments III to VII black; abdominal segments III to VI dark orange and VII dark orange with extensive black marks. *Ventral coloration:* Head black; rostral segments dark to pale chestnut orange; thorax, abdominal sterna and genital capsule bright reddish brown with pleural abdominal segments III to VII pale orange yellow; anterior lobe of metathoracic peritreme yellow and posterior lobe black; coxae, trochanters and femora pale reddish brown; tibiae and tarsi pale chestnut orange.

Female: *Genitalia:* Gonocoxae I enlarged dorso-ventrally, in caudal view closed, in lateral view barely convex, with upper border almost straight. Coloration: similar to male. Rostral segments I and II dark chestnut orange and III and IV pale chestnut orange; legs bright pale reddish brown with subbasal yellow ring at tibiae; connexival segments VIII and IX black with anterior third dark yellow; abdominal segments VIII and IX dark brown with dark yellow reflections; gonocoxae I bright reddish brown with upper margin dark yellow; paratergite VIII and IX bright reddish brown.

Type material.—Holotype ♂, Indonesia: Irian Jaya, Wamena Pass Valley, 1,900 m, 15–16 September 1990, A. Riedel (ZSM). Paratypes: 1 ♂, Indonesia: Irian Jaya, Wamena Llugwa Melanggama, 1,800–2,000 m, 9–12 September 1990, A. Riedel (UNAM). 1 ♂, 1 ♀, Indonesia: Irian Jaya, Wamena Pass Valley, 1,900 m, 15–16 September 1990, A. Riedel (ZSM).

Discussion.—This species is diagnosed mostly on basis of the shape of the posteroventral edge of male genital capsule (Figs. 1–6), the presence of an acutely produced postocular tubercle, and by the shape of the eyes that are spherical, elevated, and protruding on a short stalks. In *L. cordigera* Brailovsky (1994), the postocular tubercle is not acutely produced, the eyes are spherical and weakly protrudent, and the posteroventral edge of male genital capsule is heart-shape (Fig. 2).

Etymology.—From the Latin *sordidus,* meaning dirty and referring to the blackish color.

Lothygia consocia
Brailovsky and Barrera, new species

(Fig. 4)

Description.—*Measurements:* Male: Head length 1.80; width across eyes 1.64; interocular space 0.96; interocellar space

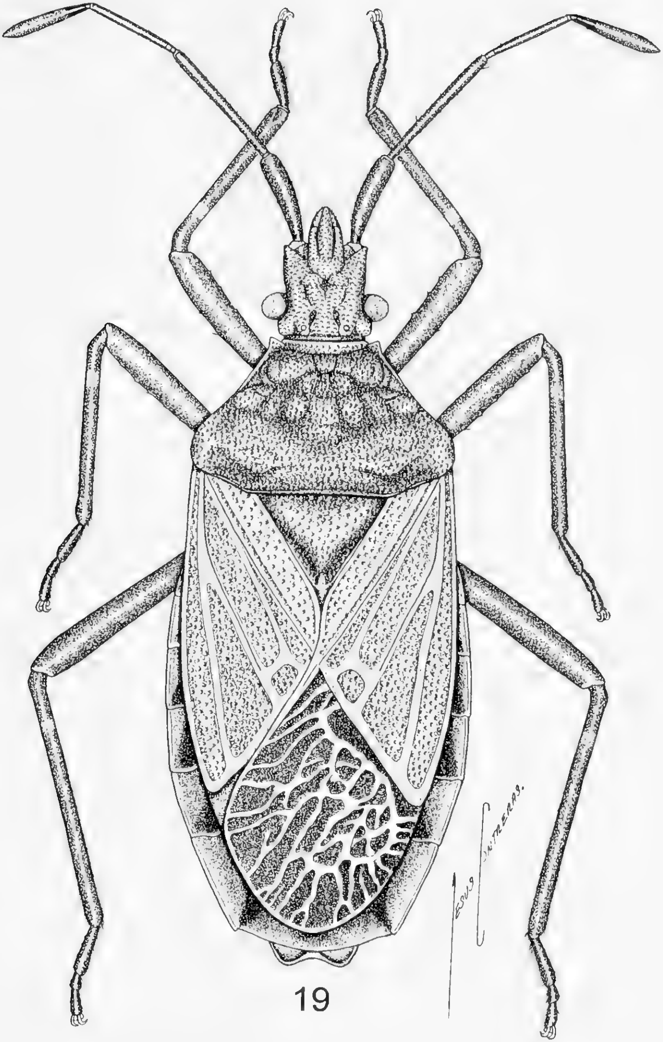

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Fig. 19. Dorsal view of *Lothygia sordida*, male.

0.48; preocular distance 1.20; length antennal segments: I, 1.36; II, 1.76; III, 1.16; IV, 1.36. Pronotum: Length 2.04; width across frontal angles 1.60; width across humeral angles 3.36. Scutellar length 1.36; width 1.64. Body length 10.00. Female: Head length 1.92; width across eyes 1.72; interocular space 0.98; interocellar space 0.47; preocular distance 1.36; length antennal segments: I, 1.40; II, 1.88; III, 1.24; IV, 1.36. Pronotum: Length 2.24; width across frontal angles 1.60; width across humeral angles 3.52. Scutellar length 1.48; width 1.64. Body length 11.30.

Male: *Head:* Longer than wide; tylus apically truncate; antenniferous tubercle unarmed, with apex truncate; eyes spherical, and barely protrudent; rostrum reaching middle third of abdominal sternite VII; postocular tubercle conically protuberant.

Thorax: Pronotum wider than long; frontal angles produced forward as conical teeth; humeral angles rounded, not exposed.

Hemelytron: Submacropterous, reaching middle third of abdominal sternite VII.

Genital capsule: Posteroventral edge laterally produced in a short blunt lobes, and between them with large concave plate (Fig. 4).

Dorsal coloration: Head black; tylus, and juga shiny dark reddish brown; antennal segments dark chestnut orange; dorsal surface of postocular tubercle dark yellow; anterior lobe of pronotum black, and posterior lobe and scutellum dark reddish brown; clavus and corium pale reddish brown; hemelytral membrane dark brown, with veins and basal angle dark orange; connexivum bright orange yellow, with posterior third of segments III to VII black; abdominal segments orange. *Ventral coloration:* Head black; rostral segments bright chestnut; thorax, abdominal sterna, and genital capsule bright reddish brown with pleural margin of abdominal sterna III to VII bright orange yellow; anterior lobe of metathoracic peritreme yellow and posterior lobe black; legs reddish brown, with dark chestnut orange reflections at femora.

Female: Tylus apically with small spiny projection; hemelytra submacropterous, reaching posterior margin of abdominal segment VII. Genitalia. Gonocoxae I enlarged dorso-ventrally, in caudal view closed, in lateral view barely convex, with upper border almost straight. Coloration: similar to the male. Upper margin of metapleuron with orange yellow rectangular spot close to middle third; connexival segments VIII and IX orange yellow, with posterior border black; abdominal segments VIII and IX dark orange; gonocoxae I bright reddish brown with internal angle and apical margin yellow; paratergite VIII and IX dark chestnut orange, with basal third black.

Type material.—Holotype ♂, Indonesia: Irian Jaya, Paniai Province, S Mulia Trail to Wuyuneen, 1,900–2,000 m, 6–7 July 1994, A. Riedel (Ent. Expl. New Guinea, 1990–1994) (WUCO). Paratypes: 1 ♀, same data as for holotype (UNAM). 1 ♀, Indonesia: Irian Jaya, Paniai Province, N Mulia trail to Dowome, 2,200–2,500 m, 8 July 1994, A. Riedel (Ent. Expl. New Guinea, 1990–1994) (WUCO).

Discussion.—*Lothygia consocia,* is easily recognized by the shape of the posteroventral edge of male genital capsule (Fig. 4), and by the submacropterous condition of the hemelytra which reach the middle third of abdominal sternite VII. On the previous known species of *Lothygia,* the hemelytra exhibit a macropterous condition, reaching or extending beyond the apex of last abdominal segment (Brailovsky 1994).

Etymology.—From the latin *consocius,* a companion: one of several species occurring sympatrically in Irian Jaya.

KEY TO *LOTHYGIA* SPECIES (MODIFIED FROM BRAILOVSKY 1994)

1. Abdominal segments I to VI black; gonocoxae I in caudal view opened 2
– Abdominal segments I to VI orange yellow; gonocoxae I in caudal view closed 3
2. Tylus apically with a short spiny projection; posteroventral edge of male genital capsule

with short median plate (Fig. 1) . . . . *L. papuana* Brailovsky

– Tylus apically globose, truncate; posteroventral edge of male genital capsule with large median plate (Fig. 3) . . . . *L. enarotadi* Brailovsky

3\. Frontal angles poorly developed; male genital capsule with posteroventral edge sinuate, and laterally barely exposed (Fig. 6) . . . . *L. sandaracine* Brailovsky

– Frontal angles well developed, produced forward as conical expansions 4

4\. Submacropterous, reaching middle third of abdominal sternite VII; posteroventral edge of male genital capsule with large concave plate (Fig. 4) . . . . *L. consocia* new species

– Macropterous, reaching or extending beyond the apex of last abdominal segment; posteroventral edge of male genital capsule without large concave plate (Figs. 1,5) 5

5\. Eyes spherical, elevated, and protruding on a short stalk; posteroventral edge of male genital capsule with deep "U" concavity (Fig. 5) . . . . *L. sordida*, new species

– Eyes spherical, weakly protrudent; posteroventral edge of male genital capsule heart-shaped (Fig. 1) . . . . *L. cordigera* Brailovsky

Sciophyroides splendidula
Brailovsky and Barrerra, new species
(Figs. 9, 13)

Description.—*Measurements:* Male: Head length 2.79; width across eyes 2.17; interocular space 1.14; interocellar space 0.48; preocular distance 1.88; length antennal segments: I, 3.28; II, 4.52; III, 2.74; IV, 1.98. Pronotum: Length 3.59; width across frontal angles 2.04; width across humeral angles 5.64. Scutellar length 3.10; width 2.48. Body length 18.38. Female: Head length 2.82; width across eyes 2.23; interocular space 1.20; interocellar space 0.53; preocular distance 1.82; length antennal segments: I, 3.03; II, 4.27; III, 2.66; IV, 2.04. Pronotum: Length 3.53; width across frontal angles 2.10; width across humeral angles 6.07. Scutellar length 3.34; width 2.66. Body length 19.43.

Male: *Head:* Elongate, longer than wide, and dorsally flat; tylus projecting anteriad of juga, upturned to form sharp bifid horn; antenniferous tubercle unarmed; ocelli with large diameter, and clearly tuberculate; antennal segment II the longest, IV the shortest, and I longer than III; mandibular plate armed with sharp and small tubercle, visible in dorsal view; postocular tubercle protuberant; rostrum reaching middle third of abdominal sternite V.

Thorax: Pronotum wider than long; frontal angles produced forward as small conical teeth; humeral angles rounded, not exposed.

Legs: Femora unarmed, and ventrally with tiny denticles; tibiae cylindrical and sulcate.

Scutellum: Triangular, flat, and conspicuously longer than wide; apex subacute.

Hemelytron: Macropterous, reaching posterior margin of last abdominal segment.

Genital capsule: Posteroventral edge trifurcate, each lobe robust and wide; central lobe the longest, directed upward and backward, and lateral lobes remarkably folded downward (Fig. 9).

Dorsal coloration: Head dark reddish brown with the space between ocelli and eye, and dorsal view of postocular tubercle dark yellow; antennal segments I to III dark chestnut orange with basal joint of III yellow; antennal segment IV dark chestnut to dark yellow with basal and apical third dark reddish brown; pronotum, scutellum, clavus, and corium pale reddish brown with external margin of humeral angles and apex of scutellum yellow; middle third of calli dark reddish brown; hemelytral membrane dark ambarine; connexivum dark reddish brown with posterior margin yellow; dorsal abdominal segments bright orange with posterior margin of VII dark reddish brown. *Ventral coloration:* Ground color dark yellow with punctures dark to pale reddish brown; rostral segments I and II dark chestnut orange, III pale chestnut orange, and IV dark yellow; anterior lobe of metathoracic peritreme yellow and posterior lobe dark reddish brown; coxae and trochanters reddish brown; femora reddish brown with irregular yellow ring close to middle third; tibiae reddish brown with two yellow rings, one subbasal, the other one close to middle third; tarsi pale chestnut orange; pleural abdominal sterna reddish brown with posterior margin yellow; genital capsule reddish brown.

Female: Abdominal sternite VII without plica and fissura; gonocoxae I enlarged dorso-ventrally; in caudal view closed, in lateral view with upper third convex, and inner angle produced on a median lobe (Fig. 13). Coloration: similar to male. Connexival segments VIII and IX dark reddish brown with posterior margin yellow; dorsal abdominal segments VIII and IX and mesosternum dark reddish brown; genital plates dark reddish brown with inner margin of paratergite VIII and upper margin of gonocoxae I dark yellow.

Type material.—Holotype ♂, Papua New Guinea, Owen Stanley Range, Goilala Bome, 1,950 m, 24 February–7 March 1958, W. W. Brandt (BPBM). Paratypes: 1 ♀, Papua New Guinea, Eastern Highlands District No. 6, Pengage Camp, East Slopes Mt. Wilhelm, 2,770 m, 19–20 September 1959, L. J. Brass (Sixth Archbold Expedition to New Guinea) (AMNH); 1 ♂, NE Papua New Guinea, East Highlands, Aiyura, 1,800–1,900 m, 6 January 1965, J. Sedlacek (UNAM).

Discussion.—Brailovsky and Barrera (1996) described the genus *Sciophyroides* and includ 10 species, of them only *S. acuminatus* Brailovsky and Barrera, and *S. pumilus* Brailovsky and Barrera have the middle third of the posteroventral edge of male genital capsule produced upward (Figs. 10–11). On the other species the middle third has a pronounced or relatively small U-shaped or V-shaped concavity, laterally enclosed by robust or tiny lobes.

In *Sciophyroides acuminatus* the central lobe is elongate and acute (Fig. 10), in *S. pumilus* stout and shorter than lateral lobes (Fig. 11), and in *S. splendidula* Brailovsky, New Species, is stout and clearly longer than lateral lobes which are folded downward. The female of *S. acuminatus* has gonocoxa I in lateral view remarkably exposed, with inner third widely concave (Fig. 12), and in the new species gonocoxa I in lateral view is barely convex, with inner third weakly concave (Fig. 13). The female of *S. pumilus* is unknown.

Etymology.—The species name is derived from the Latin *splendidulus,* meaning diminutive and formed from *splendidus,* and refers to the remarkable shape of the male genital capsule.

ACKNOWLEDGMENTS

For access to the collections under their respective care or for the loan of specimens, we thank Randall T. Schuh (AMNH), Mick Webb (BMNH), Gordon Nishida (BPBM), Klaus Schonitzer (ZSM), and Wolfgang Ullrich. We also thank Albino Luna (UNAM) and Jesus Contreras (UNAM) for the dorsal view illustrations.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 373–379

ANNOTATED LIST OF THE BARK AND AMBROSIA BEETLES (COLEOPTERA: SCOLYTIDAE) OF MARYLAND, WITH NEW DISTRIBUTIONAL RECORDS

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Abstract.—A total of 110 species of Scolytidae are reported from Maryland. Thirty species reported new to Maryland are: *Hylastes opacus* Erichson, *Dendroctonus valens* LeConte, *Tomicus piniperda* (L.), *Phloeotribus dentifrons* (Blackman), *Carphoborus bicornis* Wood, *Polygraphus rufipennis* (Kirby), *Hylocurus flaglerensis* Blackman, *Micracisella opacicollis* (LeConte), *Ips avulsus* (Eichhoff), *Dryocoetes affaber* (Mannerheim), *D. autographus* (Ratzburg), *D. granicollis* (LeConte), *Lymantor decipiens* (LeConte), *Trypodendron betulae* Swaine, *T. lineatum* (Olivier), *T. retusum* (LeConte), *T. scabricollis* (LeConte), *Ambrosiodmus obliquus* (LeConte), *Xyleborus planicollis* Zimmermann, *Xylosandrus crassiusculus* (Motschulsky), *Cryphalus rubentis* Hopkins, *Pityoborus comatus* (Zimmermann), *Pityophthorus balsameus* Blackman, *P. cariniceps* LeConte, *P. confusus* Blandford, *P. liquidambarus* Blackman, *P. opaculus* LeConte, *P. puberulus* (LeConte), *Pseudopityophthorus asperulus* (LeConte), and *Corthylus punctatissimus* (Zimmermann). Of the 110 species reported in the state, 19 are not native to North America.

Key Words: Scolytidae, distribution, Maryland

The geography of Maryland is exceptionally diverse for its small size. Five physiographic provinces cover the State from east to west (Coastal Plain, Piedmont, Ridge and Valley, Blue Ridge, and Allegheny Plateau). With this diversity in land forms comes a diversity of forest types. In addition, due to its position in the Mid-Atlantic Region, forest types commonly found in the southeastern U.S. and the northeastern U.S. can be found in Maryland.

The variety of forests in Maryland is reflected in its forest insect fauna. This is especially true of the bark and ambrosia beetles. On the Coastal Plain in southeastern Maryland, southern species, such as *Dendroctonus frontalis* (Zimmermann), are common, whereas in the mountainous, western portion of the State, more northern species, such as *Polygraphus rufipennis* (Kirby) are found. Historically, many general collectors and scolytid specialists at the National Museum of Natural History, Smithsonian Institution (USNM), Washington, DC and USDA in Beltsville, MD, have collected extensively in Maryland. The USNM collection and publications from the first half of the 20th century contains many bark beetle records from the state; however, recently there has been very little information on the scolytid fauna of Maryland.

Since 1987, bark beetle collecting and surveys have been conducted as part of the routine forest pest survey activities by the Maryland Department of Agriculture. Additionally, since 1993, an extensive trapping

Table 1. Non-native scolytids found in Maryland.

Species	Origin	Year
Ambrosiodmus rubricollis (Eichhoff)	Asia	1940's
Dryoxylon onoharaensum (Murayama)	Asia	1990's
Euwallacea validus (Eichhoff)	Asia	1980's
Hylastes opacus Erichson	Europe	1990's
Hylastinus obscurus (Marsham)	Europe	<1900
Hypothenemus californicus Hopkins	Neotropics?	19??
Hypothenemus crudiae (Panzer)	Neotropics?	19??
Scolytus mali (Bechstein)	Europe	1950's
Scolytus multistriatus (Marsham)	Europe	1900's
Scolytus rugulosus (Muller)	Europe	<1900
Tomicus piniperda (Linnaeus)	Europe	1990's
Xyleborinus saxeseni (Ratzeburg)	Europe	<1900
Xyleborus pelliculosus Eichhoff	Asia	1980's
Xyleborus pfeili (Ratzeburg)	Europe	1990's
Xyleborus atratus Eichhoff	Asia	1980's
Xyleborus californicus Wood	Asia	1990's
Xyleborus dispar (Fabricius)	Europe	1900's
Xylosandrus germanus (Blandford)	Asia	1930's
Xylosandrus crassiusculus (Motschulsky)	Asia	1980's

program has been conducted as part of several USDA-APHIS programs to survey for exotic bark beetles that may have been introduced into the US.

One hundred ten species are listed herein as occurring in Maryland. This is comparable to the numbers of species reported from some of the much larger western states (Furniss et al. 1992, Furniss and Johnson 1987, Gast et al. 1989). Since 1987, 106 species have been collected in the above mentioned surveys, the remaining four species are from historical records. Thirty species are reported as new to Maryland. Most of these new records are for species previously reported in one or more neighboring states. The exceptions are *Pityoborus comatus* (Zimmermann) and *Hylocurus flaglerensis* Blackman with closest records from North Carolina and Florida, respectively. In a recent paper (Rabaglia and Williams 2002), two species of *Hylesinus* from western and midwestern North America were reported from Maryland.

Sources of published records are Wood and Bright (1992) and Bright and Skidmore (1997). Species listed as "Newly Reported in Maryland" are those species not listed from Maryland in these publications or other refereed publications since 1994. Species electronically reported as occurring in Maryland (i.e., *Tomicus piniperda* (L.), *Hylastes opacus* Erichson and *Xylosandrus crassiusculus* (Motschulsky)) are reported as new in this publication.

Of the 110 species now reported from Maryland, 19 are not native to North America (Table 1). Recent publications have discussed the origins and the increasing occurrence of these introductions (Atkinson et al. 1990 and Vandenberg et al. 2000). Since 1980, nine species of exotic scolytids have become established in Maryland, six of which are native to Asia. With increasing trade, an active shipping port and a diversity of forests, this number is likely to continue to increase.

Abbreviations for repositories of specimens new to Maryland are: MDAC—Maryland Department of Agriculture, Annapolis, MD; RJRC—Robert J. Rabaglia collection, Annapolis, MD and USNM—National Museum of Natural History, Smithsonian Institution, Washington, DC. Numbers of specimens appear in parenthesis with abbreviations.

New Maryland Records of Scolytidae

Species are arranged taxonomically as listed in Wood and Bright (1992). For Maryland localities, the first Maryland record is given, followed by other counties from which the species has been collected.

Subfamily Hylesininae

Hylastes opacus Erichson

Distribution.—Asia, Europe; USA: ME, NH, NY, VT, VA, WV, MD: Garrett Co. Keyser's Ridge, 25 April 1996, Virginia pine log, MDA coll. (1, MDAC). Other counties: Allegany, Baltimore, Carroll, Cecil, Harford, Queen Anne's, Washington. Comments: This exotic bark beetle is becoming increasingly common in stumps of cut pine trees, and survey traps baited with α-pinene.

Dendroctonus valens LeConte

Distribution.—USA: AZ, CA, CO, DE, ID, IL, IN, KS, ME, MA, MI, MN, MT, NV, NH, NJ, NM, NY, NC, OH, OR, PA, SD, UT, VT, VA, WA, WV, WI, WY, MD: Anne Arundel Co., Annapolis, 6 April 1988, R.J. Rabaglia coll. (1, MDAC). Other counties: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Montgomery, Queen Anne's, Washington. Comments: The red turpentine beetle is a common species across the state except for the extreme southeastern Coastal Plain where it is replaced by *Dendroctonus terebrans* (Olivier).

Tomicus piniperda (L.)

Distribution.—Africa, Asia, Europe; USA: IL, IN, ME, MI, NH, NY, OH, PA, VT, WI, MD: Allegany Co., Oldtown, 3 April 1995, ex: α-pinene-baited trap, MDA coll. (1, USNM). Other counties: Frederick, Garrett, Washington. Comments: The pine shoot beetle has been found only in α-pinene baited funnel traps in the four western counties. It has not been collected in trees through 2001.

Phloeotribus dentifrons (Blackman)

Distribution.—USA: DC, FL, IL, KS, LA, MI, MS, NJ, ND, OH, PA, SC, TX, VA, WV, MD: Kent Co., Meliota, 7 May 1997, MDA coll. ex: Ipslure-baited trap (1, MDAC).

Carphoborus bicornis Wood

Distribution.—USA: AL, DC, FL, PA, SC, MD: Talbot Co., Trappe, 2 February 1988, R.J. Rabaglia coll. (3, MDAC). Other counties: Baltimore, Calvert, Caroline, Queen Anne's, Wicomico.

Polygraphus rufipennis (Kirby)

Distribution.—USA: AK, AZ, CO, DC, ID, ME, MA, MI, MN, MT, NH, NJ, NM, NY, NC, ND, OR, PA, SD, TN, UT, VT, VA, WA, WV, WY, MD: Garrett Co., Bittinger, 29 July 1988, R.J. Rabaglia coll. (1, MDAC).

Subfamily Scolytinae

Hylocurus flaglerensis Blackman

Distribution.—USA: DE, FL, MD: Kent Co., Sandy Bottom, 3 May 1994, R.J. Rabaglia coll. (1, RJRC). Other counties: Baltimore, Talbot. Comments: Prior to these collections, and collections in Delaware (Rabaglia and Valenti 2003), this species was known only from the type series in Florida.

Micracisella opacicollis (LeConte)

Distribution.—USA: DE, DC, IL, GA, KS, MA, MI, MN, MO, NJ, NY, NC, OH, PA, VA, WV, MD: Frederick Co., Ijamsville, 21 April, 1995, MDA coll. ex: Ipslure-baited trap (1, MDAC).

Ips avulsus (Eichhoff)

Distribution.—USA: AL, AR, DC, FL, GA, LA, MS, NJ, NC, PA, SC, TX, VA, WV, WI, MD: Washington Co., Ft Frederick State Park, 19 October 1993, R.J. Rabaglia coll. ex: Ipslure-baited trap (3, MDAC). Other counties: Anne Arundel, Montgomery, Prince George's, St. Mary's, Talbot, Washington, Wicomico, Worcester.

Dryocoetes affaber (Mannerheim)

Distribution.—USA: AK, AZ, CO, ID, ME, MI, MN, MT, NH, NM, NY, NC, OR, PA, SD, TN, UT, WA, WV, WI, WY, MD: Garrett Co., Swallow Falls State Park, 27 June 1995, R.J. Rabaglia coll. (1, MDAC).

Dryocoetes autographus (Ratzeburg)

Distribution.—Africa, Asia, Europe; USA: AK, CA, CO, DE, ME, MI, MN, MT, NV, NH, NM, NY, NC, OR, PA, SD, TN, UT, VA, WA, WV, WI, WY, MD: Garrett Co., Swallow Falls State Park, 27 June 1995, R.J. Rabaglia coll. (2, MDAC).

Dryocoetes granicollis (LeConte)

Distribution.—USA: AR, DE, DC, FL, GA, IL KY, LA, MO, NJ, NY, NC, OH, PA, TX, VA, MD: Baltimore Co., Glen Arm, 30 May 1987, W. Steiner coll. (2, USNM). Other counties: Anne Arundel, Baltimore, Cecil, Queen Anne's, St. Mary's.

Lymantor decipiens (LeConte)

Distribution.—USA: DE, IA, KY, ME, MA, MI, MN, MS, NJ, NY, OH, PA, VA, WV, MD: Caroline Co., Tuckahoe State Park, 5 May 1994, R.J. Rabaglia coll. (1, MDAC). Other counties: Allegany, Baltimore, Caroline, Carroll, Cecil, Frederick, Harford, Kent.

Trypodendron betulae Swaine

Distribution.—USA: ID, ME, MA, MO, MT, NH, NJ, NY, OR, SD, WI, MD: Garrett Co., Hutton, 10 April 1995, MDA coll. ex: α-pinene baited trap (1, MDAC).

Trypodendron lineatum (Olivier)

Distribution.—Africa, Asia, Europe; USA: AK, AZ, CA, CO, CT, DC, ME, MI, MO, MT, NV, NH, NM, NY, OR, PA, SD, TN, UT, WA, WV, WY, MD: Garrett Co., Accident, 5 May 1993, MDA coll. ex: terpene-baited trap (2, MDAC). Other counties: Washington.

Trypodendron retusum (LeConte)

Distribution.—USA: AZ, CA, CO, CT, ID, MI, MO, MT, NV, NH, NM, NY, OR, PA, SD, UT, VT, WA, WV, WI, WY, MD: Garrett Co., Accident, 12 April 1994, Joe Winters coll. ex: Ipslure-baited trap (1, MDAC).

Trypodendron scabricollis (LeConte)

Distribution.—USA: AR, ME, MO, MS, NJ, NC, PA, SC, VA, WV, MD: Allegany Co., Luke, 3 April 1995, MDA coll. α-pinene-baited trap (1, MDAC). Other counties: Anne Arundel, Frederick, Garrett, Montgomery, Washington.

Ambrosiodmus obliquus (LeConte)

Distribution.—Africa, South America; USA: DE, DC, FL, GA, LA, MS, NC, VA, MD: Charles Co., Cedarville State Forest, 3 June 1988, R.J. Rabaglia coll. (1, RJRC). Other counties: Anne Arundel, Dorchester, Kent, Queen Anne's, St. Mary's, Talbot.

Xyleborus planicollis Zimmermann

Distribution.—USA: IL, IN, MO, NC, PA, MD: Garrett Co., Accident, 1 October 1999, MDA coll. ex: Allison-Pike trap (1, MDAC).

Xylosandrus crassiusculus (Motschulsky)

Distribution.—Africa, Asia; USA: DE, FL, GA, LA, MS, NC, SC, TX, MD: Washington Co., Big Pool, 29 July 1993, R.J. Rabaglia coll. ex: Frontalin-baited trap (1, MDAC). Other counties: Anne Arundel, Baltimore, Cecil, Harford, Kent, Prince George's, Queen Anne's, Worcester. Comments: Commonly known as the Asian ambrosia beetle, this species is becoming increasingly common in survey traps, and occasionally attacks landscape trees and nursery stock.

Cryphalus rubentis Hopkins

Distribution.—USA: NC, PA, WV, MD: Garrett Co., Table Rock, 10 April 1995, MDA coll. ex: α-pinene-baited trap (3, MDAC). Other counties: Allegany. Comments: Hundreds of specimens have been collected in funnel traps baited with α-pinene in the western counties.

Pityoborus comatus (Zimmermann)

Distribution.—USA: AL, FL, GA, LA, MS, NC, SC, MD: Cecil Co., Elk Neck State Forest, 17 April 1997, MDA coll. ex: sulcatol-baited trap (5, MDAC). Comments: This is the first record of this species north of North Carolina. It has been found only in sulcatol-baited funnel traps.

Pityophthorus balsameus Blackman

Distribution.—USA: ME, MI, MN, NH, NY, NC, WV, WI, MD: Garrett Co., Keysers Ridge, 28 May 1997, MDA coll. ex: spruce (1, MDAC).

Pityophthorus cariniceps LeConte

Distribution.—USA: CT, DE, IN, KY, ME, MA, MI, MN, NH, NY, NC, OH, PA, SC, VA, WI, MD: Baltimore Co., Loch Raven Resv., 20 April 1993, R.J. Rabaglia coll. ex: Ipslure-baited trap (1, MDAC). Other counties: Allegany, Cecil, Frederick, Garrett, Harford. Comments: This twig-infesting species probably occurs state-wide, and is found often in Ipslure-baited funnel traps.

Pityophthorus confusus Blandford

Distribution.—USA: AL, AR, DE, FL, GA, LA, MS, NC, PA, SC, TX, VA, WV, MD: Talbot Co., Seth State Forest, 29 June 1988, R.J. Rabaglia coll. (1, MDAC). Other counties: Cecil, Dorchester, Prince George's, St. Mary's, Worcester.

Pityophthorus liquidambarus Blackman

Distribution.—USA: AR, CT, DE, DC, FL, GA, IL, IN, IA, LA, MS, NC, WV, MD: Somerset Co., Wellington, 19 May 1994, R.J. Rabaglia coll. (1, MDAC). Other counties: Charles.

Pityophthorus opaculus LeConte

Distribution.—USA: AK, AZ, CA, CO, DE, ID, ME, MI, MN, NV, NH, NM, NY, PA, SD, UT, WV, WY, MD: Carroll Co., Eldersburg, 1 June 1995, MDA coll. ex: Chalcoprax-baited trap (1, MDAC).

Pityophthorus puberulus (LeConte)

Distribution.—USA: DE, DC, IN, KS, KY, ME, MA, MI, MN, NH, IA, NJ, NY, NC, OH, PA, RI, VA, WV, WI, MD: Cecil Co., Chesapeake City, 25 April 1994, R.J. Rabaglia coll. (1, MDAC). Other counties: Allegany, Calvert, Garrett, Howard, Kent, Prince George's, St. Mary's, Talbot, Washington.

Pseudopityophthorus asperulus (LeConte)

Distribution.—USA: CT, DC, FL, GA, IL, LA, ME, MA, MS, MI, NJ, NY, NC, PA, TN, TX, WV, MD: St Mary's Co., Hollywood, 12 June 1996, R.J. Rabaglia coll. (1, MDAC).

Corthylus punctatissimus (Zimmermann)

Distribution.—USA: AR, CO, CT, DC, FL, GA, IL, KY, MA, MI, MN, MS, NH, NJ, NY, NC, OH, PA, RI, TN, VT, VA, WV, MD: Montgomery Co., Brighton, 13 April 1995, MDA coll. ex: Ipslure-baited trap, (1, MDAC). Other counties: Anne Arundel, Cecil, Kent.

LIST OF MARYLAND SCOLYTIDAE

a = Species newly reported in Maryland.
b = Exotic species found in Maryland.
c = Species previously reported in Maryland, but not collected in recent surveys.

Hylesininae

Hylastini

Hylastes opacus Erichson—a,b
Hylastes porculus Erichson
Hylastes salebrosus Eichhoff
Hylastes tenuis Eichhoff
Hylurgops rugipennis pinifex (Fitch)

Hylesinini

Hylastinus obscurus (Marsham)—b
Hylesinus aculeatus Say
Hylesinus californicus (Swaine)

Hylesinus criddlei (Swaine)
Hylesinus fasciatus LeConte
Hylesinus pruinosus Eichhoff

Tomicini

Dendroctonus frontalis (Zimmermann)
Dendroctonus terebrans (Olivier)
Dendroctonus valens LeConte—a
Hylurgopinus rufipes (Eichhoff)
Tomicus piniperda (L.)—a,b

Bothrosternini

Cnesinus strigicollis LeConte

Phloeotribini

Phloeotribus dentifrons (Blackman)—a
Phloeotribus frontalis (Fabricius)
Phloeotribus liminaris (Harris)

Phloeosinini

Chramesus chapuisi LeConte—c
Chramesus hicoriae LeConte
Phloeosinus dentatus (Say)

Polygraphini

Carphoborus bicornis Wood—a
Carphoborus bifurcus Eichhoff
Polygraphus rufipennis (Kirby)—a

Scolytinae

Scolytini

Scolytus mali (Bechstein)—b
Scolytus multistriatus (Marsham)—b
Scolytus muticus Say
Scolytus quadrispinosus Say
Scolytus rugulosus (Muller)—b

Micracini

Hylocurus flaglerensis Blackman—a
Hylocurus langstoni Blackman—c
Hylocurus rudis (LeConte)
Micracis suturalis LeConte
Micracis swainei Blackman
Micracisella opacicollis (LeConte)—a
Pseudothysanoes lecontei Blackman
Thysanoes fimbricornis LeConte

Ipini

Ips avulsus (Eichhoff)—a
Ips calligraphus (Germar)
Ips grandicollis (Eichhoff)
Ips pini (Say)
Orthotomicus caelatus (Eichhoff)
Pityogenes hopkinsi Swaine
Pityogenes plagiatus (LeConte)

Dryocoetini

Dryocoetes affaber (Mannerheim)—a
Dryocoetes autographus (Ratzburg)—a
Dryocoetes betulae Hopkins
Dryocoetes granicollis (LeConte)—a
Dryoxylon onoharaensum (Murayama)—b
Lymantor decipiens (LeConte)—a

Crypturgini

Crypturgus alutaceus Schwarz

Xyloterini

Trypodendron betulae Swaine—a
Trypodendron lineatum (Olivier)—a
Trypodendron retusum (LeConte)—a
Trypodendron scbricollis (LeConte)—a
Xyloterinus politus Say

Xyleborini

Ambrosiodmus obliquus (LeConte)—a
Ambrosiodmus rubricollis (Eichhoff)—b
Ambrosiodmus tachygraphus (Zimmermann)
Euwallacea validus (Eichhoff)—b
Xyleborinus saxeseni (Ratzburg)—b
Xyleborus affinis Eichhoff
Xyleborus atratus Eichhoff—b
Xyleborus californicus Wood—b
Xyleborus celsus Eichhoff
Xyleborus dispar (Fabricius)—b
Xyleborus ferrugineus (Fabricius)
Xyleborus intrusus Blandford
Xyleborus pelliculosus Eichhoff—b
Xyleborus pfeili (Ratzeburg)—b
Xyleborus planicollis Zimmermann—a
Xyleborus pubescens Zimmermann
Xyleborus sayi (Hopkins)
Xyleborus viduus Eichhoff
Xyleborus xylographus (Say)
Xylosandrus crassiusculus (Motschulsky)—a,b
Xylosandrus germanus (Blandford)—b

Cryphalini

Cryphalus rubentis Hopkins—a
Hypothenemus californicus Hopkins—b
Hypothenemus crudiae (Panzer)—b
Hypothenemus dissimilis (Zimmermann)
Hypothenemus eruditus Westwood
Hypothenemus interstitialis (Hopkins)
Hypothenemus rotundicollis (Eichhoff)
Trischidas atoma (Hopkins)—c

Corthylini

Conophthorus coniperda (Schwarz)
Corthylus columbianus Hopkins
Corthylus punctatissimus (Zimmermann)—a
Gnathotrichus materiarius (Fitch)
Monarthrum fasciatum (Say)
Monarthrum mali (Fitch)
Pityoborus comatus (Zimmermann)—a
Pityophthorus balsameus Blackman—a
Pityophthorus cariniceps LeConte—a
Pityophthorus confusus Blandford—a
Pityophthorus crinalis Blackman
Pityophthorus dentifrons Blackman—c
Pityophthorus lautus Eichhoff
Pityophthorus liquidambarus Blackman—a
Pityophthorus opaculus LeConte—a
Pityophthorus puberulus (LeConte)—a
Pityophthorus pulchellus Eichhoff
Pityophthorus pulicarius (Zimmermann)
Pityophthorus pullus (Zimmermann)
Pseudopityophthorus asperulus (LeConte)—a
Pseudopityophthorus minutissimus (Zimmermann)
Pseudopityophthorus pruinosus (Eichhoff)
Pseudopityophthorus pubescens Blackman

ACKNOWLEDGMENTS

Donald E. Bright identified or verified the identity of many of the specimens, his help is greatly appreciated. I also thank the Maryland Department of Agriculture field staff for aiding in survey trap setup and collections. Also thanks to Gaye Williams for her critical reviews of earlier drafts of the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 380–387

DESCRIPTION OF A NEW SPECIES OF BRACONIDAE, *MONOCTONUS ALLISONI* (HYMENOPTERA: BRACONIDAE: APHIDIINAE), AND DISCUSSION OF THE APHID-PARASITOID GUILD FOR *NASONOVIA* SPP. (HEMIPTERA: APHIDIDAE) IN NORTHWESTERN UNITED STATES

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Abstract.—A new species of aphid parasitoid, ***Monoctonus allisoni* Pike and Starý,** is described from Washington. It is found in association with *Nasonovia* (*Eokakimia*) *wahinkae* (Hottes) (Hemiptera: Aphididae) on pale larkspur, *Delphinium glaucum* Watson, in a montane forest setting. This is the first native *Monoctonus* in North America known to attack *Nasonovia* spp. A key to the parasitoid guild of *Nasonovia* is provided.

Key Words: aphid, parasitoid, *Monoctonus, Nasonovia*

A new species of aphid parasitoid of the Braconid genus *Monoctonus* Haliday was found in Washington's Blue Mountains attacking aphids of the species *Nasonovia* (*Eokakimia*) *wahinkae* (Hottes) on pale larkspur, *Delphinium glaucum* Watson. This unusual occurrence represents the first native *Monoctonus* in North America known to attack *Nasonovia*. The parasitism was over a large colony, suggesting that the aphid was a preferred host of the parasitoid. The new species is described here. A key to the *Nasonovia* parasitoid guild for northwestern United States is provided.

MATERIAL AND METHODS

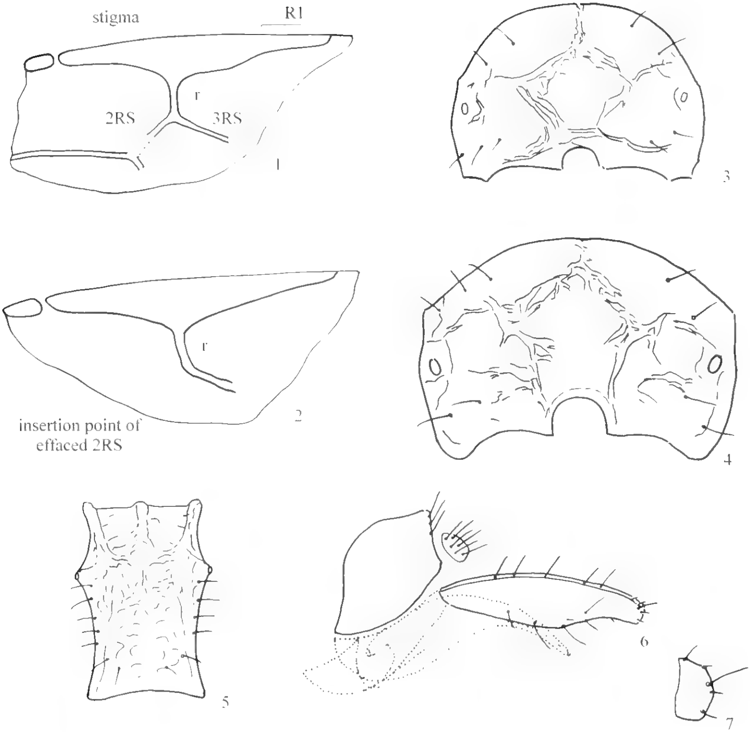
All aphid parasitoids were reared from field-collected aphids. The key to the *Nasonovia* parasitoid guild is based on rearings from aphid collections originating from a wide array of plants (see Pike et al. 2000), other original information of the authors, and from published records by Mackauer (1962a), Marsh (1979), and Starý and Remaudière (1977). They are also the basis for establishing and confirming tritrophic (plant-aphid-parasitoid) associations. Additionally, a broad framework of records of parasitoids of *Nasonovia* spp. from Europe [Starý (1966, 1976), Starý et al. (1971, 1973, 1977), Tizado (1992), Tizado and Nuñez Perez (1991), and original files of P. Starý] was reviewed in reference to the present studies.

Descriptive morphology characterizing *Monoctonus allisoni* follows that of Huber and Sharkey (1993), and Sharkey and Wharton (1997). Aphid nomenclature corresponds to Remaudière and Remaudière (1997).

DESCRIPTION

Monoctonus allisoni Pike and Starý, new species
(Figs. 1–7)

Diagnosis.—The shape of the ovipositor sheath distinguishes the new species from



Figs. 1–7. *Monoctonus allisoni*, female (illustrations not to same scale). 1–2, Forewings (in part), two drawings showing variation in venation. 3–4, Propodea (dorsal view, two drawings showing variation). 5, Petiole (dorsal view). 6, Genitalia with ovipositor sheath (lateral view). 7, Ovipositor sheath apex, close-up. Abbreviations: R1 = distal abscissa of post-marginal vein [= metacarpus]; r, 2RS, 3RS = wing veins.

the known Nearctic species of *Monoctonus* in which the ovipositor sheath is distinctly plough-share shaped; in *M. allisoni,* the sheath is only moderately widened ventrally. The latter character places *M. allisoni* close to *Harkeria rufa* (Cameron), but it is easily distinguished by antennal segment number: *M. allisoni* has 15–16 segments; *H. rufa* has 18–19 segments (see Discussion below).

Etymology.—Named in recognition of David Allison, Washington State University Research Technologist, who has contributed significantly for many years to the research on aphid parasitoids in northwestern USA.

Description.—Female: *Head:* Eye medium-sized, with sparse setae. Tentorio-ocular line shorter than half of inter-tentorial line. Malar space almost twice as long as tentorio-ocular line (5:3). Maxillary palpus 4-, labial palpus 3-segmented. Antenna 15–16 segmented, filiform. Flagellomere 1 (F1) three times as long as wide, setae somewhat longer than half its width, without longitudinal placodes. Flagellomere 2 subequal to F1, with one placode. Medial to apical flagellomeres only ¼ wider than F1, antenna not thickened toward apex.

Mesosoma: Mesonotum smooth, with sparse long setae along sides. Notauli distinct in ascendant portion only.

Forewing (Figs. 1–2): Stigma about 5 times as long as broad. Metacarpus (R1) short, equal to about ¼ stigma width. Radial abscissa (r) slightly longer than half of 3RS. 2RS sometimes effaced or rather colorless in basal portion. M+m-cu often colorless; stigma, metacarpus (R1), r, and 3RS well-pigmented and distinct.

Propodeum (Figs. 3–4): Distinctly areolated, pentagonal areola complete in spite of some variation due to rugosities in upper portion.

Metasoma: Petiole (Fig. 5) about twice as long as wide at apex; width at spiracles ⅓ shorter than segment length; spiracular tubercles prominent laterally, situated at end of basal third, surface feebly rugose, with indications of longitudinal carinae along sides and with 4–5 long setae along sides in middle and apical third.

Genitalia: Ovipositor sheath (Fig. 6–7) slightly arcuate and only moderately widened ventrally.

Coloration: Generally bicolorous. Head brown, face and lower third yellow. Mandible with brown apices. Palpi yellow. Antenna brown, scape and pedicel light brown with yellow markings. Mesosoma with mesonotum brown, sometimes scutellum and propodeum somewhat darkened, remainder yellow. Tegula brown. Wing venation light brown. Legs yellow. Metasoma with basal and apical areas yellow, brown in middle. Petiole basally yellow, remainder more or less brown. Ovipositor sheath yellow.

Body length: 2.0–2.2 mm.

Male. Antenna 17–18 segmented. Coloration generally bicolorous to prevalently brown. Head prevalently brown with clypeus, lower part of gena, mandible and palpi light brown. Antenna brown, apex of pedicel with yellow ring. Mesosoma brown with yellow markings, mesonotum brown. Wing venation light brown. Legs yellow to largely yellow brown. Metasoma brown, except more or less yellow base.

Material.—Holotype ♀, reared from *Nasonovia (Eokakimia) wahinkae* (Hottes), USA, Washington, Columbia County, Bluewood Ski Resort, 17-IX-2001, on *Delphinium glaucum,* sample coded A1G342, coll. G. Graf. Paratypes (same data as holotype), dry mounted 7 (1 ♀, 6 ♂) slide mounted 13 (8 ♀, 5 ♂). Holotype deposited in National Museum of Natural History, Smithsonian Institution (USNM), Washington, D.C. Paratypes deposited in USNM (2 ♀, 2 ♂), Washington State University-Prosser (4 ♀, 3 ♂), and collection of P. Starý in České Budějovice (3 ♀, 6 ♂).

PARASITOID GUILD OF *NASONOVIA* SPP. IN NORTHWESTERN UNITED STATES

The following species-guilds were analyzed: *Nasonovia (Kakimia) alpina* (Gillette & Palmer), *N. (K.) aquilegiae* (Essig), *N. (Capitosiphon) crenicorna* (Smith & Knowlton), *N. (K.) cynosbati* (Oestl.), *N. (K.) houghtonensis* (Troop), *N. (K.) polemonii* (Gillette & Palmer), *N. (Nasonovia) ribisnigri* (Mosley), *N. (Eokakimia) wahinkae* (Hottes), and unidentified *Nasonovia* spp. Most of the *Nasonovia* parasitoid guild members (*Aphidius polygonaphis* Fitch, *Ephedrus californicus* Baker, *Lysiphlebus testaceipes* (Cresson), *Praon occidentale* Baker, *P. humulaphidis* Ashmead, *P. unicum* (Smith) are more or less broadly oligophagous species across various aphid genera (Pike et al. 2000). *Aphidius kakimiaphidis* Smith, is the most common parasitoid of *Nasonovia,* although it does not attack all species in the genus. The new species, *Monoctonus allisoni,* is currently known to attack only a single aphid species, *Nasonovia (Eokakimia) wahinkae.*

Nasonovia ribisnigri, a European aphid now widespread in North America, has a parasitoid guild of native broad oligophages (*Ephedrus californicus, Praon humulaphidis,* and *P. unicum*), and an introduced European parasitoid, *Monoctonus crepidis* (Haliday) (recognized in Canada and parts of the USA, see Mackauer 1962a, Marsh 1979; also see discussion below). Interestingly, this aphid is not attacked by the common native *Nasonovia*-attacking parasitoid, *Aphidius kakimiaphidis.*

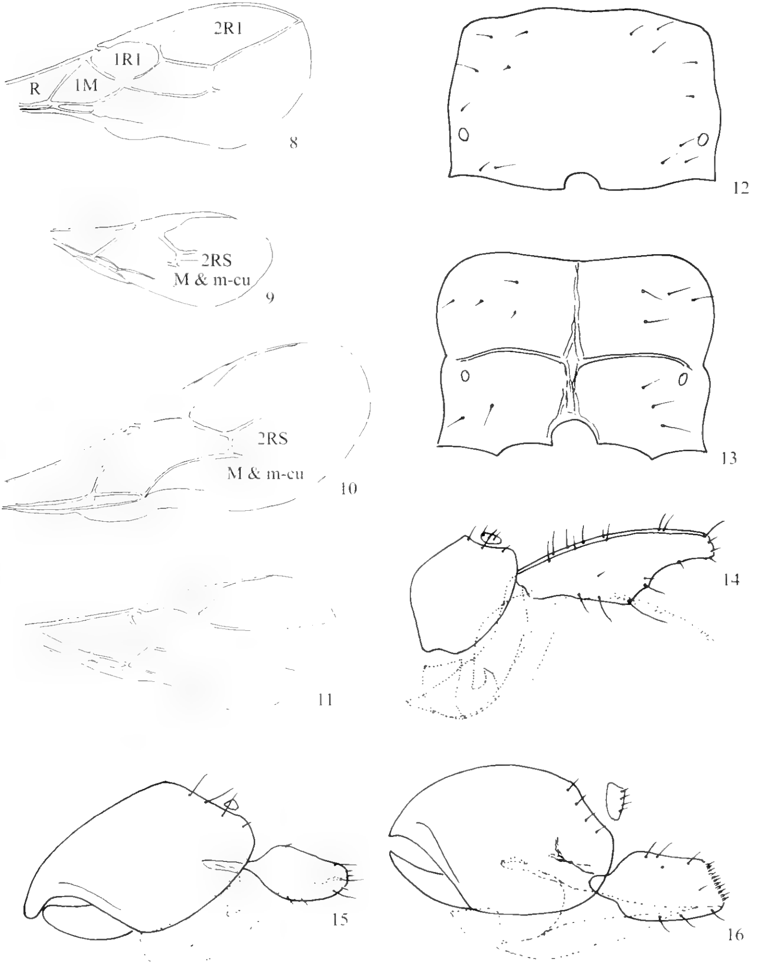
KEY TO THE PARASITOIDS OF *NASONOVIA* IN NORTHWESTERN UNITED STATES

1. Forewing with four enclosed cells along anterior margin (R, M1, 1R1, 2R1) (Fig. 8) . . . . *Ephedrus californicus* (Baker)
– Forewing with less than 4 enclosed cells along anterior margin 2
2(1). Forewing with vein r perpendicular or almost perpendicular to stigma (Figs. 1–2); ovipositor sheath arcuate, curved downward (Figs. 6, 14) (*Monoctonus*) 3
– Forewing with vein r not perpendicular to stigma; ovipositor sheath curved slightly upward (Figs. 15–16) 4
3(2). Ovipositor sheath plough-share shaped (Fig. 14). Antenna 14–15 segmented . . . . *Monoctonus crepidis* (Haliday)
– Ovipositor sheaths only gradually widened ventrally (Fig. 6). Antenna 15–16 segmented . . . . *Monoctonus allisoni* Pike and Starý, n. sp.
4(2). Forewing with vein 2RS absent (Fig. 11) (*Praon*) 5
– Forewing with vein 2RS present (Figs. 9, 10) 7
5(4). Flagellomere 1 dark. Mesosoma unicolorous, uniformly dark 6
– Flagellomere 1 testaceous. Mesosoma distinctly bicolorous, more or less lighter in lower part. Antenna 17–20 segmented . . . . *Praon humulaphidis* Ashmead
6(5). Antenna 17–18 segmented . . . . *Praon occidentale* Baker
– Antenna 14–16 segmented . . . . *Praon unicum* Smith
7(4). Forewing with vein M & m-cu incomplete (Fig. 9). Propodeum smooth (Fig. 12) . . . . *Lysiphlebus testaceipes* (Cresson)
– Forewing with vein M & m-cu complete (Fig. 10). Propodeum areolated (Fig. 13) (*Aphidius*) 8
8(7). Antenna 13–14 segmented . . . . *Aphidius kakimiaphidis* Smith
– Antenna 17–19 segmented . . . . *Aphidius polygonaphis* (Fitch)

DISCUSSION

Taxonomy of *Monoctonus allisoni.*—The combination of several key characters of *M. allisoni* position it between *Monoctonus* and *Harkeria* Cameron (*sensu* van Achterberg 1989). *Harkeria rufa* Cameron (specimens from Finland and from northwestern United States examined by P. Starý) have relatively distinct pentagonal areola on the propodeum, and a typical narrow petiole without prominent spiracular tubercles, whereas *Paramonoctonus* Starý (see Starý 1959) which was synonymized with *Harkeria* by van Achterberg (1989), lack the complete areola, i.e., have merely lower divergent carinae. This suggests a need for full re-evaluation and reclassification of *Monoctonus, Harkeria* and *Paramonoctonus* (possibly *Boreogalba* Mackauer, mentioned below)

In *Monoctonus allisoni,* the propodeum is distinctly areolated, in spite of some variation in size and sculpture (Figs. 3–4) due to less defined carinae among the rugae. *Monoctonus allisoni* has the maxillary palpi 4- and labial palpi 3-segmented (*M. crepidis* has the same characters), whereas 4- and 2 are defined for *Harkeria* and *Monoctonus* by van Achterberg (1989). The ovipositor sheath in *M. allisoni* is quite similar to *H. rufa,* opposite to the plough-share shaped characteristic of *M. crepidis* (Mackauer 1962a) and other species in northwestern United States (Pike et al. 2000). The forewing venation in *M. allisoni* is typical of *Monoctonus,* although some specimens have a strong reduction in vein pigmentation with merely the radial abscissa present (Fig. 2). A similar variation is known for *Harkeria* (= *Paramonoctonus*) *angustivalva* (Starý) in Europe (Starý 1959). The combination of characters for *M. allisoni* of wing venation (variation, reduction), areolated propodeum, and shape of the petiole and ovipositor sheaths, point to some likeness with the monotypic genus *Boreogalba* Mackauer (*B. gladifer* Mackauer, host unknown, see Mackauer 1962b, Mackauer and Starý 1967), but other characters differ widely, e.g., shape of the propodeum (*B. gladifer* squarish, *M. allison* anteriorly rounded) and number of antennal segments



Figs. 8–16. Various features of parasitoids attacking *Nasonovia* aphids (illustrations not to same scale). 8–11, Forewings. 8, *Ephedrus californicus*. 9, *Lysiphlebus testaceipes*. 10, *Aphidius polygonaphis*. 11, *Praon occidentale*. 12–13, Propodea. 12, *L. testaceipes*. 13, *A. polygonaphis*. 14–16, Genitalia. 14, *Monoctonus crepidis*. 15, *L. testaceipes*. 16, *A. polygonaphis*.

(*B. gladifer* 11 segments; *M. allisoni* 15–16 segments).

Monoctonus crepidis in North America.—*Monoctonus crepidis* (Haliday), a species broadly distributed in Europe, was detected on *Nasonovia ribisnigri* in Canada by Mackauer (1962a) (also reported by Marsh 1979). It was presumed introduced into North America from Europe via ship-transported plants with parasitized aphids. Evidence points to its establishment in North America in about 1953 in southeastern Québec. In 1977, Starý and Remaudiere (1977) further recognized its presence on *N. ribisnigri* in Québec and its outward spread in North America. Although not confirmed in northwestern United States, we expect it will become part of the *Nasonovia* parasitoid guild; thus, it is included in the preceding key.

Harkeria rufa and *Nasonovia houghtonensis.*—This association was presented by Pike et al. (2000), but, after careful checking of the original labeled material, it was determined *Macrosiphum osmaroniae* was the correct host, instead of *Nasonovia houghtonensis.* Thus, *Harkeria rufa* is not recognized here as part of the *Nasonovia*-parasitoid guild.

Nasonovia-parasitoid guilds in Europe and North America.—In Europe, the known *Nasonovia* species attacked by parasitoids are: *Nasonovia* (*Kakimia*) *brachycyclica* Holman, *N.* (*Kakimia*) *dasyphylli* Stroyan, *N.* (*Nasonovia*) *nigra* Hille Ris Lambers, *N.* (*Nasonovia*) *pilosellae* Boerner, *N.* (*Nasonovia*) *ribisnigri* (Mosley), *N.* (Kakimia) *saxifragae* Stroyan, and some unidentified species. The typical or common parasitoid guild for *Nasonovia* are *Aphidius hieraciorum* Starý, *Harkeria angustivalva* (Starý), *Monoctonus crepidis* (Haliday), and *Praon pubescens* Starý. These are almost all uniformly oligophagous on *Nasonovia* species. On rare occasion, the common guild is supplemented by *Aphidius ervi* Haliday, *A. picipes* (Nees), *Ephedrus cerasicola* Starý, *E. persicae* Froggatt, and *E. plagiator* (Nees). Also included in the guild is *Monoctonus hispanicus* Tizado, which apparently attacks only species in the subgenus *Kakimia.*

Certain aphid-plant combinations may play a part in the parasitoid guild composition for a given area. *Aphidius hieraciorum* and *Praon pubescens* parasitize *Nasonovia* on both its primary (*Ribes*) and secondary (*Hieracium*) hosts. In contrast, *Harkeria angustivalva* and *Monoctonus crepidis* (Mackauer 1962a) attack *Nasonovia* only on *Hieracium.* Populations of *Aphidius ervi, A. picipes,* and *Ephedrus plagiator,* usually uncommon on *Nasonovia,* may increase depending upon proximity and type of other suitable aphids immediately present or nearby.

In reviewing *Nasonovia* guilds in Europe and in North America, some basic phenomena are evident. (1) The European guild manifests more *Nasonovia*-specific oligophagous parasitoids than the North American guild, even though each continent has prevalently native aphid species. (2) The host range analysis of the aphidiid guilds manifests four groups (Starý 1981): a) species-specific parasitoids, which are rare (possibly *Monoctonus hispanicus*); b) oligophages specific to *Nasonovia* (examples: *Aphidius hieraciorum, A. kakimiaphidis, Harkeria angustivalva,* and *Praon pubescens*); c) oligophages specific to *Nasonovia* and closely related groups (examples: *Monoctonus crepidis* on *Nasonovia,* and *Hyperomyzus* [the latter genus is closely associated with *Nasonovia,* see Hille Ris Lambers 1949, Heie 1979, Foottit and Richards 1993]); and d) broadly oligophagous, or "sweeper" species.

Economic significance of *Nasonovia.*—A majority of the *Nasonovia* spp. (43 recognized, Remaudière and Remaudière 1997) reside in meadows and forest undergrowth from lowlands to high mountains, with some species adapted to urban parks and gardens where suitable hosts exist. Most of these are of little or no economic importance. Most are uncommon and the parasitoid associations are unknown. There are, however, four species, *Nasonovia brachy-*

cyclica Holman, *N. cynosbati* (Oestlund), *N. houghtonensis* (Troop), and *N. ribisnigri* (Mosley), which at times are pestiferous on *Ribes* spp. (gooseberries and currants). The latter species also is recognized to feed on lettuce and other herbaceous plants. The aphids feeding on *Ribes* commonly cause retardation and a curling and twisting of terminal growth and leaves (Blackman and Eastop 1984).

The distribution of the economic or potentially economic species is as follows: *N. brachycyclica,* Czech Republic (Holman 1972); *N. cynosbati* and *N. houghtonensis*: North America; and *N. ribisnigri,* Europe, east to Ukraine, and accidentally introduced in North America and South America (Blackman and Eastop 1984).

ACKNOWLEDGMENTS

This study was made possible in part with support from Washington State University, Grant A6007105 (Grant Agency of the Academy of Sciences, Czech Republic), and the Entomology Institute Project Z5007907 (Academy of Sciences of the Czech Republic).

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 388–396

REDESCRIPTION OF *BLASTOBASIS YUCCAECOLELLA* DIETZ 1910 (LEPIDOPTERA: GELECHIOIDEA: COLEOPHORIDAE: BLASTOBASINI), WITH OBSERVATIONS ON ITS BIOLOGY

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Abstract.—A redescription of the adult of *Blastobasis yuccaecolella* Dietz 1910 is given, and for the first time the larva and pupa are described. Observations on the biology of this species are discussed. Photographs of the habitat, host plant, and dried floral parts and seed pods infested by the larva are included.

Key Words: Blastobasinae, distribution, *Yucca*

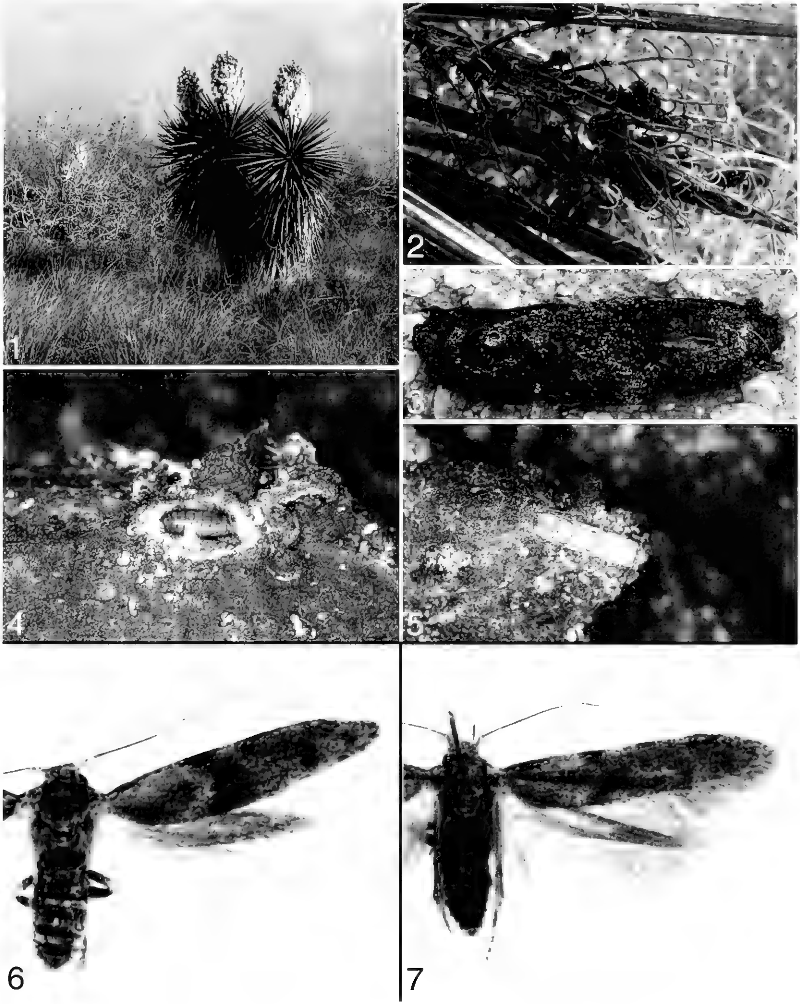
Three blastobasine moths, *Holcocera gigantella* (Chambers 1876), *H. paradoxa* Powell 1976 and *Blastobasis yuccaecolella* Dietz 1910 are known to feed on Yucca (Agavaceae) in southwestern United States and México. *Blastobasis yuccaecolella* is known from Texas and from Nuevo León, México. Adults of this species were first reared from the seed pods of *Yucca baccata* Torrey in Texas (Dietz 1910). *Holcocera gigantella* and *H. paradoxa* are known to be sympatric in at least part of their ranges, but it is unknown whether they co-occur with *Blastobasis yuccaecolella*.

Although the Blastobasinae (Coleophoridae) are treated by Powell (1980) and Powell et al. (1999) as scavengers, several species feed primarily on living plant tissue. Here we redescribe *B. yuccaecolella* and for the first time describe the larva and pupa. In addition, the host, habitat, larval habits, and distribution of *B. yuccaecolella* are discussed.

MATERIALS AND METHODS

Larvae of *Blastobasis yuccaecolella* ranging from second to final instar were collected from the seed pods of *Yucca treculeana* Carrière in February, March, and November between 1995–2000 from Laguna Atascosa National Wildlife Refuge, Cameron County (26°15′N, 7°21′W), and Santa Ana National Wildlife Refuge, Hidalgo County, Texas (26°02′N, 98°05′W). A single specimen was reared from *Yucca filifera* Chabaud (Agavaceae) in Baño de San Ignacio, near Linares, Nuevo León, México (24°52′N, 99°34′W). In addition, a series of specimens used by Dietz (1910) for his original description was examined at the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). All of these latter specimens are labelled as having been collected in 1897 from *Yucca baccata* in Texas.

For SEM study, larvae and pupae were cleaned in 10% alcohol with a camel's hair brush, and dehydrated in increasing concentrations of alcohol to absolute alcohol. After dehydration, specimens were critical point dried using a Tousimis critical point dryer, mounted on SEM stubs, and coated with gold-palladium (40/60%), using a Cressing-



Figs. 1–7. Habitat, host, pupa, and adult of *Blastobasis yuccaecolella*. 1, *Yucca treculeana* and habitat in Texas. 2, Dried fruits. 3, Dried seed pod. 4, Pupa. 5, Live adult. 6–7, Pinned specimens of reared adults.

ton sputter coater. The ultrastructure of the larva and pupa was studied with an Amray 1810 scanning electron microscope at an accelerating voltage of 10 kV.

Morphological observations and measurements of the larva, pupa, and adult, were made using dissecting (reflected light) and compound microscopes (transmitted light) with a calibrated micrometer. The Methuen Handbook of Colour (Kornerup and Wanscher 1978) was used as a color standard. Genitalia were dissected as described by Clarke (1941), except Mercurochrome and chlorazol black were used as staining agents. All pinned specimens of reared adults and lots of immature specimens were assigned voucher label and deposited in USNM.

RESULTS

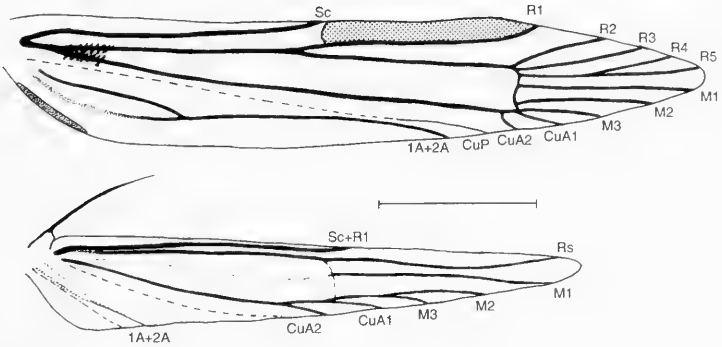
Blastobasis yuccaecolella Dietz 1910
(Figs. 1–23)

Adult.—*Head:* Scales of vertex and frontoclypeus brown tipped with pale brown, or brownish gray tipped with pale brown; outer surface of labial palpus dark brown or brown intermixed with pale brown scales to near apical area of segment II and basal and apical areas of segment III, inner surface pale brown intermixed with few brown and dark brown scales along ventral and subventral surfaces; scape of antenna with brown scales tipped with pale brown, flagellum pale brownish gray; flagellomeres wider, with longer cilia in male than in female; first flagellomere excised, forming a deep notch in male; proboscis pale brown. *Thorax:* Tegula with scales brownish gray tipped with pale gray, or pale brown basally near white distally, or pale brown basally brownish gray distally; mesonotum with scales brownish gray tipped with pale gray, or scales dark brownish gray tipped with pale gray basally, or brownish gray tipped with pale gray distally. Forewing (Figs. 6–7): Length 5.6–8.5 mm (n = 122): Brown scales tipped pale brown and white, intermixed with pale brown and dark brownish-gray scales; median fascia complete or incomplete; base with dark brownish-gray scales between costa and CuP present or absent; cell with three dark brownish-gray spots, 1 near middle and 2 near distal end; marginal spots distinct, faint, or absent; venation with M_3 and CuA_1 branched from distoposterior angle of cell; CuA_2 distal from CuA_1; undersurface brown. Hindwing: Translucent brownish gray; venation with cubitus 4-branched, each vein stalked in series and extending to posterior margin.

Male genitalia (Fig. 9): Uncus wider basally than long, gradually narrowed toward a rounded apex, sparsely setose dorsally, with 3 pairs of long lateral setae; gnathos a rounded ventral support for tuba analis, posterorventral margin medially produced into a small bidentate process; vinculum wide; juxta bandlike; ventral part of valva distally emarginate ventrally near abruptly rounded base; apically produced into a spinelike process with a flat inner margin; valva with dorsal part setose, elongate, digitate, widening basally and confluent with proximal flange; proximal flange elongate, apicoventral margin rounded, with dense stout setae to margin; microtrichiate membrane across posterior margin of tegumen and margins of proximal flange; tergal setae present; aedeagus nearly straight, slightly narrowed from base to apex; sclerite of aedeagus singly twisted from midlength; anellus conical, with several stout setae.

Female genitalia (Fig. 10): Ovipositor telescopic, with 4 membranous subdivisions; eighth sternum elongate, setose along posterior margin; eighth tergum with a narrow, elongate, darkly pigmented pattern along median longitudinal axis; ostium bursae slightly posterior to seventh sternum, surrounded by sparse microspinules on surrounding membrane; seventh sternum with perpendicular notch on posterolateral margin; inception of ductus seminalis slightly anterior to ostium bursae; ductus bursae long, membranous in about posterior ¾, with rows of internal, imbricate platelets within anterior ¼; corpus bursae slightly elongate, with lobe on posterior end and hornlike signum near midlength.

Larva (Figs. 11–20).—Length 6.1–10.5 mm [n = 39]. Body pale violet on dorsolateral surface, tonofibrillary platelets, areas between folds, and venter white; setae on small pinacula; prolegs with crochets on



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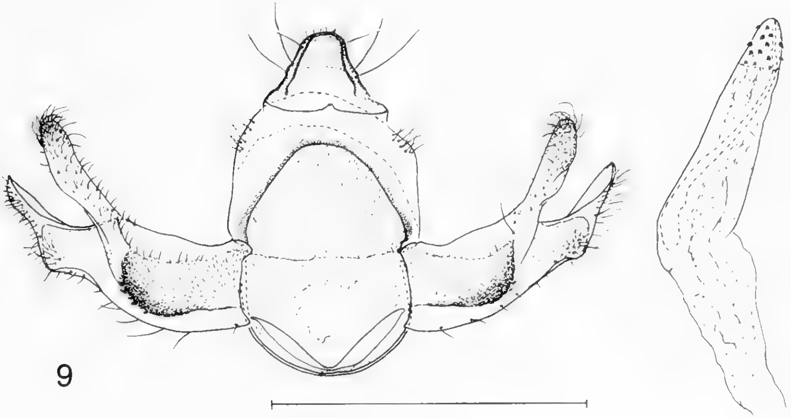

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Figs. 8–9. Wing venation and male genitalia of *Blastobasis yuccaecolella*. 8, Wing venation. Scale = 1.0 mm. 9, Male genitalia. Scale = 0.5 mm.

A3–A6 and A10. Head (Figs. 11–14, 19): Hypognathous; adfrontal sclerites slightly narrowed (Fig. 11), P1 about 4 times the length of P2, about even with apex of frons and slightly below F2; F2 above apex of frons, slightly longer than F1; C3 at least twice the length of F1; C2 in straight line with C3, and slightly above C1; A2 in straight line with and above A1, A1 and A3 at least twice length of A2; L1 laterad to A3, about ½ length of A3; SS3 at least twice the lengths of SS2 and SS1; SS1 slightly laterad of mandibular condyle, SS2 posterad to stemma-5; S2 about twice the length of S1 and S3; S3 lateroposterad to SS2, S2 lateroposterior to stemma-1, and S1 adjacent to stemma-3; labrum with 12 setae, 2 pair of subequal median setae in same horizontal plane and perpendicular with median longitudinal axis, 2 pair of

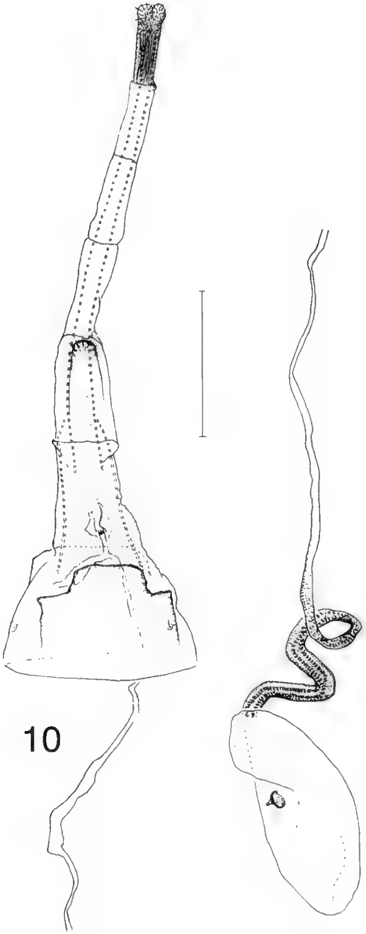

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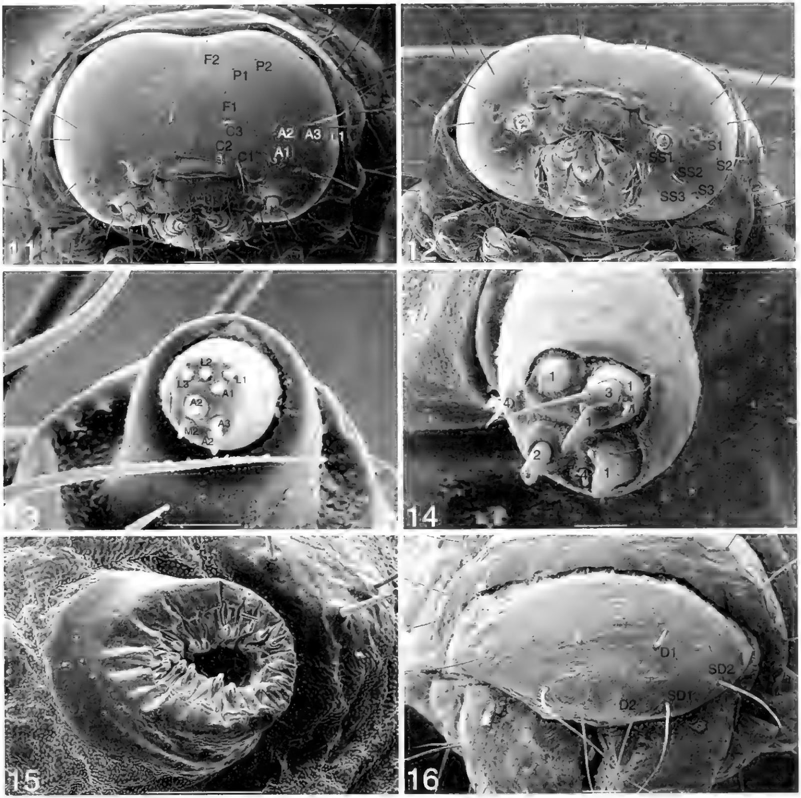
Fig. 10. Female genitalia of *Blastobasis yuccaecolella*. Scale = 1.0 mm.

equal marginal setae ventrolaterad to median setae, and 2 pair of subequal lateral setae along margin; mandible with two distinct dentitions and 2 subequal setae on ventral surface (Fig. 19); apical sensilla on maxillary palpus (Fig. 13) similar to that of *Blastobasis graminea* (Adamski 1999); antennal sensilla (Fig. 14) with 2 more sensilla basiconica and 1 more sensillum trichodeum than *B. graminea* (Adamski 1999); submental pit oblong. Prothorax (Fig. 17): Shield with SD1 slightly longer than XD1 and XD2; D2 about as long as SD1, about equidistant to XD2 and XD1, and in straight line with D1; SD2 as long as or slightly longer than D1, about equidistant to SD1 and XD2, and anterirad to D2 and D1; L-group on pinaculum ventroanterirad to spiracle; L1 about twice the length of L2 and L3; SV1 slightly longer than SV2; V1's close, about ¼–⅕ distance as V1's on T2–T3. Mesothorax and metathorax (Fig. 17): D2 about 2½ times the length of D1; D2 and D1 on same pinaculum; D2 slightly anterirad and more than twice the length of D1; SD1 and SD2 on same pinaculum; SD1 slightly anterirad to SD2 and more than twice the length of SD2; L1 and L2 on same pinaculum, ventroanterior to pinaculum bearing SD1 and SD2; L1 at least twice the lengths of L2 and L3; L3 dorsoposterior of pinaculum bearing L1 and L2; SV1 about as long as L1, in straight line with L3. Abdomen (Figs. 15–16, 18, 20): A1–A2 (Fig. 18) with D2 at least 2½ times length of D1, SD1 above spiracle; SD2 microscopic, on same pinaculum as SD1 (not shown); L2 and L1 on same pinaculum, beneath and slightly posteriad spiracle; L2 about 2½ times length of L1; L3 posteroventrad of pinaculum bearing L1–L2, and in line with D2; SV-group trisetose, SV1 about 2½ times length of SV2 and SV3; crochets (Fig. 15) uniordinal, in circle, reduced or absent laterally; A8 (Fig. 20) with SV1 in line with L3; A9 (Fig. 20) with pinaculum bearing D1–D2 orientated about 45–90° from pinaculum bearing L1–L2; SD1 closer to dorsal pinaculum than to lateral pinaculum; L3 proximal to SV-group setae; SV1 and SV2 on separate pinacula, SV2 posteroventrad to SV1; V-group setae slightly farther apart on A10 than on A8–A9; A10 (Figs. 16, 20):

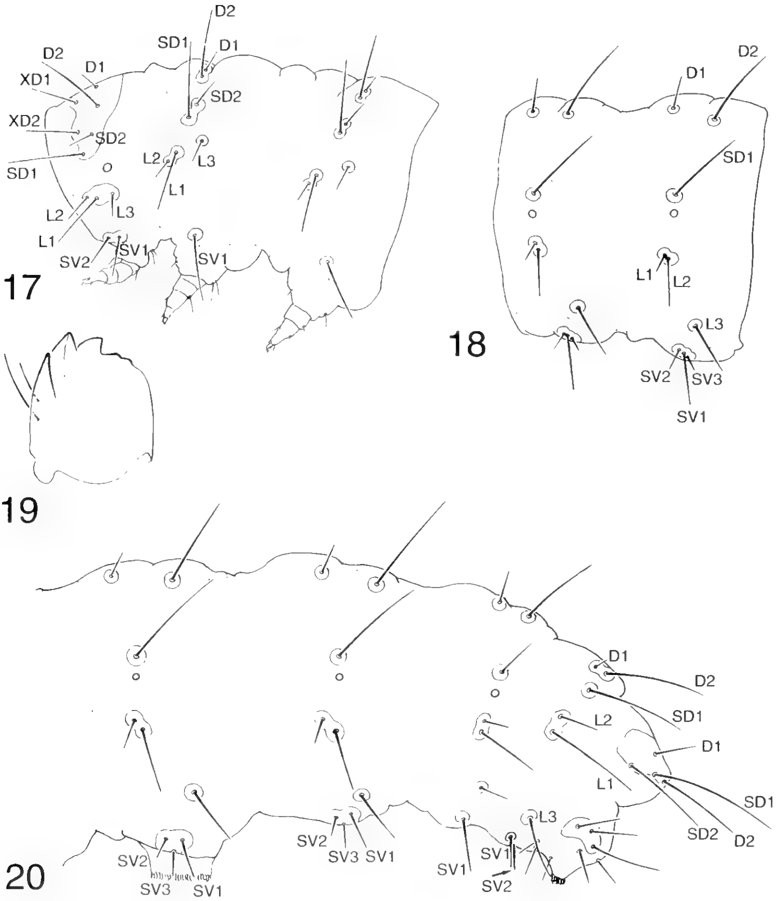


Figs. 11–16. Scanning electron micrographs of larva of *Blastobasis yuccaecolella*. 11–12, Head capsule. Scale = 100 μ. 13, Sensilla on apex of maxillary palpus. Scale = 10 μ. A2 = sensillum styloconicum; A1, A3, M1, M2, L1, L2, and L3 = sensilla basiconica. 14, Sensilla on apical portion of antenna. Scale = 10 μ. 1 = sensilla basiconica, 2 = sensilla chaetica, 3 = sensillum styloconicum, 4 = sensilla trichodeum. 15, Proleg. Scale = 100 μ. 16, Anal plate. Scale = 100 μ.

anal plate with SD2 and D2 equal in length, SD1 longest, D1 the shortest.

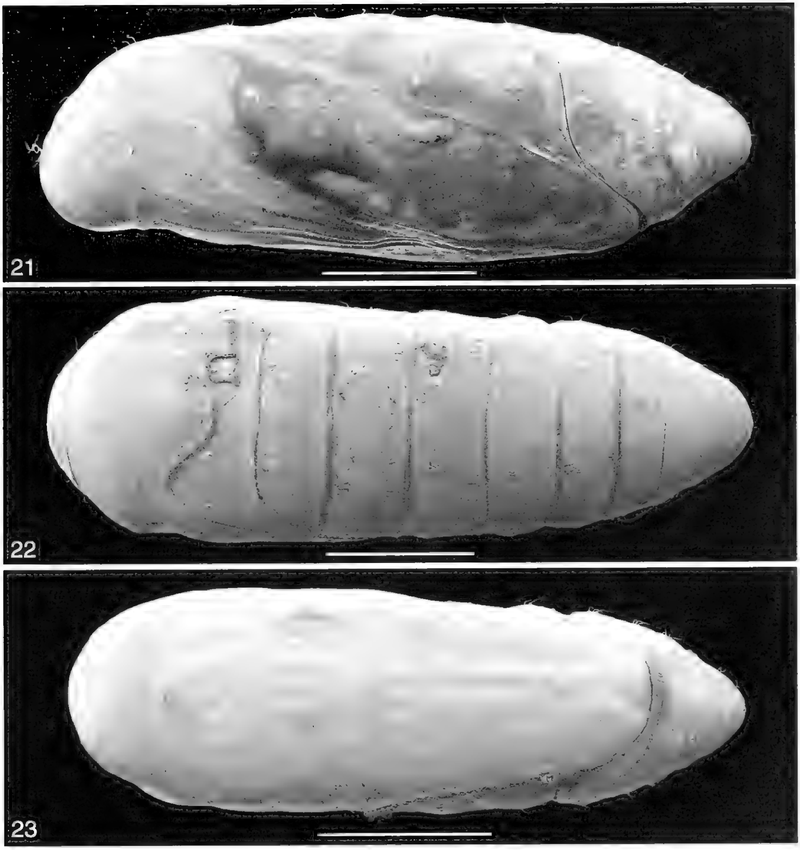
Pupa (Figs. 21–23).—Ovate, brownish yellow to yellowish brown; length 4.0–4.8 mm (n = 20); mostly smooth with shallow wrinkles throughout; frontoclypeal suture present; epicranial suture distinct; caudal part of antennae converging, separating at distal end exposing metathoracic legs; maxillary palpus present; labial palpus absent; prothoracic leg exposed laterad to maxillary palpus.

Biology.—The larvae of *Blastobasis yuccaecolella* feed on dried remains of flowers (Fig. 2) and dried seed pods (Fig. 3) that accumulate in the leaf rosette. Old fruits occasionally remain on the infructescence for one or a few years, or become wedged in the narrow groove of rigid Yucca leaves created by their upwardly curved edges.



Figs. 17–20. Mandible and setae maps of larva of *Blastobasis yuccaecolella*. 17, Mandible. 18, Prothorax, meso- and metathorax. 19, Abdominal segments 1–2. 20, Abdominal segments 7–10.

Larvae are found concealed underneath and inside old fruits, where they feed on the dried fleshy portions of the fruit and to a lesser extent on seeds. The feeding results in diagnostic frass beneath the fruits. Larvae also forage freely in larger aggregates of old flowers and fruits that may increase up for years and form strongly decomposed humuslike material. Pupation takes place in a thin cocoon lined externally with frass (Fig. 4), typically located beneath old fruits or other plant parts. Adults are known to emerge between December and March or later. Most emergences take place late in the afternoon. The emerging adults are cryptic on the plant matter (Fig. 5), and tend to hide



Figs. 21–23. Pupa of *Blastobasis yuccaecolella*. 21, Lateral view. 22, Dorsal view. 23, Ventral view. Scale 1 mm.

rather than to fly when disturbed. Adults have been observed at night in flowers.

DISCUSSION

Yucca baccata is a readily identified species, primarily distributed from New Mexico to easternmost California (Reveal 1977). The easternmost published record of Yucca baccata is from Crockett County, Texas, southwest of Big Lake (Webber 1953), and all other reports refer to sites west of Marathon (McKelvey 1938). The species has been observed farther east than these records 43 km W of Eldorado in westernmost Schleicher County, Texas, in the transition zone from Chihuahuan desert to the Edwards Plateau ecoregion (Pellmyr, unpublished observation). Thus, it is likely that the population of *Blastobasis yuccaecolella* from which this species was first collected and described originated from a site within the Chihuahuan desert, in the westernmost quarter of Texas. Elevation ranges from sea level for the easternmost records, 250 m for the Mexican site, and 750 m or more for *Yucca baccata* sites in western Texas.

The characteristic habitats of *Yucca treculeana* in eastern Texas (Fig. 1) and Nuevo Leon are Tamaulipan grasslands, often interspersed by dense thornscrub (Pellmyr 1999). *Yucca baccata* occurs in several communities in westernmost Texas; so, the habitat of *Blastobasis yuccaecolella* in that area cannot be determined from available locality data.

Powell and Mackie (1966) and Powell (1984) reared *Holcocera gigantella* and *H. paradoxa* from both green and dried seed pods of *Yucca whipplei* (Torrey) Trelease. In addition, *H. gigantella* was reared by Coquillett and Riley from seed pods of *Y. brevifolia* Engelmann, and Powell reared the moth from flowers of *Agave orcuttiana* Trelease (Agavaceae) (Powell 1984). *Blastobasis yuccaecolella* has not yet been reared from green seed pods of either *Yucca baccata* or *Y. treculeana.*

In general, it appears that *Blastobasis yuccaecolella* and the above mentioned holcocerine moth species that utilize *Yucca* for their larval host feed within dried seed pods, and to a lesser extent, on the stems and floral parts of the plant. The number of generations per year, timing of oviposition, and ovipositional sites are not known for *B. yuccaecolella.*

ACKNOWLEDGMENTS

We thank Scott D. Whittaker, Director, Scanning Electron Microscopy Laboratory, Smithsonian Institution, Washington, DC, for his assistance with ultrastructural studies; John S. Steiner and James F. Di Loreto, Office of Imaging, and Photographic Services, Smithsonian Institution, for the photographs of the imagos and production of digital plates; and Kuniko Arakawa for the illustrations of the setal maps of the larva. Field work for this study was funded to Olle Pellmyr by the National Science Foundation and the National Geographic Society.

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PROC. ENTOMOL. SOC. WASH.
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LUGOIOPS MAYA, A NEW GENUS AND SPECIES OF EPHEMEROPTERA (BAETIDAE) FROM CENTRAL AMERICA

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Abstract.—Small minnow mayfly (Ephemeroptera: Baetidae) larvae taken from a mountain rivulet in Baja Verapaz, Guatemala are described as ***Lugoiops maya*, new genus and new species.** The new genus is a member of the *Baetodes* complex of genera, being more advanced than *Moribaetis* or *Mayobaetis*, and sharing numerous synapomorphies with both *Prebaetodes* and *Baetodes*, and additional synapomorphies with *Baetodes*. The precise cladistic relationships deduced for the new genus are discussed and a new key to genera of the *Baetodes* complex is provided. Larvae of *L. maya* are striking because of their relatively large size, unique structural characteristics, such as absence of gills 1, and their torrential habitat.

Key Words: *Lugoiops*, new genus, new species, Baetidae, Guatemala

With the recent discovery of the genus *Prebaetodes* Lugo-Ortiz and McCafferty in Colombia and Ecuador (Lugo-Ortiz and McCafferty 1996), an essential phylogenetic link was found that demonstrated the relationship of the highly apotypic Western Hemisphere genus *Baetodes* Needham and Murphy with more typical baetines, vis-à-vis the Western Hemisphere genera *Moribaetis* Waltz and McCafferty and *Mayobaetis* Waltz and McCafferty. As a result, the phylogenetic origin of what had been an anomalous genus was hypothesized for the first time, and a distinctive monophyletic group of genera, the *Baetodes* complex, was delineated in the Western Hemisphere. McCafferty (1998) applied the cladistic relationships within the *Baetodes* complex to biogeographic analysis to show that the origin of the Pan-American genus *Baetodes* was clearly Neotropical, as was that of other members of the complex. The biogeography of this complex was further elucidated by McCafferty (1999).

Recently, larvae of relatively large and unusual small minnow mayflies collected from a mountain rivulet in Guatemala in July of 2001 were sent to WPM independently by W. D. Shepard (Sacramento, California) and DEB for examination. These larvae proved to be an unknown member of the *Baetodes* complex of Baetidae, sharing for example, the apicolateral setal row found on the denticulate claws throughout the complex, a thickened labrum also common throughout much of the complex, and absence of the villopore and other characteristics associated with other complexes of Baetidae. Study of the character state distribution and cladistic relationships within the *Baetodes* complex revealed that the species should not be subsumed by any other genus in the complex and that a new genus was justified within the context of a strictly phylogenetic classification (see below). At the same time, the newly discovered lineage provided additional cladistic characterization that further demonstrated the morphological transition from the more stereotypic minnowlike baetid larval form to the highly apotypic and unusual *Baetodes* form. Moreover, its phenetic distinctiveness makes recognition at the generic level practical. Below, we describe the new genus and species, and provide associated cladistic, diagnostic, and habitat data.

We are honored to name the genus after Carlos Lugo-Ortiz (Cidra, Puerto Rico), who in recent years has contributed the primary thrust in the discovery and elaboration of the biodiversity of the family Baetidae in the Neotropics as well as the Southern Hemisphere in general, but especially Africa and Madagascar. The work of Dr. Lugo-Ortiz has provided the basis for further research on the Baetidae by establishing standards of description and analysis, diligently seeking to bring the taxonomy of Baetidae in line with modern systematics that recognizes taxa as discreet inter-related phylogenetic lineages. The gender of the genus is masculine.

Lugoiops McCafferty and Baumgardner, new genus

(Figs. 1–11)

Larva.—*Head*: Orientation (Figs. 1–2) extremely hypognathous. Antenna (Figs. 1–2) approximately one and one-half times length of head capsule length; scape and pedicel subcylindrical in cross-section, with tufted row of fine, simple setae dorsolaterally. Lateral margins of frons broadly connecting to clypeus (Fig. 2). Labrum (Figs. 2–3) basally somewhat constricted, with lateral margins rounded, relatively short, not expanded to nearly round overall shape; dorsal surface with slightly bulbous prominence basomedially and two such laterally. Mandible (Figs. 4–5) not continuously convex laterally; denticles not fan shaped. Labial palp (Fig. 8) three-segmented, with segment 1 and 2 subequal in length and with short, somewhat dome-shaped segment 3. *Thorax*: Legs (Figs. 1, 9) elongate, outspread from body; tibiae slightly twisted. Hindwingpad very small. *Abdomen*: terga lacking tubercles or patches of setae. Gills present on segments 2–7 (Fig. 1), dorsolaterally oriented but overlapping abdominal pleura. Paraprocts (Fig. 11) without marginal denticulation. Median caudal filament reduced to unsegmented conical vestige (Fig. 1). Cercus (Fig. 1) bare, lacking medial setae and lateral spination.

Type species.—*Lugoiops maya*, n. sp.

Discussion.—*Lugoiops* larvae are distinctive in many ways, but especially because of their large size along with their elongate, outspread legs, the vestigial median caudal filament, and the absence of gills 1. Edmunds et al. (1976) gave the body length dimensions of *Baetodes* larvae as 3.0 to 8.0 mm. This size range is also applicable to known *Prebaetodes* (Lugo-Ortiz and McCafferty 1996). *Moribaetis* and *Mayobaetis* larvae, which have generally been considered to be rather large baetids have lengths of up to about 10.0 mm. Known *Lugoiops* larvae by these standards, however, are even larger, being around 12.0–13.0 mm when mature. A modified key to the larval stage of genera of the *Baetodes* complex that includes *Lugoiops* and additional comparative characterization within the complex is included below.

With application of the cladistic analysis of Lugo-Ortiz and McCafferty (1996) and character state polarity and distribution presented by them, along with new character assessment and re-analysis herein, we have been able to place *Lugoiops* within the hypothesized cladogram. Demonstrative of its placement in the *Baetodes* complex, *Lugoiops* shares a primary synapomorphy defining that complex, i.e., the possession of apicolateral setation on the denticulate claws. *Lugoiops* also possesses a basomedial prominence dorsally on the labrum, which Lugo-Ortiz and McCafferty (1996) had originally indicated was an apomorphy

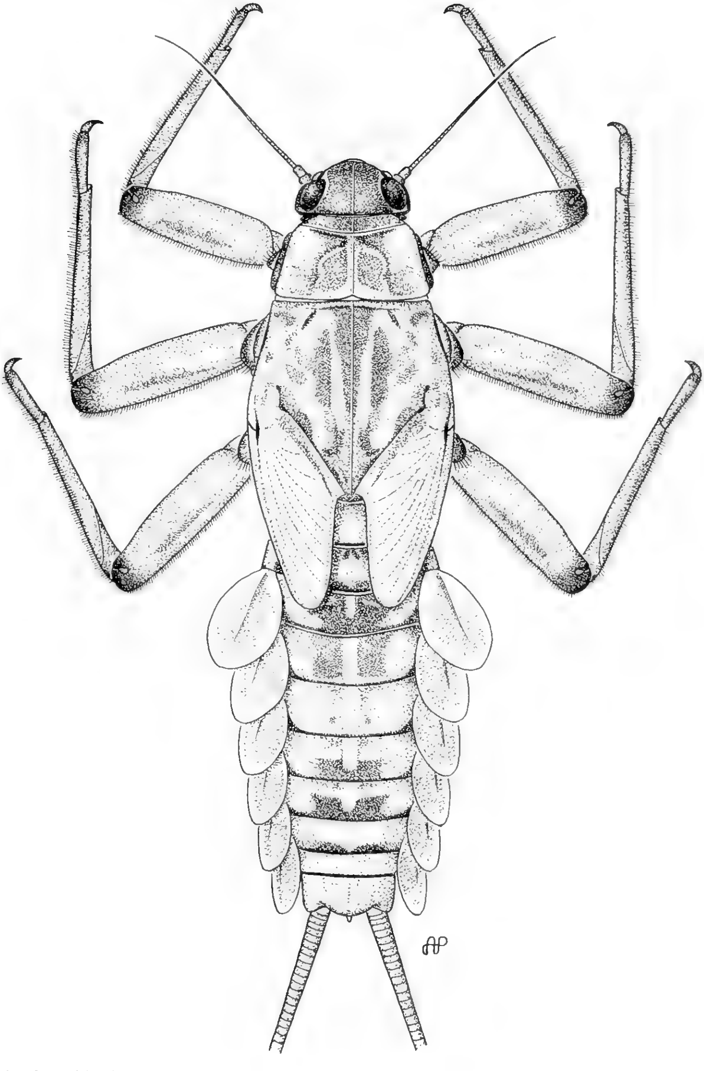


Fig. 1. Larval habitus of *Lugoiops maya*.

found only in *Moribaetis*. However, we have found such a labrum not only in *Lugoiops*, but also to a lesser extent in *Mayobaetis* and also in *Baetodes*, where it can be highly developed in some species, e.g., *B. inermis* Cohen and Allen. Therefore, that characteristic should no longer be considered a restricted autapomorphy within the *Baetodes* complex, but likely may very well have been present ancestrally in the complex and as such an apomorphy that further helps define this monophyletic grouping of genera.

Within the *Baetodes* complex, *Lugoiops* shares all of the synapomorphies defining the clade made up of *Mayobaetis*, *Prebaetodes*, and *Baetodes*, i.e., the lack of marginal denticulation on the paraprocts, the dorsolateral setation at the base of the antennae, and reduced median caudal filament. *Lugoiops* does not share the single apomorphy, involving the unique attenuated frons, that is associated with the relatively plesiotypic genus *Moribaetis* within the complex.

Lugoiops does not possess any of the autapomorphies that are identified with the individual *Mayobaetis* lineage, i.e., lateral spination on the cerci and dorsoventrally flattened antennal scapes and pedicels. On the other hand, it does share synapomorphies previously shown to be common to *Prebaetodes* and *Baetodes*, including an even shorter median caudal filament, elongate legs, and the slightly twisted tibiae.

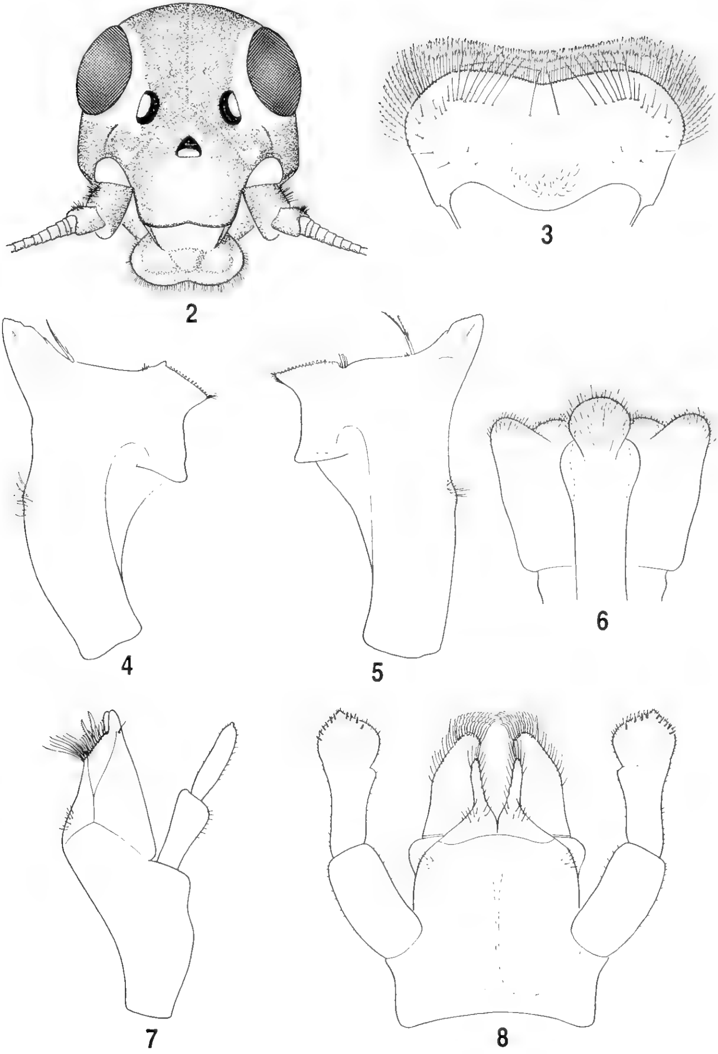
Lugoiops does not share any of the apomorphies that Lugo-Ortiz and McCafferty (1996) used to distinguish the individual *Prebaetodes* lineage, having neither the laterally convex mandibles nor expanded and nearly round labrum that are autapomorphic in *Prebaetodes*. Also, based on the cladistic analysis of Lugo-Ortiz and McCafferty (1996), except for an even shorter median caudal filament, *Lugoiops* does not share apomorphies that distinguish the individual *Baetodes* lineage, i.e., the apomorphic abdominal gill arrangement (1–5) or the dorsal abdominal armature.

A strong indication of the sister relationship of *Lugoiops* within this apotypic *Lugoiops-Prebaetodes-Baetodes* clade, however, is demonstrated by at least one compelling character state that we are able to add to the analysis, that is the complete loss of medial setae (swimming hairs) on the cerci of both *Lugoiops* and *Baetodes*.

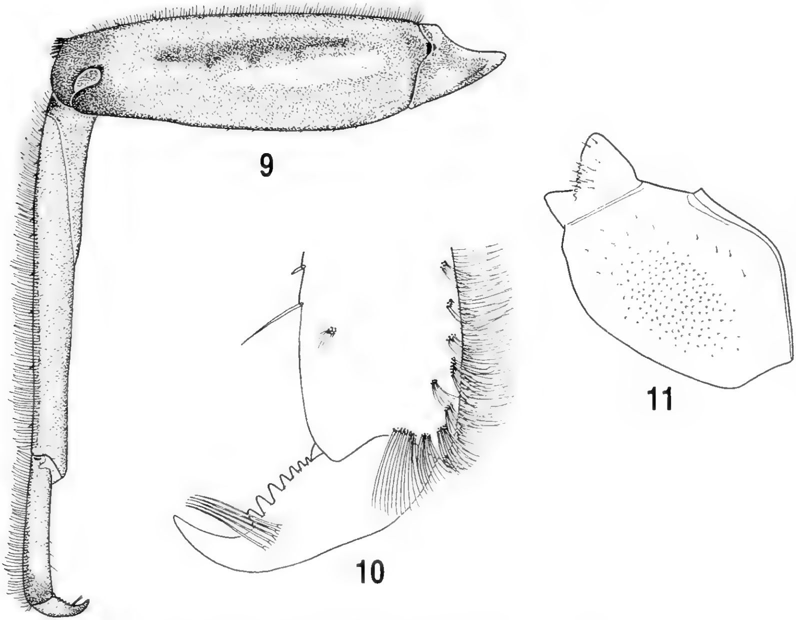
The loss of gills 1 in *Lugoiops* is an autapomorphy within the complex. Another characteristic possibly unique to the *Lugoiops* lineage includes the reduction of the median caudal filament to a minute, unsegmented, conical vestige. However, we cannot be absolutely sure such a middle tail vestige is unique to *Lugoiops*, because although considerable material of *Baetodes* that we have studied consistently have quite short (always less than one-fifth the cercus length) but segmented middle tails, Edmunds et al. (1976) stated that the middle tails of *Baetodes* were reduced to stubs, and thus that might indicate that they had seen specimens with unsegmented vestiges as we have observed in *Lugoiops*.

Regardless of the fine degree of reduction of the median caudal filament, *Prebaetodes* and *Baetodes* could also be considered two-tailed in the vernacular along with *Lugoiops*. Certain two-tailed, rheophilic baetid larvae throughout the world also have developed tergal tubercles or setal patches (e.g., Lugo-Ortiz and McCafferty 1999, Lugo-Ortiz et al. 2001, Jacobus and McCafferty 2001). Although this is also the case in *Baetodes*, there is no indication of such development in *Prebaetodes* or *Lugoiops*.

In *Moribaetis*, *Mayobaetis*, and *Prebaetodes*, the gills are held outspread from the abdomen, or if appressed are oriented dorsal of the abdominal pleura. In *Lugoiops* and many *Baetodes* (e.g., see abdominal illustrations in Cohen and Allen [1978]), the gills are held appressed to the abdomen more or less over the pleura. Also in *Baetodes*, the gills are often held out from the abdomen ventral of the abdominal pleura, thus leading to the standard descriptor of



Figs. 2–8. *Lugoiops maya*, larva. 2, Head (frontal). 3, Labrum (dorsal). 4, Angulate mandible. 5, Planate mandible. 6, Hypopharynx. 7, Maxilla. 8, Labium.



Figs. 9–11. *Lugoiops maya*, larva. 9, Foreleg (anterior face). 10, Claw. 11, Paraproct.

Baetodes larvae as having ventral gills. From these observations, it appears that laterally appressed gills, especially as seen in the more posterior gills of *Lugoiops*, may have been the condition in the most immediate common ancestor to the *Lugoiops*-*Baetodes* clade. This orientation developed into an extreme ventral orientation within *Baetodes*.

Hindwings are not present in *Baetodes* alates; however, hindwingpads can be either vestigial or entirely lacking in the larvae of *Baetodes*, which indeed are also intergenerically variable with respect to the degree of labral thickening and degree of ventral orientation of the gills, as mentioned above. The hindwingpad variable conditions are not without precedence among other baetids, even within the same species, as is illustrated by the North American *Acentrella turbida* (McDunnough), where in some larvae there are vestigial hindwingpads and in others there are none (see McCafferty et al. 1994). It is not all together clear from the very small size of the hindwingpads whether the alates of *Lugoiops* will lack hindwings or have only minute hindwings. In either case, this is an unusual instance among Ephemeroptera, where a large mayfly would have this amount of reduction in hindwings, because such reduction has usually been regarded to be associated with body size reductionism in general (McCafferty and Waltz 1990). Another atypical example of such hindwing reduction in a large alate mayfly is represented by the very small hindwings found in the large *Dipteromimus* McLachlan mayflies (Pisciforma: Dipteromimidae) in Japan. If the hindwings are indeed present in the alates

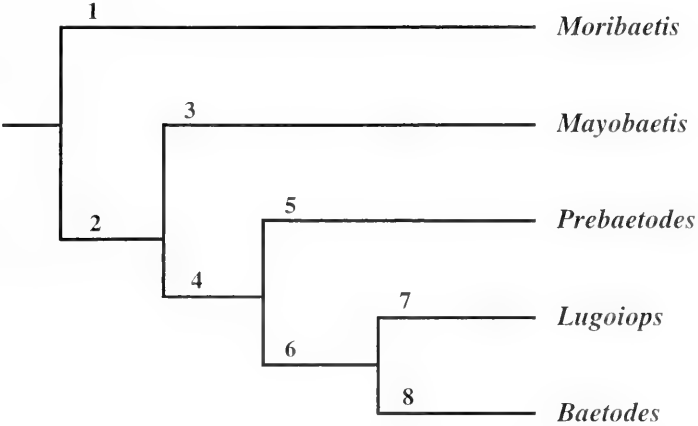


Fig. 12. Derived cladogram of the *Baetodes* complex. Evidential apomorphies (see text also): 1—frons attenuate; 2—loss of paraproct marginal denticulation, basal antennal setation developed, some shortening of middle tail; 3—lateral cerci spines present, scape and pedicel depressed; 4—additional shortening of middle tail, reduction of middle tail setation, elongation of legs, slight twist of tibiae; 5—laterally convex mandibles, expanded labrum; 6—cerci bare, middle tail more shortened, gill not outspread or held dorsal to abdominal pleura; 7—gills 1 lost, middle tail unsegmented; 8—gills 6 and 7 lost, gills can be held ventral of abdominal pleura, armature present on middle abdominal terga.

of *Lugoiops*, then the complete loss of the alate hindwings in *Prebaetodes* and *Baetodes*, could be seen as a convergence related to size reduction in those two lineages, because other members of the complex are all relatively good sized baetids. Such hindwing loss is subject to homoplasy throughout many baetid clades.

Lugo-Ortiz and McCafferty (1996) noted only antennal pedicel setation in the cladistic character state distributions among the *Baetodes* complex, and, as indicated above, its commonality in *Mayobaetis*, *Prebaetodes*, and *Baetodes* (to which can now can be added *Lugoiops*). In actuality, *Prebaetodes* and *Baetodes* have antennal base setation essentially confined to the pedicel, whereas *Mayobaetis* and *Lugoiops* have such setation also well developed on the scape. Possible explanations of this, given the preponderance of cladistic evidence stated here, is that the common ancestor of the *Mayobaetis-Prebaetodes-Lugoiops-Baetodes* clade possessed setation on both the pedicel and scape and it became independently reduced on the scapes of *Prebaetodes* and *Baetodes*, or alternatively, that it developed independently on the scapes of *Mayobaetis* and *Lugoiops*. Because there is no knowledge of any function related to the various arrangements, we are left with no clue as to which alternative may be more probable. It is certainly possible that further review of the speciose genus *Baetodes* may reveal some variation of these two arrangements within that genus also.

From the above review and analysis of cladistics, *Lugoiops* falls as a sister genus of *Baetodes*, which together are opposite *Prebaetodes* within this advanced clade of the *Baetodes* complex. Our entire hypothesized cladogram can be seen in Fig. 12. Sequencing conventions allow each of the sequenced lineages as described above to be recognized at the same taxonomic level—in this case the genus level.

KEY TO THE LARVAE OF GENERA OF THE WESTERN HEMISPHERE *BAETODES* COMPLEX

1. Tarsal claws with 1–5 or more setae on apicolateral aspect of denticulate claws (Fig. 10; figs. 9, 15, 32, 39 [Lugo-Ortiz and McCafferty 1996]); villopore absent; labrum often raised over dorsal surface into three broad mounds or at least thickened basomedially (Fig. 2; figs. 2, 5 [Lugo-Ortiz and McCafferty 1996]) . . . . *Baetodes* complex, 2
– Tarsal claws without setae as above; villopore present or absent; labrum not thickened as above . . . . . other Western Hemisphere Baetidae
2. Median caudal filament over one-half length of cerci (fig. 10 [Lugo-Ortiz and McCafferty 1996]); antennal pedicels lacking rows of tufts of setae in dorsal or lateral aspect (fig. 7 [Lugo-Ortiz and McCafferty 1996]; figs. 2–5 [Waltz and McCafferty 1985]); hindwingpads relatively well developed . . . . *Moribaetis*
– Median caudal filament less than one-half length of cerci (Fig. 1; figs. 16, 37, 41 [Lugo-Ortiz and McCafferty 1996]); antennal pedicels with row or tuft of setae dorsolaterally (Fig. 2; figs. 12, 25, 38 [Lugo-Ortiz and McCafferty 1996]); hindwingpads variable or absent. . . . 3
3. Gills present on abdominal segments 1–5 (figs. 9–24 [Cohen and Allen 1978]; fig. 40 [Lugo-Ortiz and McCafferty 1996]), ventral or appressed laterally; middle abdominal terga with tubercles or setal patches . . . . *Baetodes*
– Gills present on abdominal segments 1–7 or 2–7 (Fig. 1; fig. 12 [Waltz and McCafferty 1985]; fig. 33 [Lugo-Ortiz and McCafferty 1996]), outspread, dorsal, dorsolaterally or laterally appressed; abdominal terga without tubercles or setal patches 4
4. Cerci without medial setae (Fig. 1); gills present on abdominal segments 2–7 (Fig. 1); median caudal filament reduced to unsegmented vestige (Fig. 1) . . . . *Lugoiops*
– Cerci with medial setae (figs. 16, 37 [Lugo-Ortiz and McCafferty 1996]); gills present on abdominal segments 1–7 (gills 1 may be very small) (fig. 12 [Waltz and McCafferty 1985]; fig. 33 [Lugo-Ortiz and McCafferty 1996]); median caudal filament multisegmented short tail (figs. 16, 37 [Lugo-Ortiz and McCafferty 1996]) 5
5. Legs slender-elongate (fig. 31 [Lugo-Ortiz and McCafferty 1996]); hindwingpads vestigial; labrum large and near round (fig. 25 [Lugo-Ortiz and McCafferty 1996]); median caudal filament with lateral setae reduced (fig. 37 [Lugo-Ortiz and McCafferty 1996]) . . . . . *Prebaetodes*
– Legs robust (fig. 14 [Lugo-Ortiz and McCafferty 1996]); hindwingpads relatively well developed; labrum shorter, somewhat quadrate (fig. 12 [Lugo-Ortiz and McCafferty 1996]); median caudal filament with lateral setae developed (fig. 16 [Lugo-Ortiz and McCafferty 1996]) . . . . *Mayobaetis*

***Lugoiops maya* McCafferty and Baumgardner, new species**

(Figs. 1–11)

Larva.—Mature body (Fig. 1) length 12.0 mm; cercus length 14.5 mm; antenna length 3.0 mm. *Head*: Color brown; frons (Fig. 2) with somewhat diffuse white spot centrally; white areas also between each compound eye and lateral ocellus; lateral branches of frontal suture below but not contacting lateral ocelli. Antennal scape and pedicel (Fig. 2) brown, with white membranous sub-base exposed. Short labrum (Figs. 2–3) slightly emarginate, with thick brush of short marginal setae extending more sparsely along rounded lateral margins. Mandibles shaped as in Figs. 4 and 5, with denticles extremely fused; angulate mandible (Fig. 4) with mola nearly perpendicular to long axis of body of mandible, and with prostheca with only slight branching; prostheca of planate mandible (Fig. 5) long, double and with branching setules in distal two-thirds. Hypopharynx (Fig. 6) setate distally, with lingua narrowly rounded distally, and with superlinguae overlapping bilobular distally. Maxillary palp (Fig. 7) two-segmented, short, extending about as far as nearly conical galealacinae. Labium (Fig. 8) with glossa reduced; paraglossa well developed, with strong apical tuft of brushing setae; labial palp with segment 2 with minute medioapical thumb, and segment 3 with short marginal setae and sparse, small submarginal spines. *Thorax*: Nota (Fig. 1) brown with lighter brown striations and patches; pleura brown with extensive white inter-sclerite areas; sterna white. Legs (Figs. 1, 9) light brown with some markings anteriorly and cream concolorous posteriorly; anterior face of femora (Fig. 9) with whitish swordlike mark extending medially from base to somewhat over one-half length of femora, and with darker diffuse elongate marking (near dorsal edge and dorsad of swordlike mark) extending in middle two-thirds of length of femora; ventral tip of femora overlapping strongly recurved dorsal tip (Fig. 9); thick row of medium sized setae extending along dorsal edge of femora and extending along edge of tibiae and tarsi (Fig. 9); tarsi also with scattered short, stout setae and longer subapical bristle on surface opposite inward bend of tarsal claws, and with tufts of fine, hairlike setae apically and along on outer face (Fig. 10). Tarsal claws (Fig. 10) with five to eight denticles, most developed apically, and with five lateroapical, blond setae at base of curved claw tip. *Abdomen*: Abdominal terga light brown with dark brown markings as in Fig. 1, only terga 9 and 10 concolorous medium brown (lighter in younger larvae); terga 3 most darkly marked and tergum 5 least darkly marked. Sterna cream to yellow-brown, without distinctive markings. Paraproct (Fig. 11) with irregular submarginal denticulation.

Material examined.—Holotype: Mature larva, Guatemala, Baja Verapaz, unnamed stream, 0.3 km south of La Cumbre, 1,274 m elevation, 15/00/34N 90/13/51W, VI-12-2001, W. D. Shepard, fluid preserved in Purdue Entomological Research Collection (PERC), West Lafayette, Indiana. Paratypes: One nearly mature larva, same data and deposition as holotype; one nearly mature larva, same data, except collected by DEB and deposited at Texas A & M University (TAMU), College Station, TX. Other material: four larvae with some parts slide-mounted, same data, at PERC; two larvae, same data, at TAMU; and two larvae at Laboratorio Entomología Systemática, Univerisdad del Valle de Guatemala, Guatemala City.

Etymology.—The specific epithet is a noun in apposition, after the Maya Native Americans, which lived in southern Mexico and northern Central America, including the Guatemalan region.

Discussion.—*Lugoiops maya* was collected from a torrential mountain rivulet of only a few centimeters in width and depth that was coursing down a deep and narrow-sided crevice at about a 30° grade. Larvae were clinging to rocky substrate. Other mayfly species collected at this site were also members of the *Baetodes* complex, including *B. noventus* Cohen and Allen, *B. deludens* Lugo-Ortiz and McCafferty, and *Mayobaetis ellenae* (Mayo). The former two were also found clinging in the rapid current, but *M. ellenae* was taken in the splash zone along the side of the stream. Lugo-Ortiz and McCafferty (1996) indicated that the more plesiotypic members of the *Baetodes* complex were often found in moderate current and splash zone environments in the Neotropics. Observations of splash-zone habitation had been made previously by WPM in Costa Rica for *Moribaetis maculipennis* (Flowers). Lugo-Ortiz and McCafferty (1996) also noted that *Baetodes* and *Prebaetodes* were, however, known as clingers in current. To this latter adaptive grouping, can now be added *Lugoiops*. Lugo-Ortiz and McCafferty (1996) showed correlation between habitat and morphological transitions within the *Baetodes* complex. Based on this, the new data we present for *Lugoiops* would have been to a large extent predictable.

ACKNOWLEDGMENTS

We thank Arwin Provonsha (West Lafayette, IN) for the illustrations used herein, Pat Randolph and Lu Sun (West Lafayette, IN) for technical assistance, and Bill Shepard (Sacramento, CA) for contributing specimens. Mike Meyer and Pat Randolph (West Lafayette, IN) commented on early drafts of the manuscript. Jack Schuster and Enio Caño (Guatemala City, Guatemala) helped with collecting permits.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 407–424

A REVIEW OF THE NEOTROPICAL SPECIES OF *BRACHYDEUTERA* LOEW (DIPTERA: EPHYDRIDAE)

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Abstract.—The Neotropical species of the genus *Brachydeutera* Loew are reviewed, including description of a new species, ***B. dentata*** (Paraguay: Parque Nacional Ybyquí [26°05′S, 56°48′W]). The extraordinary vagility of *B. longipes* Hendel is documented, having recently been discovered in South America as far south as Bolivia. Another primarily Neotropical species, *B. neotropica* Wirth, demonstrates slight but consistent variation that is described and illustrated. Tools for identification (keys, illustrations, short diagnoses) as well as maps are provided.

Key Words: Review, Diptera, Ephydridae, Dagini, *Brachydeutera, B. dentata* new species, Neotropical Region

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Specimens of *Brachydeutera* Loew are most commonly associated with lentic aquatic habitats, and adults are frequently encountered on the surfaces of small, stagnant pools or in ditches where the water is largely undisturbed (Williams 1938, Foote 1995, Keiper and Walton 2000). The habitats may be ephemeral and often they are slightly to highly polluted (Venkatesh 1976). Some species are associated with coastal marine habitats, including mangrove swamps (Foote 1995). Adults of *Brachydeutera* are easily recognized among shore flies because of their conspicuously pectinate arista, projected and carinate face, lateroclinate fronto-orbital setae, and the shortened costal vein (extending to vein R_{4+5}) and vein R_{2+3}. In addition, the thorax is often essentially two toned with the mesonotum being darker, usually brown, and the pleural areas whitish gray to gray. Specimens are comparatively large for shore flies, with body lengths of approximately 2–5 mm. So far as we know, the larvae are highly polyphagous on microbial, algal, and detrital materials (Foote 1995, Keiper and Walton 2000). Various species occur throughout most temperate and tropical regions (Mathis and Zatwarnicki 1995), and worldwide there are 15 species with greater diversity in the Old World tropics, especially the Afrotropical Region.

The purpose of this paper is to review the Neotropical fauna, including description of a new species, *B. dentata,* from Argentina and Paraguay. Counting this new species, there are now five species known from the neotropics and 16 species worldwide (Mathis and Zatwarnicki 1995). One of these species, *B. longipes* Hendel, is adventive to the New World from Asia, and we document herein the tremendous vagility of this species, which was first reported from the East Coast of North America (Mathis and Steiner 1986) and which has now been found throughout the Caribbean and Central America and in South America from Venezuela south to Bolivia.

Brachydeutera had previously been classified in: (1) the subfamily Napaeinae Cresson (Sturtevant and Wheeler 1954), (2) the tribe Hyadinini Philips et al. of the subfamily Parydrinae Wirth and Stone (Wirth 1965, 1968, Cogan and Wirth 1977, Cogan 1980), (3) the tribe Parydrini of the subfamily Parydrinae (Cogan 1984, Mathis 1989), and (4) most recently in the subfamily Ephydrinae Zetterstedt, tribe Dagini Mathis (Zatwarnicki 1992, Mathis and Zatwarnicki 1995). Here we continue to advocate placement of *Brachydeutera* in the tribe Dagini of the subfamily Ephydrinae. Keiper and Walton (2000) provided evidence from feeding habits to support placement of *Brachydeutera* in Ephydrinae but suggested a separate tribe for the genus, given its unique and opportunistic feeding strategy as a generalist on a variety of algal and microbial taxa. We suggest, however, that its generalized polyphagy is probably a plesiomorphic condition and thus prefer to maintain the genus in Dagini, perhaps as a lineage near the base of this tribe. Like other tribes and genera of Ephydrinae, including Dagini, the fronto-orbital setae are lateroclinate. In accordance with this classification and to facilitate better recognition of *Brachydeutera,* we have provided a key to New World genera of Dagini. We also recharacterize *Brachydeutera* within the context of this tribe and subfamily.

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, frequently 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 surstylus. Zatwarnicki (1996) suggested that the pre- and postsurstylus 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. 3–5. The new species description is composite and not based solely on the holotype. One head and two venational ratios that are used in the descriptions are defined below. All ratios are based on three specimens, representing the largest, smallest, and one intermediate. Gena-to-eye ratio is the genal height measured at the maximum eye height divided by the eye height. Costal vein ratio is the straight line distance between the apices of R_{2+3} and R_{4+5} divided by the distance between the apices of R_1 and R_{2+3}. M vein ratio is the straight line distance along vein M between crossveins (dm-cu and r-m) divided by the distance apicad of dm-cu.

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.
BMNH	The Natural History Museum (formerly the British Museum (Natural History)), London, England, United Kingdom.
CNC	Canadian National Collection, Ottawa, Canada.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA.
NMW	Naturhistorisches Museum, Wien, Austria.

SYSTEMATICS

Tribe Dagini Mathis

Dagini Mathis 1982: 3. Type genus: *Dagus* Cresson 1935.

KEY TO THE NEW WORLD GENERA AND SPECIES GROUPS OF DAGINI

1. Costal vein short, extending only to vein R_{4+5}; face with distinct, mediovertical carina, extended from ptilinal suture to oral margin; arista distinctly pectinate, longest rays subequal to length of 1st flagellomere . . . *Brachydeutera* Loew

– Costal vein long, extending to vein M; face evenly transversely arched, not carinate; arista essentially bare to subpectinate with longest rays not more than ½ length of 1st flagellomere . . . 2

2. Ventral ½–⅔ of face distinctly projected anteriorly, arched transversely and vertically (best seen in profile); fronto-orbital setae 3, anterior seta smaller; pulvilli lacking; postpronotum with 1 to a few setulae . . . . *Dagus* Cresson

– Face shieldlike, broadly but more shallowly projected over most of height; usually 1–2 fronto-orbital setae; pulvilli present, conspicuous; postpronotum bare 3

3. Gena high, equal to or greater than eye height; genal seta well developed and conspicuous; prescutellar acrostichal setae well developed; propleuron setulose; 5th tarsomere with dorsoapical process extended beyond base of tarsal claws . . . . *Diedrops* Mathis and Wirth

– Gena short, usually not more than ½ eye height; genal seta, if present, weakly developed and inconspicuous; prescutellar acrostichal setae not evident; propleuron lacking setulae; 5th tarsomere not as above (*Physemops*) 4

4. Halter capitellum black; ocellar setae lacking; arista long, over twice combined length of first 3 antennal segments; vein CuA_1 along posterior margin of discal cell bowed posteriorly . . . . the *nemorosus* group

– Halter capitellum pale, usually yellowish; ocellar setae present, conspicuous; arista shorter, rarely not over twice combined length of first 3 antennal segments; vein CuA_1 along posterior margin of discal cell straight . . . . the *panops* group

Genus *Brachydeutera* Loew

Brachydeutera Loew 1862: 162. Type species: *Brachydeutera dimidiata* Loew 1862 (= *Notiphila argentata* Walker 1853), monotypy.—Williston 1908: 309 [key].—Hennig 1952: 349 [immature stages, key].—Wirth 1964: 3–12 [revision]; 1968: 20 [Neotropical catalog].—Mathis 1983: 177–180 [review Nearctic fauna].— Mathis and Steiner 1986: 56–61 [key to Nearctic species with addition of *B. longipes* Hendel].—Lizarralde de Grosso 1989: 46–47 [review, Argentina].—Mathis and Zatwarnicki 1995: 229–232 [world catalog].

Description.—Small to large shore flies, body length 1.45–5.35 mm.

Head: Frons much wider than long, microtomentose, appearing dull, mesofrons not distinguished from remainder of frons; lateroclinate fronto-orbital setae 2–3; both inner and outer vertical setae present; 1 pair of cruciate, interfrontal setae inserted in front and laterad of anterior ocellus; ocelli arranged in isosceles triangle, distance between anterior ocellus and posterior ocelli less than that between posterior ocelli; ocellar setae well developed, proclinate and divergent; pedicel lacking dorsoapical, prominent seta; arista conspicuously pectinate, bearing 6–12 dorsally branching rays, longer rays subequal to length of 1st flagellomere. Face generally bare except for 3–12 setulae laterally; face with prominent vertical, median carina between antennal grooves, extending from ptilinal suture to epistome; epistomal margin of face broadly emarginate medially, emargination shallowly rounded; clypeus conspicuous within epistomal emargination as a wide, transverse band. Eye bare, large, prominent, slightly oval vertically. Genal seta lacking or much reduced.

Thorax: Chaetotaxy generally weakly developed; postpronotal, presutural, supra-alar, and prescutellar acrostichal setae reduced but usually evident; posterolateral dorsocentral and postalar setae better developed; otherwise macrochaetotaxy of scutum reduced; acrostichal and dorsocentral tracks represented by reduced setae; scutellum setose dorsally, with a basal and apical seta, these not arising from tubercles; notopleural setae usually 2, anterior seta weakly developed; anepisternum with 1 seta; katepisternum usually with 1 seta, frequently pale, inconspicuous, less well developed than anepisternal seta; prosternum bare of setulae. Costal vein short, extending to vein R_{4+5}; vein R_{2+3} short, not extending beyond level of crossvein dm-cu; vein M apicad of crossvein dm-cu evanescent. Legs generally lacking prominent setae; forebasitarsomere short, subequal in length to other tarsomeres; mid- and hindbasitarsomeres longer, about twice length of other tarsomeres; claws with curvature more abrupt apically; pulvilli evident but poorly developed.

Abdomen: Flattened dorsoventrally in female; convex dorsally in male; 5th tergite of male elongate, length subequal to tergite's basal width. Male terminalia as follows: epandrium attenuate dorsally, not extended around cerci to form cercal cavity, extended ventromedially (perhaps with fused surstyli) to form a narrow, ventral plate posteroventral to cerci (the surstyli are ventral extensions of the epandrium and may not be homologous with the gonostyli); postsurstylus and subepandrial sclerite lacking; hypandrium attached basally at basal ⅓ of surstyli; pre- and postgonites fused to each other and to hypandrium as digitiform, well-sclerotized processes; aedeagus poorly sclerotized, as a conical or keel-shaped, semihyaline lobe or protuberance; ejaculatory apodeme apparently lacking.

Discussion.—Although the phylogenetic relationships between *Brachydeutera* and other genera within the subfamily Ephydrinae are not resolved, there is considerable evidence supporting the monophyly of the genus. Morphological evidence, mostly autapomorphies, is as follows: 1. arista conspicuously pectinate. 2. face, especially at oral margin, projected. 3. face vertically carinate. 4. fronto-orbital setae lateroclinate. 5. costal vein short, extending to vein R_{4+5}. 6. vein R_{2+3} short. 7. male epandrium attenuate dorsally, not extending dorsally around and above the cerci to form a cercal cavity. 8. epandrium extended ventromedially (perhaps including fused surstyli) to form a narrow, ventral plate, posteroventral to cerci.

KEY TO NEOTROPICAL SPECIES OF *BRACHYDEUTERA*

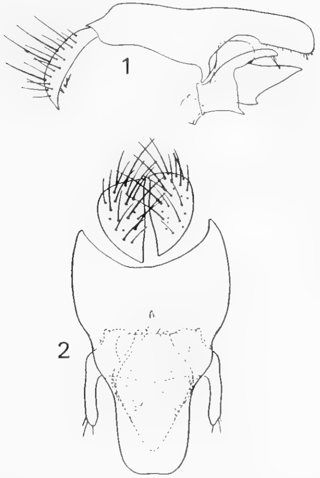
1. Brown color of anepisternum gradually becoming paler ventrally, merging with pale gray . . . . *B. longipes* Hendel
– Brown color of anepisternum continued ventrally to about dorsal ⅙–⅓, thereafter sharply delimited from pale gray coloration on ventral pleural region 2
2. Facial carina low, bluntly rounded, especially ventrally; male terminalia as in Figs. 17–18 . . . . *B. sturtevanti* Wirth
– Facial carina high, sharply defined, especially ventrally 3
3. Gonite spatulate apically . . . *B. neotropica* Wirth
– Gonite digitiform or tapered toward apex . . . 4
4. Apparent merger of fused surstyli with epandrium in lateral view indicated by an angulate emargination; gonite tapered toward apex, bearing well developed, stout, spinelike setae apically (Fig. 3) . . . . . . *B. dentata,* new species
– Apparent merger of fused surstyli with epandrium in lateral view broadly rounded; gonite digitiform apically, narrowly rounded, sometimes with stronger setae apically but not stout, spinelike (Fig. 1) . . . . *B. argentata* (Walker)

Brachydeutera argentata (Walker)
(Figs. 1–2)

Notiphila argentata Walker 1853: 407 [USA; LT (sex ?; designated by Mathis 1983: 178), BMNH].

Brachydeutera argentata: Osten Sacken 1878: 203 [generic combination].—Crawford 1914: 37 [parasitoid: *Cyrtogaster glasgowi* Crawford (= *C. trypherus* (Walker), Pteromalidae)].—Sturtevant and Wheeler 1954: 204–205 [review, distribution].—Wirth 1964: 5–6 [revision].—Scheiring and Foote 1973: 163 [natural history].—Mathis 1983: 179 [figures of male terminalia].—Woodley and Hilburn 1994: 29 [list, Bermuda].—Mathis and Zatwarnicki 1995: 230 [world catalog].

Brachydeutera dimidiata Loew 1862: 163 [USA. District of Columbia: "Washington"; LT ♀ (designated by Mathis 1983:



Figs. 1–2. Structures of the male terminalia of *Brachydeutera argentata*. 1, Cerci, epandrium (+ fused surstyli ?), gonite, and aedeagus, lateral view. 2, Same, posterior view.

178), MCZ].—Osten Sacken 1878: 203 [synonymy].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: facial carina high, sharply defined, especially ventrally; brown color of anepisternum continued ventrally to about dorsal ⅙–⅓, thereafter sharply delimited from pale gray coloration on ventral pleural region; apparent merger of fused surstyli with epandrium in lateral view broadly rounded (Fig. 1); gonite digitiform apically, narrowly rounded (Fig. 2).

Specimens examined.—BERMUDA. Hamilton (swamp near), Dec, W. S. Brooks (2 ex; MCZ).

Distribution.—Nearctic: Bermuda, Canada (QC), USA (FL, IA, MI, MA, ME, NC, NJ, OH, TX).

Remarks.—We have included this species in this review because of its occurrence on Bermuda, which is often omitted from other faunal reviews. Although having a Neotropical component, the fauna of Bermuda is mostly temperate and is especially influenced by the southeast Nearctic Region (Woodley and Hilburn 1994).

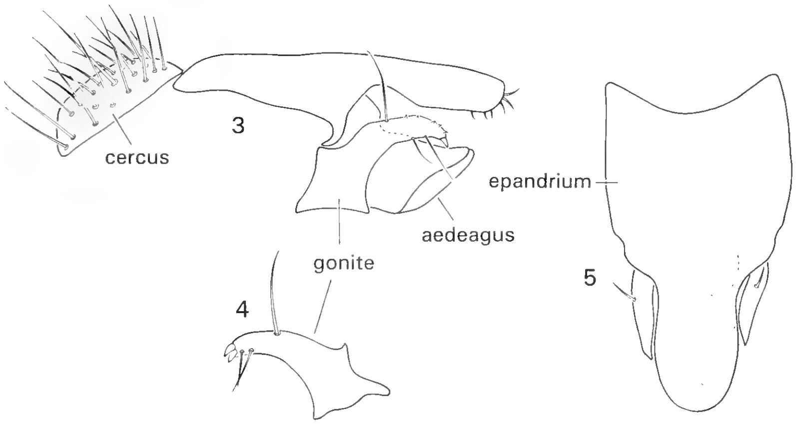
Brachydeutera dentata Mathis and Winkler, new species

(Figs. 3–5)

Description.—Moderately small to medium-sized shore flies, body length 2.5–3.3 mm.

Head: Frons uniformly brown except for olivaceous to greenish areas laterad of ocelli; 3 lateroclinate fronto-orbital setae, anteriormost seta weaker, ½–⅔ length of posterior setae. Antenna and ridge of facial carina brown, concolorous with frons. Aristal rays 9–11. Facial carina prominent, narrow and pointed in holotype male, wider and more blunt in paratype females. Clypeus and face silvery white, except for ridge of carina and narrow margin along oral emargination. Face with 4–5 setulae laterally. Palpus pale, yellowish.

Thorax: Mesonotal chaetotaxy poorly developed; setae barely evident, setae of main setal tracks small. Mesonotum mostly brown, with olivaceous stripes laterad of the acrostichal track, laterad of dorsocentral track, near dorsal margin of notopleuron, in supra-alar area, and at merger of scutum and scutellum. Scutellar ratio 0.71; distance between apical scutellar setae less than between basolateral scutellar seta and apical seta. Anterior notopleural seta present, weaker than posterior seta; katepisternal seta present. Brownish coloration of mesonotum continued ventrally to dorsal ⅙ of anepisternum, thereafter abruptly delimited from grayish to silvery-white coloration of ventral portion of pleural areas; anepisternum with posterior margin silvery gray. Wing hyaline; vein R_{2+3} slightly to moderately arched; vein R_{4+5} noticeably arched; costal vein ratio 2.8–3.4; M vein ratio 0.58–0.60. Femora mostly yellowish, with slightly darker patch apically on dorsal surface; tibiae yellowish basally, becoming gradually darker apically; tarsomeres brown.



Figs. 3–5. Structures of the male terminalia of *Brachydeutera dentata*. 3, Cerci, epandrium (+ fused surstyli ?), gonite, and aedeagus, lateral view. 4, Left gonite, lateral view. 5, Same as 4, posterior view.

Abdomen: Dorsum with posterolateral, grayish areas on tergites 2–5 of males and 2–6 of females. Terminalia of male are as follows (Figs. 3–5): dorsal surface of epandrium in posterior view shallowly concave; epandrial width at dorsum only slightly wider than lateral margins of cerci, parallel sided; epandrium + surstyli (Fig. 3) elongate, narrow in ventral view, sides subparallel, widest in the middle, and rounded apically; in lateral view, apex of epandrium + surstyli bluntly rounded with several short setae present apically on dorso-anterior surface, parallel sided on distal ½, forming angulate concavity at base of fused surstyli; aedeagus in ventral view angulate, pointed distally, with rounded ventral lobes basally; gonite (Figs. 4–5) subrectangular basally, posteroventral angle drawn out into digitiform process which is strongly procurved, narrowing apically, with 1–2 strong apical spurs and a prominent dorsal seta.

Type material.—Holotype ♂ is labeled "PARAGUAY. Parag.: Parq. Nac. Ybyquí (26°05'S, 56°48'W) 15 Mar. 1986/HOLOTYPE ♂ Brachydeutera dentata W. N. Mathis & Winkler USNM [red; species name, gender symbol, and "& Winkler" handwritten]." The holotype is double mounted (glued to a paper triangle), is in good condition (wings flexed down), and is deposited in the USNM. Twelve paratypes (3 ♂, 9 ♀; USNM) bear the same locality data as the holotype. Other paratypes are from: ARGENTINA. Buenos Aires: Punta Lara (8 km N Villa Elisa), 4 Dec 1979, C. M. and O. S. Flint, Jr. (1 ♂, 2 ♀; USNM).

Distribution (Fig. 6).—Neotropical: Argentina (Buenos Aires), Paraguay (Paraguay).

Etymology.—The specific epithet, *dentata*, is of Latin derivation and refers to the toothlike setae at the apex of the gonite.

Remarks.—Externally this species is nearly identical to three congeners: *B. argentata* (eastern North America), *B. ibari* Ninomyia (Europe and northern Asia), and *B. neotropica* (Florida south to Argentina). Of these species, however, only the range of *B. neotropica* includes Argentina. Structures of the male terminalia of *B. dentata* differ significantly from other *Brachydeutera* and easily distinguish it. The gonite is tapered gradually, more so apically, and has distinctive, stout, spurlike setae at the apex. In addition, the ventromedial extension of

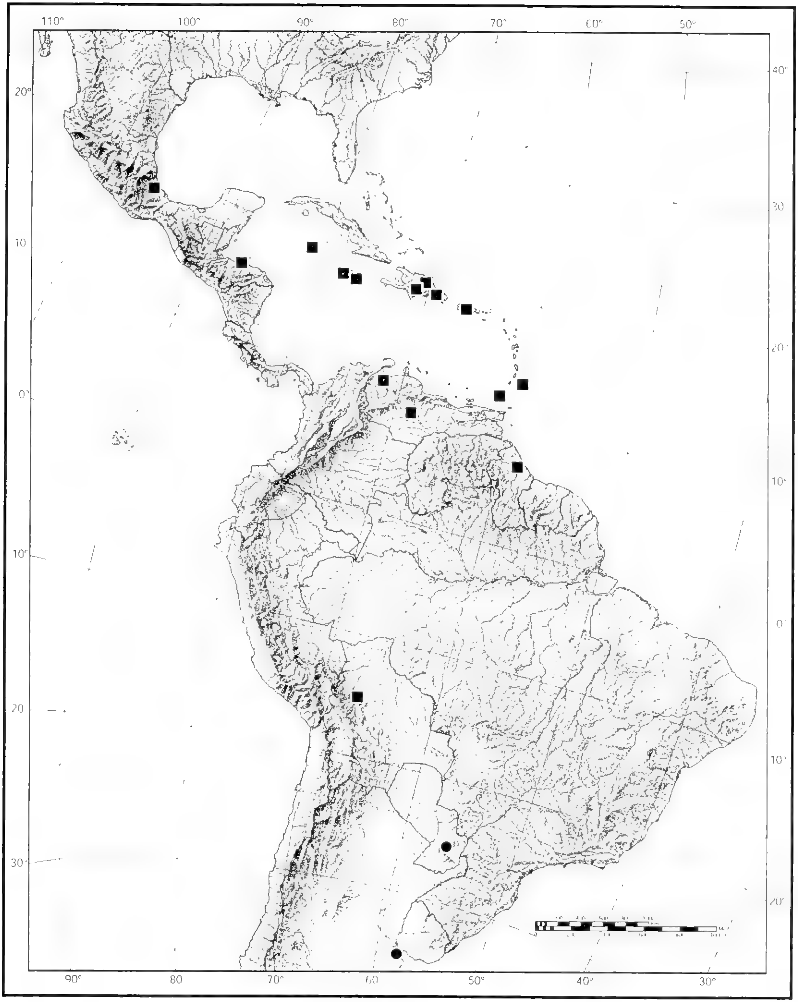


Fig. 6. Distribution map for *Brachydeutera dentata* (filled circles) and *B. longipes* (filled squares).

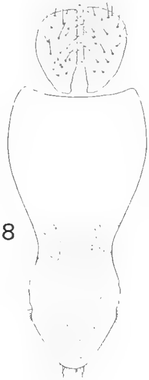
the epandrium (? and fused surstyli) is narrower and more elongate than in similar congeners. In contrast, *B. neotropica* has a spatulate gonite, and *B. ibari* and *B. argentata* have digitiform gonites with blunt apices (these may have thickened, spinelike setae apically, but these are not comparable to the stout, pointed, spurlike gonal setae of *B. dentata*). The shape of the elongate epandrium (+ fused surstyli ?) of *B. ibari*, a Palearctic species, somewhat resembles that of *B. dentata* in having a relatively deep and angulate emargination along the anterior surface (best seen in lateral view), but the extended epandrium (+ fused surstyli) of *B. ibari* are more nearly parallel sided in posterior view (see illustrations in Mathis and Ghorpadé 1985: 13, and Wirth 1964: 10 [as *B. argentata*]).

Brachydeutera longipes Hendel
(Figs. 6–8)

Brachydeutera longipes Hendel 1913: 99 [Taiwan. Kankau; LT ♂ (designated by Mathis and Ghorpadé 1985: 15), NMW].—Wirth 1964: 7–8 [revision].—Venkatesh 1976: 345–346 [biology].—Venkatesh et al. 1977a: 60–61 [coexistence with *Culex fagitans* Wiedemann]; 1977b: 10–13 [behavior].—Mathis and Ghorpadé 1985: 15–18 [revision].—Mathis and Steiner 1986: 56–60 [revision].—Mathis and Zatwarnicki 1995: 231 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: facial carina low, less prominent; generally paler in color, especially the dorsum of mesonotum and abdomen; anterior notopleural seta present; brown color of anepisternum gradually becoming paler ventrally, merging with pale gray; apparent merger of fused surstyli with epandrium in lateral view with a shallow, broad swelling along anterior margin; gonite (Fig. 7) narrow, sinuous, slightly spatulate apically.

Specimens examined.—BARBADOS. St. Philip: Gemswick (13°05′N, 59°28.5′W), 31 Aug 1997, W. N. Mathis (1 ♂, 1 ♀; USNM).



Figs. 7–8. Structures of the male terminalia of *Brachydeutera longipes*. 7, Cerci, epandrium (+ fused surstyli ?), gonite, and aedeagus, lateral view. 8, Same, posterior view.

BOLIVIA. La Paz: Guanay (15°29.8′S, 67°52.7′W; 460 m), 13 Mar 2001, W. N. Mathis (1 ♂; USNM).

CAYMAN ISLANDS. Grand Cayman: Hutland (1.5 km S; 19°20′N, 81°13′W), 18 Feb 1993, W. E. Steiner, J. M. Swearingen, F. J. Burton (1 ♂, 2 ♀; USNM).

DOMINICAN REPUBLIC. *Hato Mayor:* Hato Mayor (5.5 km E; 18°46.4′N, 69°12.5′W), 26 May 1998, D. and W. N. Mathis (2 ♂; USNM). *La Vega:* Rio Camu (3.5 km NW La Vega; 19°13.8′N, 70°35.2′W; 100 m), 18 May 1998, D. and W. N. Mathis (3 ♂, 2 ♀; USNM). *Pedernales:* Pedernales (18°01.8′N, 71°44.7′W), 19–20 Mar 1999, W. N. Mathis (8 ♂; USNM). *Puerto Plata:* River Camu (14 km E Puerto Plata; 19°11.9′N, 70°37.4′W), 17

May 1995, W. N. Mathis (1 ♂, 2 ♀; USNM).

GRENADA. *St. George:* Point Salines Airport (W end; 12°0.3′N, 61°47.7′W), 12 Sep 1997, W. N. Mathis (2 ♂; USNM).

GUYANA. Georgetown (6°48.6′N, 58°08.6′W), 20–29 Aug 1997, W.N. Mathis (14 ♂, 3 ♀; USNM).

HONDURAS. *Cortés:* San Pedro Sula (8 km S; 15°25.7′N, 88°1.4′W), 25–26 Sep 1995, D. and W. N. Mathis (1 ♂; USNM).

JAMAICA. *Manchester:* Alligator Pond (17°52.1′N, 77°33.9′W), 8 May 1996, D. and W. N. Mathis, H. Williams (4 ♀; USNM). *St. Andrew:* Mavis Bank (near coffee factory; 18°01.4′N, 76°39.7′W; waterfall), 21–23 Apr 2000, W. N. Mathis (10 ♂, 6 ♀; USNM). *St. Elizabeth:* near Port Kaiser (17°52.3′N, 77°34.9′W), 8 May 1996, D. and W. N. Mathis, H. Williams (3 ♀; USNM).

MEXICO. *Veracruz:* Ciudad Alemán (100 m), 3 May 1985, W. N. Mathis (7 ♀; USNM).

PUERTO RICO. Jayuya (2 km E; Rio Saliente; 18°12.8′N, 66°33.9′W), 22 Sep 1995, D. and W. N. Mathis (13 ♂, 4 ♀; USNM).

VENEZUELA. *Guarico:* Hato Masaguaral (45 km S Calabozo; 8°57′N, 67°58′W; 75 m; uv light; gallery forest), 3–5 Jun 1988, M. Epstein (11 ♂, 7 ♀; USNM). *Zulia:* Maracaibo, Lagunas de Oxidación-ICLAM, Ciudad Universitaria (tanque pequeno), 18 May 1994, M. Garcia (2 ♂, 1 ♀; USNM).

Distribution (Fig. 6).—Nearctic: Canada (ON), USA (GA, MD, NC). Neotropical: Bolivia (La Paz), Guyana, Honduras, Mexico (VRC), Venezuela (Guarico, Zulia), West Indies (Barbados, Cayman Islands, Dominican Republic, Grenada, Jamaica, Puerto Rico). Oriental: Cambodia, China, India, Indonesia, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam. Palearctic: Iraq, Japan.

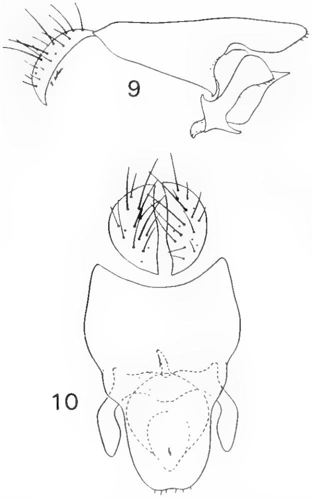
Remarks.—Over 15 years ago, Mathis and Steiner (1986) first reported this species from the New World, and all of the locality records were then from the Nearctic Region (southern Canada south to Georgia). In their world catalog, Mathis and Zatwarnicki (1995) included Mexico and Venezuela to the known distribution in the New World, and here, we add several islands in the Caribbean and other siltes as far south as Bolivia in South America (Fig. 6). These records clearly indicate that this species is well adapted to habitats in the New World and that it apparently disperses with considerable ease or is more synanthropic and is dispersed by human activity.

This species is clearly the most distinctive and easily identified species in the New World, especially the brown color of the anepisternum, which gradually becomes paler ventrally, merging with the pale gray coloration ventrally. The distinctive morphological features provide additional evidence that this species is adventive in the New World. In the Old World, *B. longipes* is quite similar and closely related to *B. pleuralis* Malloch, which also overlaps in much of its distribution (Mathis and Ghorpadé 1985). Distinguishing between *B. longipes* and *B. pleuralis* will probably require examination of characters of the male terminalia.

Brachydeutera neotropica Wirth
(Figs. 9–16)

Brachydeutera argentata of authors, not Walker [misidentification]: Williston 1897: 4 [in part, Brazil].—Cresson 1918: 67–68 [Costa Rica]; 1930: 105 [in part, Argentina, Mexico]; 1938: 34 [in part, Brazil].—Hendel 1930: 134 [in part, Bolivia].—Souza Lopes 1941: 654 [list, Brazil].—Sturtevant and Wheeler 1954: 204–205 [in part].—Wirth 1956: 18 [in part, Bahamas]; 1964: 5 [in part, distribution].

Brachydeutera neotropica Wirth 1964: 8 [Mexico. Vera Cruz: La Gloria, Cardel; HT ♂, USNM (66452)]; 1968: 20 [Neotropical catalog].—Mathis 1983: 178–179 [key, illustrations of male terminalia].—Lizarralde de Grosso 1973: 83 [bi-



Figs. 9–10. Structures of the male terminalia of *Brachydeutera neotropica.* 9, Cerci, epandrium (+ fused surstyli ?), gonite, and aedeagus, lateral view. 10, Same, posterior view.

ology, immature stages, Argentina]; 1989: 47 [review, Argentina].—Mathis and Zatwarnicki 1995: 231 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: facial carina high, sharply defined, especially ventrally; brown color of anepisternum continued ventrally to about dorsal ⅙–⅓, thereafter sharply delimited from pale gray coloration on ventral pleural region; apparent merger of fused surstyli with epandrium in lateral view indicated by an angulate emargination; gonite spatulate apically.

Specimens examined.—ARGENTINA. *Buenos Aires:* 27 Sep 1905 (1 ♀; USNM). *Tucumán:* Lacavera, 22–23 Nov 1951, M. L. Aczel, R. Golbach (3 ♂; USNM); Tucumán (mercury light trap), Feb 1935, R. Golbach (1 ♂; USNM).

BAHAMAS. *South Bimini Island:* May 1951, M. Cazier (1♂; AMNH).

BARBADOS. *Christ Church:* Graeme Hall Swamp (13°04.2′N, 59°34.7′W), 12 Sep 1996, W. N. Mathis (1 ♂; USNM). *St. Joseph:* Joes River (13°12.8′N, 59°32.3′W), 10 Sep 1996, W. N. Mathis (8 ♂, 2 ♀; USNM). *St. Philip:* Gemswick (13°05′N, 59°28.5′W), 31 Aug 1997, W. N. Mathis (9 ♂, 4 ♀; USNM).

BOLIVIA. *Cochabamba:* Cochabamba (17°23.3′S, 65°07′W; 2,610 m), 25 Mar 2001, W. N. Mathis (9 ♂, 2 ♀; USNM). *La Paz:* Guanay (3 km E; 15°30.2′S, 67°52.3′W; 500 m), 14 Mar 2001, W. N. Mathis (1 ♂, 3 ♀; USNM); Guanay (22 km SE; 15°17.8′S, 68°15.6′W; 540 m), 17 Mar 2001, W. N. Mathis (1 ♀; USNM); Mapiri (Rio Mapiri; 15°18.6′S, 68°13′W; 720 m), 17 Mar 2001, W. N. Mathis (1 ♀; USNM).

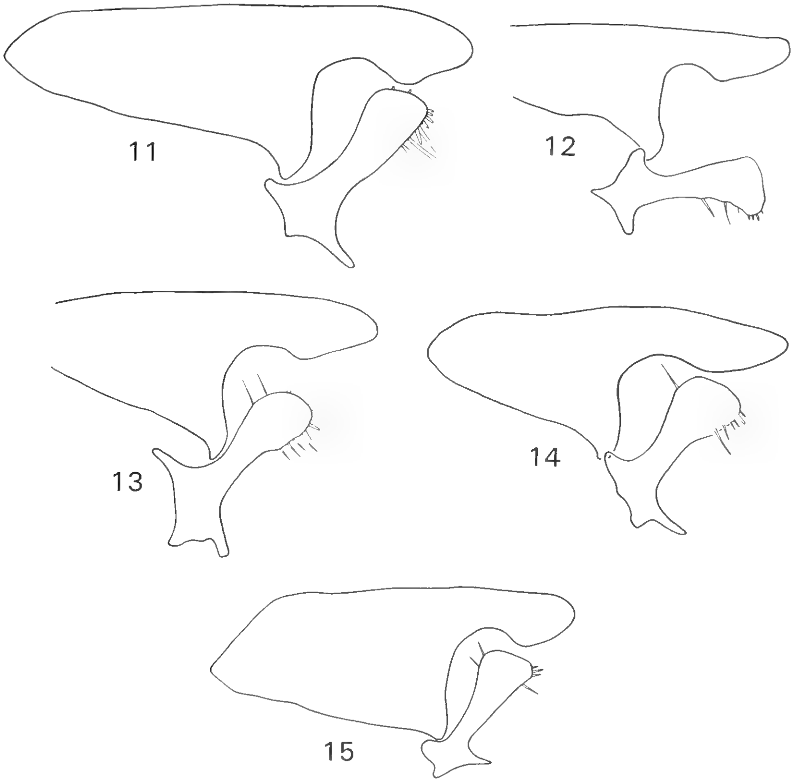
BRAZIL. *Paraná:* Foz do Iguaçu (25°30.1′S, 54°32.4′W), 26 Aug 2000, D. and W. N. Mathis (3 ♀; USNM). *Rio de Janeiro:* Ilha da Marambaia (23°03.6′S, 43°59.1′W), 4 Sep 2000, D. and W. N. Mathis (1 ♀; USNM).

CAYMAN ISLANDS. *Grand Cayman:* Hutland (1.5 km S; 19°20′N, 81°13′W; black light; forest near mangrove), 18 Feb 1993, W. E. Steiner, J. M. Swearingen, F. J. Burton (3 ♂, 3 ♀; USNM).

COLOMBIA. *Antioquia:* El Retiro (7 km N), 26 Feb 1984, W. N. Mathis (1 ♀; USNM).

COSTA RICA. *Limón:* Suerre (10°17′N, 83°24′W), 14 Jul 1923, A. Alfaro (1 ♂, 1 ♀; USNM). *Puntarenas:* Las Loras, F. Knab (1 ♀; USNM). *San José:* La Caja (8 km W San José), 1930, P. Schmidt (2 ♂; USNM); San José, J. F. Tristan (1 ♂, 1 ♀; USNM).

CUBA. *Cienfuegos:* Soledad, Jardín Botánico (22°7.5′N, 80°19.2′W), 13 Dec 1994, W. N. Mathis (7 ♂; USNM); Topes de Collantes (5 km WNW; 21°56.5′N, 80°2.3′W; 600 m), 11 Dec 1994, W. N. Mathis (2 ♂, 2 ♀; USNM). *Havana:* Ojo de Aqua (23°54.6′N, 82°29.1′W), 8 Dec 1994, W. N. Mathis (1 ♂; USNM); Havana (beach;



Figs. 11–15. Male terminalia of *Brachydeutra neotropica.* 11, Epandrium (+ fused surstyli ?) and gonite (Bolivia. Cochabamba: Cochabamba). 12, Epandrium (+ fused surstyli ?) and gonite (Bolivia. La Paz: Guanay). 13, Epandrium (+ fused surstyli ?) and gonite (Ecuador. Manabi: Flavia Alfonso (42.7 km E)). 14, Epandrium (+ fused surstyli ?) and gonite (Ecuador. Imbaburra: Laguna San Pablo). 15, Epandrium (+ fused surstyli ?) and gonite (Cuba. Pinar del Rio: Soroa).

23°5.8′N, 82°27.7′W), 2–14 Dec 1994, W. N. Mathis (5 ♂, 2 ♀; USNM). *Pinar del Rio:* Soroa (22°47.7′N, 83°W), 4–6 Dec 1994, W. N. Mathis (15 ♂, 1 ♀; USNM). *Sancti Spiritus:* Topes de Collantes (21°55.2′N, 80°02′W; 350 m), 10 Dec 1994, W. N. Mathis (1 ♂, 2 ♀; USNM); Topes de Collantes (21°54.4′N, 80°01.4′W; 670 m), 9–11 Dec 1994, W. N. Mathis (2 ♀; USNM).

DOMINICA. Cabrits, 22 Mar 1989, W. N. Mathis (1 ♀; USNM).

DOMINICAN REPUBLIC. *Barahona:* Barahona (18°12′N, 71°05.3′W), 25 Mar 1999, W. N. Mathis (3 ♂, 1 ♀; USNM); Cabral (canals E of Cabral; 18°15.2′N, 71°13.4′W), 16 May 1995, W. N. Mathis (4 ♂, 1 ♀; USNM); Ojeda (17°58.2′N, 71°10.6′W), 22 Mar 1999, W. N. Mathis (1 ♂; USNM); Paraíso (5 km N; 18°01.5′N, 71°11.6′W; 150 m), 21 Mar 1999, W. N. Mathis (1 ♂, 2 ♀; USNM). *Distrito Nacional:* Santo Domingo (Jardín Botanico; 18°29.9′N, 69°56.9′W), 25 May 1998, D. and W. N. Mathis (1 ♀; USNM). *El Seibo:* El Seibo (5 km E; 18°44.73′N, 68°59.2′W; 120 m), 12 May 1995, W. N. Mathis (2 ♂, 3 ♀; USNM); Rincón (near; 18°45.3′N, 68°55.7′W), 12 May 1995, W. N. Mathis (1 ♂, 1 ♀; USNM). *Hato Mayor:* Hato Mayor (5.5 km E; 18°46.4′N, 69°12.5′W), 26 May 1998, D. and W. N. Mathis (2 ♀; USNM). *Independencia:* Los Bolos (18°37.8′N, 71°39.2′W; 1,370 m), 24 Mar 1999, W. N. Mathis (2 ♂, 1 ♀; USNM); Puerto Escondido (18°19.6′N, 71°35′W; 1,370 m), 24 Mar 1999, W. N. Mathis (2 ♂, 2 ♀; USNM). *La Romana:* Isla Saona, Mano Juan (18°08.1′N, 68°44.5′W), 13 May 1995, W. N. Mathis (2 ♀; USNM). *La Vega:* El Rio (9.5 km E; 19°0.9′N, 70°33.5′W; 980 m), 6–7 May 1995, W. N. Mathis (5 ♂, 5 ♀; USNM); Jarabacoa (1–2 km S; 19°06.9′N, 70°37′W; 520 m), 8–21 May 1995, 1998, D. and W. N. Mathis (13 ♂, 8 ♀; USNM); Jarabacoa (5 km S; 19°05.8′N, 70°36.5′W; 640 m), 8–20 May 1995, W. N. Mathis (1 ♂, 1 ♀; USNM); Rio Camu (3.5 km NW La Vega; 19°13.8′N, 70°35.2′W; 100 m), 18 May 1998, D. and W. N. Mathis (6 ♂, 2 ♀; USNM); Salto de Jimenoa (19°06′N, 70°35.9′W; 575 m), 20 May 1995, W. N. Mathis (1 ♂; USNM). *Monseñor Nouel:* dam near Rodeo (18°53.1′N, 70°33.5′W), 22 May 1998, D. and W. N. Mathis (1 ♀ USNM); *Pedernales:* Pedernales (18°01.8′N, 71°44.7′W), 19–20 Mar 1999, W. N. Mathis (5 ♂, 2 ♀; USNM); Pedernales (19 km N; 18°09.2′N, 71°44.8′W; 230 m), 20 Mar 1999, W. N. Mathis (2 ♂, 1 ♀; USNM).

ECUADOR. *Guayas:* El Triunfo (60 km E Guayaquil), 11 Feb 1973, M. A. Deyrup (2 ♂; USNM). *Imbabura:* Laguna San Pablo (0°12.1′N, 78°14.1′W), 28 Aug 1999, W. N. Mathis (1 ♂; USNM). *Manabi:* Arabia (12 km W Chone; 70 m), 8 Jan 1978, W. N. Mathis (2 ♀; USNM); Bandurria, Aug 1955, J. R. Levi-Castillo (2 ♂, 2 ♀; USNM). *Orellana:* Rio Tiputini (0°38.2′S, 76°8.9′W), 12–26 Aug 1999, W. N. Mathis, A. Baptista, M. Kotrba (2 ♂, 1 ♀; USNM).

GRENADA. *St. George:* Point Salines Airport (W end; 12°0.3′N, 61°47.7′W), 12 Sep 1997, W. N. Mathis (3 ♂, 3 ♀; USNM); True Blue Beach (11°59.9′N, 61°46.1′W), 15 Sep 1996, W. N. Mathis (1 ♀; USNM). *St. John:* Concord Falls (12°07.1′N, 61°43′W), 14–21 Sep 1996, W. N. Mathis (1 ♂; USNM); Concord Valley (12°06.9′N, 61°43.9′W), 14 Sep 1996, W. N. Mathis (1 ♂; USNM). *St. Patrick:* Bathway Beach (12°12.6′N, 61°36.7′W), 12 Sep 1997, W. N. Mathis (1 ♂; USNM); Levera Bay (12°13.6′N, 61°36.6′W), 18 Sep 1996, W. N. Mathis (1 ♂; USNM).

GUATEMALA. Cayuga, Jan 1915 (1 ♀; USNM). San Cristobal: Alta Vera Paz, 17 May 1926, J. M. Aldrich (1 ♂, 1 ♀; USNM).

GUYANA. CEIBA (ca. 40 km S Georgetown; 6°29.9′N, 58°13.1′W), 13–21 Apr 1994, 1995, W. N. Mathis (1 ♂; USNM). Moco-Moco (30 km E Lethem, Kanuku Mountains; 3°18.2′N, 59°39.0′W), 29 Apr 1995, W. N. Mathis (1 ♂; USNM).

JAMAICA. *Clarendon:* Grantham (18°09.3′N, 77°23.8′W; 340 m), 16 Apr 2000, W. N. Mathis (1 ♀; USNM); Portland Cottage (17°45.4′N, 77°11′W), 13 May 1996, D. and W. N. Mathis, H. Williams (5 ♂, 1 ♀; USNM); Rest (3.5 km N; 17°54.1′N, 77°21.1′W), 9 May 1996, D. and W. N. Mathis, H. Williams (1 ♀; USNM); Rest (3 km N; 17°54.3′N, 77°21.4′W), 15 Apr 2000, W. N. Mathis (1 ♂, 2 ♀; USNM); Rocky Point (2 km S, near Jackson Bay Cave; black light), 10 Dev 1975, G. F. Hevel (1 ♂, 7 ♀; USNM). *Manchester:* Alligator Pond (17°52.1′N, 77°33.9′W), 8 May 1996, D. and W. N. Mathis, H. Williams (1 ♂, 1 ♀; USNM). *Portland:* Crystal Springs (18°12.5′N, 76°37.9′W), 18 May 1996, D. and W. N. Mathis, H. Williams (1 ♂; USNM); Long Bay (2.3 km W; 18°06.5′N, 76°20′W), 24 Apr 2000, W. N. Mathis (1 ♂, 2 ♀;

USNM); Reach (4 km N; 18°03.6′N, 76°20.4′W), 15 May 1996, D. and W. N. Mathis, H. Williams (1 ♂; USNM). *St. Andrew:* Cinchona (18°04.4′N, 76°39.3′W; 1400 m), 29 Apr 2000, W. N. Mathis (5 ♂, 3 ♀; USNM); Mavis Bank (1.5 km W; 18°01.4′N, 76°39.9′W), 22 Apr 2000, W. N. Mathis (9 ♂, 3 ♀; USNM); Mavis Bank (1.7 km E; 18°02.4′N, 77°39.5′W; 575 m), Yallahs River, 21–22 Apr–1 May 2000, W. N. Mathis (1 ♀; 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 (1 ♀; USNM). *St. Elizabeth:* Elim (18°07.1′N, 77°40.6′W), 10 May 1996, D. and W. N. Mathis, H. Williams (2 ♂, 1 ♀; USNM); Elim (18°07.1′N, 77°40.5′W), 10 Apr 2000, W. N. Mathis (1 ♂, 1 ♀; USNM); near Port Kaiser (17°52.3′N, 77°34.9′W), 8 May 1996, D. and W. N. Mathis, H. Williams (6 ♂, 2 ♀; USNM).

MEXICO. *Chiapas:* Finca Prusia (33 km S Jaltenango; 1,000 m), 12 May 1985, W. N. Mathis (4 ♂, 1 ♀; USNM). *Jalisco:* Tlaquepaque, Sep 1965, N. L. H. Krauss (1 ♂; USNM). *Veracruz:* Ciudad Aleman (100 m), 3 May 1985, W. N. Mathis (1 ♂; USNM); Fortín de las Flores (952 m), 2–31 May 1981, 1985, C. M. and O. S. Flint, Jr., W. N. Mathis (6 ♂, 2 ♀; USNM); La Gloria Cardel, 1938, J. Camelo (2 ♂, 16 ♀; USNM).

PANAMA. *Canal Zone:* Fort Kobbe, 17 Jun 1952, F. S. Blanton (3 ♀; USNM); Pedro Miguel, R. C. Shannon (1 ♂; USNM). *Darien:* Punta Patiño, 21 Jun 1952, F. S. Blanton (1 ♀; USNM).

PERU. *Junín:* Perene (10°58′S, 75°13′W), R. C. Shannon (2 ♀; USNM). *Lima:* Lima, Laguna de Villa, 30 Aug 1988, W. N. Mathis (1 ♂; USNM). *Loreto:* Itaya (ca. 25 km S Iquitos), 22 Feb 1984, W. N. Mathis (1 ♀; USNM). *Madre de Dios:* Manu, Rio Manu, Cocha Salvador (240 m), 14 Sep 1988, W. N. Mathis (1 ♂; USNM).

PUERTO RICO. Caribbean National Forest, Toro Negro Unit (18°8′N, 66°30′W; Rd. 564 K.5.7.; 878 m), Dona Juana Forest, 17 Aug 1965, S. M. Gaud (1 ♂; USNM). Jayuya (2 km E; Rio Saliente; 18°12.8′N, 66°33.9′W), 22 Sep 1995, D. and W. N. Mathis (3 ♂, 1 ♀; USNM). Mayaquez, Sep–Nov 1960, M. M. Beauchamp (1 ♂; USNM). Salinas (black light; sugar cane field), 19 Feb 1964, S. M. Gaud, G. Rivera (7 ♂, 8 ♀; USNM).

ST. LUCIA. Fond St. Jacques (13°50′N, 61°02′W), 13–14 Jun 1991, D. and W. N. Mathis (1 ♂; USNM). Soufrière Botanical Garden (13°51′N, 61°04′W), 12 Jun 1991, D. and W. N. Mathis (6 ♂, 3 ♀; USNM).

ST. VINCENT. *Charlotte:* Montreal (13°12′N, 61°11′W), 9 Jun 1991, D. and W. N. Mathis (1 ♂; USNM); Peruvian Vale (13°10.7′N, 61°08.7′W), 6–8 Sep 1997, W. N. Mathis (2 ♂, 2 ♀; USNM). *St. George:* Yambou Head, 27 Mar 1989, W. N. Mathis (4 ♂, 4 ♀; USNM).

SURINAM. Paramaribo, 4 Sep 1943, D. G. Hall (4 ♂, 6 ♀; USNM).

TOBAGO. *St. Patrick:* Pigeon Point (beach; 11°9.7′N, 60°50′W), 19 Apr 1994, D. and W. N. Mathis (1 ♀; USNM).

TRINIDAD. *Victoria:* Basse Terre (7 km E; 10°07′N, 61°14′W), 27 Jun 1993, W. N. Mathis (2 ♀; USNM).

VENEZUELA. *Aragua:* Estación Experimental Cataurito, Villa de Cura (32 km E; 1,100 m), 1 Feb 1983, O. S. Flint, Jr. (5 ♂, 10 ♀). *Guarico:* Fundo Masaguaral, Lago Guacimas, 19 Jan 1983, O. S. Flint, Jr. (1 ♀; USNM); Hato Masaguaral (45 km S Calabozo; 8°57′N, 67°58′W), 3–5 Jun 1988, M. Epstein (13 ♂, 33 ♀; USNM).

Distribution (Fig. 16).—Nearctic: USA (FL, LA, NC, TX). Neotropical: Argentina (Buenos Aires, Tucumán), Bahamas, Bolivia (Cochabamba, La Paz), Brazil (Paraná, Rio de Janeiro), Costa Rica, Ecuador, Guatemala, Guyana, Mexico (CHI, JAL, VRC), Panama, Peru (Junín, Lima, Loreto, Madre de Dios), Surinam, Trinidad and Tobago, Venezuela (Aragua, Guarico), West Indies (Barbados, Cuba, Dominica, Dominican

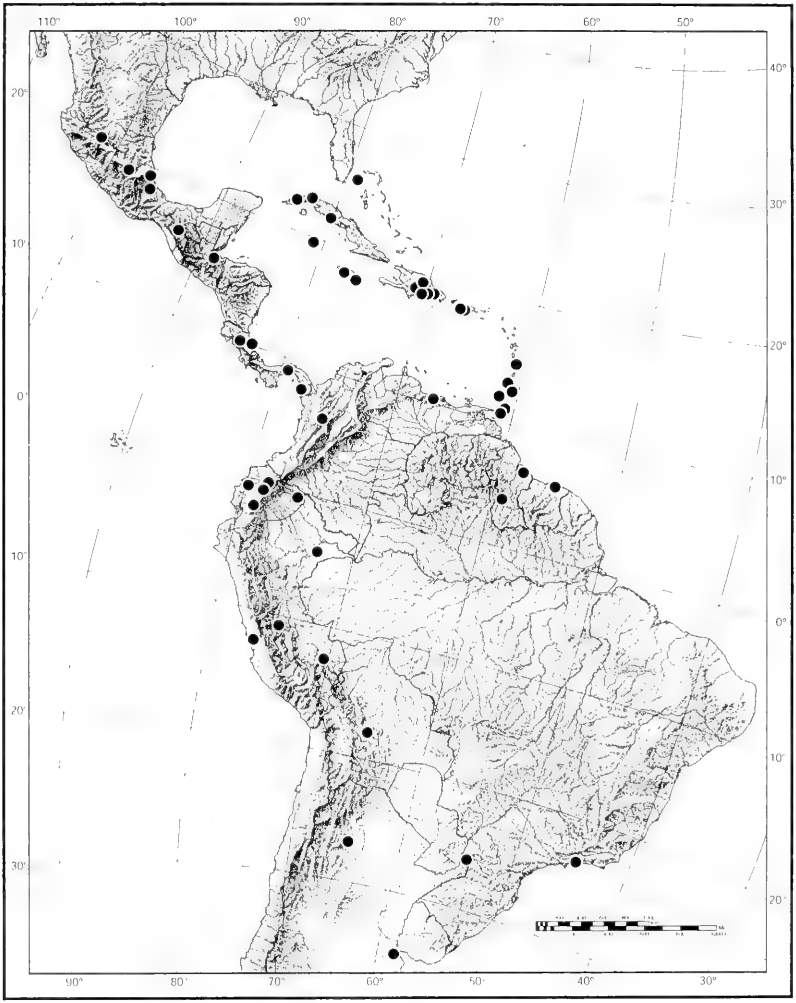
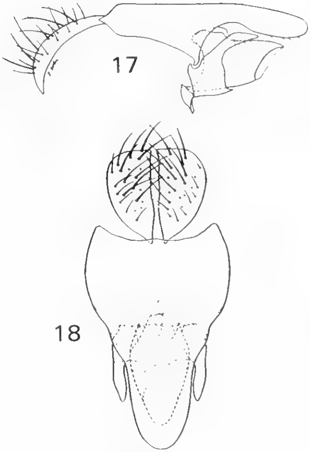


Fig. 16. Distribution map for *Brachydeutera neotropica.*

Republic, Cayman Islands, Grenada, Jamaica, Puerto Rico, St. Lucia, St. Vincent).

Natural history.—Lizarralde de Grosso (1973) described and figured the immature stages of this species, which she discovered in a variety of habitats from coastal lowlands to elevations of 1000 m in the mountains. Like other species of *Brachydeutera*, the puparium of *B. neotropica* has completely everted anterior spiracles.

Remarks.—This paper was prompted when we noted variation in the shape of the gonites and in the wing venation of Bolivian specimens from two sites (La Paz: Guanay (Fig. 12); and Cochabamba: Cochabamba (Fig. 11)). We also noted slight variation in the ventromedial extension of the epandrium (+ fused surstyli) in other specimens. After studying numerous specimens from throughout the neotropics, including dissections of male terminalia (Figs. 9–15), we have concluded that there is a single species with slight variation from population to population. More detailed studies, however, may reveal two and perhaps more species, especially as the variation noted was primarily between localities with almost no variation among specimens from a single site.



Figs. 17–18. Structures of the male terminalia of *Brachydeutera sturtevanti*. 17, Cerci, epandrium (+ fused surstyli ?), gonite, and aedeagus, lateral view. 18, Same, posterior view.

Brachydeutera sturtevanti Wirth
(Figs. 17–18)

Brachydeutera sturtevanti Wirth 1964: 11 [USA. California: San Diego County, San Diego; HT ♂, USNM (66453)].—Mathis 1983: 179 [figures of male terminalia].—Mathis and Steiner 1986: 57 [key].—Mathis and Zatwarnicki 1995: 232 [world catalog].—Keiper and Walton 2000: 468–475 [natural history, immature stages].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: facial carina low, bluntly rounded, especially ventrally; brown color of anepisternum continued ventrally to about dorsal ⅙–⅓, thereafter sharply delimited from pale gray coloration on ventral pleural region; apparent merger of fused surstyli with epandrium in lateral view indicated by a rounded emargination; gonite (Fig. 17) tapered and moderately pointed apically, apex lacking a stout, toothlike seta.

Specimens examined.—MEXICO. *México:* Nevado de Toluca, 7 Aug 1972, R. Gangan, T. P. Sluss (1 ♂, 6 ♀; USNM); Mexico City, 17 Sep, J. Muller (1 ♀; USNM); Toluca (32 km E; 3,048 m), 12 Aug 1954, P. R. Dreisbach (1 ♀; USNM). *Morelos:* Cuernavaca, Jul 1965, N. L. H. Krauss (2 ♀; USNM).

Distribution.—Nearctic: USA (AZ, CA, NM, TX). Neotropical: Mexico (MEX, MOR).

Natural history.—Keiper and Walton (2000) published an excellent study on the immature stages and biology of this species and included a key to the third-instar larvae of all available species from the New World. They discovered that larvae of this species are hyponeustic (are suspended from the water's surface by hydrofuge hairs on the posterior spiracles) and exhibit great versatility in feeding. The larvae collected or scraped algae and detritus from solid substrates or brought their mouthparts to the water's surface and created a vortex to initiate filter feeding. This species is able to colonize and complete larval development in habitats where the food quality varied considerably.

ACKNOWLEDGMENTS

We gratefully acknowledge the assistance and cooperation of many organizations and individuals who contributed to the field work and production of this paper. To David A. Grimaldi (AMNH), Jon K. Gelhaus and Donald F. Azuma (ANSP), John E. Chainey (BMNH), J. Richard Vockeroth (CNC), and their institutions, who loaned specimens, we express our sincere thanks.

The illustrations were carefully inked by Mr. Young T. Sohn. Hollis B. Williams provided technical support. We thank Robert K. Robbins for making the digitized maps available to us. For reviewing a draft of this paper, we thank Terry Wheeler, Joe B. Keiper, Tadeusz Zatwarnicki, and Stephen D. Gaimari. We are also grateful to David Challinor, former Assistant Secretary for Research, and to Anna K. Bernensmeyer and David L. Pawson, former Associate Directors for Science, National Museum of Natural History, Smithsonian Institution, for financial support to conduct research at The Natural History Museum (BMNH), London, England, through grants from the Research Opportunity Fund. In 1995, 1996, and 1998, field work on the West Indies was funded in large measure by grants from the Biodiversity Program (Biotic Surveys and Inventories, BSI), National Museum of Natural History, Smithsonian Institution (Lynne R. Parenti, former chair, George R. Zug, chair). Field work on the West Indies was greatly expedited through the able and pleasant assistance of N. Dianne Mathis, Hollis B. Williams, Kelvin Guerrero, Daniel E. Pérez-Gelabert, and Oliver S. Flint, Jr. Field work in Bolivia was supported by a grant from the Biodiversity Program (Biotic Surveys and Inventories, BSI), National Museum of Natural History, Smithsonian Institution (George R. Zug, chair). Field work in Guyana was supported by the Smithsonian Institution's Biological Diversity of the Guianas Program (publication number 64; Vicki A. Funk, Director; Carol L. Kelloff, Coordinator).

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 425–440

MIRIDAE (HETEROPTERA) RECORDED FROM CHINA SINCE THE 1995 WORLD CATALOG BY R. T. SCHUH

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Abstract.—A list of described and recorded species of Miridae from China since the 1995 world catalog of plant bugs by R. T. Schuh is presented. Information about descriptions, figures, distributions, type specimens, host plants, and references are listed in order to guide further studies on these insects.

Key Words: list, Heteroptera, Miridae, China

Miridae, the largest family in hemipteran suborder Heteroptera, contains about 10,000 species, belonging to eight subfamilies, about 30 tribes, and more than 1,000 genera (Schuh 1995, Schuh and Slater 1995). In 1995, Schuh published his fine world catalog of mirids, which followed Carvalho's world catalog (1952–1960). In 1995, Zheng published a list of Chinese mirids described since Carvalho's catalog. Because the mirid fauna of China is large, very interesting, and not wholly known, descriptions of new mirids have continued to be published since Schuh (1995) and Zheng (1995).

We have gathered these post 1995 descriptions, checked them, and present here a list of 215 species described or recorded from China since 1994. The list includes 4 genera, 125 species, 1 subspecies, and 44 records new for China, and 45 combinational or nomenclatorial changes.

Abbreviations used: BML: The Natural History Museum, London; DBNU: Department of Biology, Tiejin Nankai University; DPPBAN: Department of Plant Protection, Beijing Agricultural University; HNHM: Hungarian Natural History Museum, Budapest, Hungary; HUESJ: Hokkaido University of Education, Sapporo, Japan; DBIMNU: Department of Biology, Inner Mongolia Normal University, China; IZAS: Institute of Zoology, Academia Sinica, Beijing; NSMT: National Science Museum (National History), Tokyo, Japan; NWAU: Northwestern Agricultural University, Yangling, Shaanxi Province, China; TNHM: Tianjin Natural History Museum, Tianjin; USNM: National Museum of Natural History, Smithsonian Institution, Washington D.C.; ZIRASP: Zoological Institute, Russian Academy of Sciences, St. Petersburg; BJ: Beijing; GD: Guangdong Province; GS: Gansu Province; GX: Guangxi Province; FJ: Fujian Province; HEB: Hebei Province; HEN: Henan Province; HLJ: Heilongjiang Province; HN: Hainan Province; HUB: Hubei Province; HUN: Hunan Province; IM: Inner Mongolia Autonomous Region; JL: Jijin Province; LN: Liaoning Province; NX: Ningxia Province; QH: Qinghai Province; SAX: Shaanxi Province; TW: Taiwan Province; XJ: Xinjiang Autonomous Region; XZ: Xizang Automonous Region; YN: Yunnan Province; ZJ: Zhejiang Province.

Miridae Hahn 1833

Orthotylinae Van Duzee 1916 (1865)

Halticini A. Costa 1853

Coridromius Signoret 1862

Coridromius chinensis Liu and Zhao 1999: 57–58, figs. 3–8 (n. sp. description; distribution; dorsal view of body; male genitalia. Holotype and 32 paratypes, GX; 1 paratype, TW; 57 paratypes, FJ. All types deposited in DBNU). Host plant unknown.

Coridromius testaceous Liu and Zhao 1999: 56–57, figs. 1–2 (n. sp. description; distribution; dorsal view of body, hind leg. Holotype, HN. Deposited in DBNU). Host plant unknown.

Orthotylini Van Duzee 1916 (1865)

Cyllecoris Hahn 1834

Cyllecoris badius Liu and Zheng 1999a: 102, 103–104, figs. 22-1-1, 22-2 (n. sp. description; key; distribution; dorsal view of head and pronotum, male genitalia. Holotype, IM. Deposited in DBNU). Host plant unknown.

Cyllecoris nakanishii Miyamoto 1969; Liu and Zheng 1999a: 102, 105 (new record; key; distribution; 2 specimens examined, JL. Deposited in DBNU). Host plant unknown.

Cyllecoris opacicollis Kerzhner 1988; Liu and Zheng 1999a: 102, 105–106, figs. 22-4 (new record; key; distribution; male genitalia; 2 specimens examined, NX. Deposited in DBNU). Host plant unknown.

Cyllecoris rectus Liu and Zheng 1999a: 102, 106–107, figs. 22-5 (n. sp. description; key; distribution; dorsal view of head-pronotum; male genitalia. Holotype, HEN. Deposited in DBNU). Host: unknown.

Labopidea Uhler 1877

Labopidea algens (Vinokurov 1982) (*Orthotylus* (*Labopidea*)); Tian and Bai 1998: 125, 126, figs. 31–33 (new record; key; brief description; distribution; male genitalia; IM). Host plant: *Atriplex* sp.

Orthotylus Fieber 1858

Orthotylus (*Melanotrichus*) *minutus* Jakovlev 1877; Tian and Bai 1998: 125, 126, figs. 22–24 (new record; key; brief description; distribution; male genitalia; IM). Host plant: Chenopodiaceae.

Orthotylus (*Orthotylus*) *riparius* Kulik 1973; Tian and Bai 1998: 125, 126, figs. 7–9 (new record; key; brief description; distribution; male genitalia; IM). Host plant unknown.

Orthotylus (*Pinocapsus*) *alashanensis* Tian and Bai 1999: 66–67, 69, fig. 1 (n. sp. description; distribution; host; dorsal view of body; male genitalia. Holotype, allotype and 7 paratypes, IM. Deposited in DBIMNU). Host plant: *Sabina vulgaris* Antoine.

Orthotylus (*Pinocapsus*) *sabinae* Tian and Bai 1999: 67–69, fig. 2 (n. sp. description; distribution; host; dorsal view of body; male genitalia. Holotype, allotype and 7 paratypes, IM. Deposited in DBIMNU). Host plant: *Sabina vulgaris* Antoine.

Pseudoloxops Kirkaldy 1905

Pseudoloxops pilosus Liu and Zheng 1994: 119–121, figs. 1–3 (n. sp. description; list; key, distribution; male genitalia in different views. Holotype, GS. Deposited in DBNU). Host plant unknown.

Pseudoloxops punctulatus Liu and Zheng 1994: 121–122, figs. 4–5 (n. sp. description; list; key, distribution; male genitalia in different views. Holotype, GS. Deposited in DBNU). Host plant unknown.

Pseudoloxops robustus Liu 1999: 51–53, 57, figs. 1–7 (n. sp. description; list; key, distribution; male genitalia in different views. Holotype and 1 paratype, YN. Deposited in DBNU). Host plant unknown.

Zanchius Distant 1904

Zanchius innotatus Liu and Zheng 1999b: 388–389, fig. 1 (n. sp. description; distribution; dorsal view of body. Holotype and 3 paratypes, HN. Deposited in DBNU). Host plant unknown.

Zanchius shaanxiensis Liu and Zheng 1999b: 389–390, figs. 2–6 (n. sp. description; distribution; dorsal view of body; male genitalia. Holotype and 5 paratypes, SAX. Deposited in DBNU). Host plant unknown.

Zanchius tibetanus Liu and Zheng 1999b: 390–391, figs. 7–10 (n. sp. description; distribution; dorsal view of body; male genitalia. Holotype, XZ. Deposited in DPPBAU). Host plant unknown.

Phylinae Douglas & Scott 1865

Phylini Douglas & Scott 1865

Acrotelus Reuter 1885

Acrotelus pilosicornis qinghaiensis Qi and Bai 1995a: 144–145, figs. 1–5 (n. subsp. description; distribution; hind leg. Holotype and 8 paratypes, QH. Deposited in DBIMNU). Host plant unknown.

Atomophora Reuter 1879

Atomophora flavidus Bai and Yang 1994: 18–19, figs. 6–11 (n. sp. description; distribution; dorsal view of body; front view of head; male genitalia. Holotype and 2 paratypes, IM. Deposited in DBIMNU). Host plant unknown.

Atomophora punctulatus Bai and Yang 1994: 19–20, figs. 12–17 (n. sp. description; distribution; dorsal view of body; front view of head; male genitalia. Holotype and 7 paratypes, IM. Deposited in DBIMNU). Host plant unknown.

Campylomma Reuter 1878

Campylomma annulicornis (Signoret 1865) (*Litocoris*); Qi and Bai 1996a: 50, 52, fig. 4 (new record; list, distribution, brief description, male phallus and paramere; IM). Host plant unknown.

Campylomma verbasci (Meyer-Duer 1843) (*Capsus*); Qi and Bai 1996a: 50, 52–53, fig. 5 (new record; list, distribution, brief description, male phallus and paramere; IM). Host plant unknown.

Compsidolon Reuter 1899

Compsidolon absinthii (Scott 1870) (*Agalliastes*); Qi and Bai 1995b: 226 (new record; distributions; QH). Host plant unknown.

Compsidolon kerzhneri Kulik 1973; Bai and Yang 1994: 17 (new record; distribution; IM). Host plant unknown.

Compsidolon pumilum (Jakovlev, 1876) (*Agalliastes*); Bai and Yang 1994: 17 (new record; distribution; IM). Host plant unknown.

Compsidolon punctulatus Qi and Bai 1995b: 225–226, figs. 1–6 (n. sp. description; distribution; dorsal view of body; male genitalia. Holotype and 9 paratypes, XJ. Deposited in DBIMNU). Host plant unknown.

Dacota Uhler 1872

Dacota hesperia Uhler 1872; Bai and Chen 1996: 185 (new record; distribution; IM). Host plant unknown.

Leucopterum Reuter 1879

Leucopterum candidatum Reuter 1879; Qi and Bai 1997: 11–12, 14, figs. 8–16 (new record; redescription; distribution; dorsal view of male body; claw; male genitalia; XJ). Host plant: *Artemisia* sp.

Monochroica Qi & Bai 1996

Type species: *Monochroica alashanensis* Qi and Bai 1996

Monochroica Qi and Bai 1996b: 298–299, 302–303, figs. 1–9 (new genus; description of general characters and the type species; identification).

Monochroica alashanensis Qi and Bai 1996b: 299–301, 303–305, figs. 1–9 (n. sp. description; distribution; front view of head; lateral view of head-pronotum; tibia and tarsus of hind leg; male genitalia. Holotype, allotype and 8 paratypes, IM.

Deposited in DBIMNU). Host plant: *Sabina vulgaris* Antoine.

Oncotylus Fieber 1858

Oncotylus Fieber 1858; Qi and Bai 1997: 12 (new record).

Oncotylus vitticeps Reuter 1879; Qi and Bai 1997: 13–14, figs. 17–22 (new record; redescription; distribution; dorsal view of head and pronotum; male genitalia; XJ). Host plant: *Artemisia* sp.

Phoenicocoris Reuter 1875

Phoenicocoris qilianamus Zheng and Li 1996: 101–103, figs. 1–8 (n. sp. description; distribution; front and lateral view of head; male genitalia. Holotype and 5 paratypes, GS. Deposited in DBNU). Host plant unknown.

Placochilus Fieber 1858

Placochilus paraseladonicus Qi and Bai 1995a: 143–144, figs. 1–5 (n. sp. description; distribution; male genitalia. Holotype and 2 paratypes, XJ. Deposited in DBIMNU). Host plant unknown.

Plagiognathus Fieber 1858

Plagiognathus muculosus Zhao and Li 1996: 352, 353, figs. A, B (n. sp. description; distribution; male genitalia. Holotype, allotype and 28 paratypes, GS. Deposited in DBNU). Host plant: *Tamarix* sp.

Psallopsis Reuter 1901

Psallopsis halostachydis Putshkov 1975; Bai and Yang 1994: 18 (new record; distribution; IM). Host plant unknown.

Psallopsis kirgisicus (Becker 1864) (*Capsus*); Bai and Yang 1994: 18 (new record; distribution; IM). Host plant unknown.

Psallus Fieber 1858

Psallus (*Psallus*) *fallenii* Reuter 1883; Qi and Bai 1994b: 342 (new record; distribution; IM). Host plant unknown.

Psallus (*Psallus*) *flavescens* Kerzhner 1987; Qi and Bai 1994b: 342 (new record; distribution; IM). Host plant unknown.

Psallus (*Phylidea*) *innermongolicus* (Qi and Bai 1995) (n. nom. for *Psallus* (*Phylidea*) *kerzhneri,* (a junior primary homonym of *Psallus* (*Phylidea*) *kerzhneri* Josifov, 1992) by Qi and Bai 1995d: 256) (= *Psallus* (*Phylidea*) *kerzhneri* Qi and Bai 1994b: 341–344, figs. 3–7 (n. sp. description; distribution; hind femora; male genitalia. Holotype and allotype, IM. Deposited in DBIMNU. Host plant unknown)). (n. syn. of *Psallus* (*Phylidea*) *ulmi* Kerzhner and Josifov 1966 by Kerzhner 1997: 245–248).

Solenoxyphus Reuter 1875

Solenoxyphus flavicans Qi and Bai 1996c: 293–294, 299, figs. 1–7 (n. sp. description; key; distribution; dorsal view of male body; male genitalia. Holotype and 116 paratypes, XJ. All deposited in DBIMNU). Host plant: *Artemisia* ssp.

Solenoxyphus lepidus (Puton, 1874) (*Macrocoleus*) (*Compsidolon gobicus* Bai and Yang 1994: 17–18, figs. 1–5; n. syn. by Qi and Bai 1996c: 296–297, 299, figs. 14–20) (new record; description; key; distribution; male genitalia; XJ). Host plant: *Artemisia* ssp.

Solenoxyphus viridulus Qi and Bai 1996c: 295–296, 299, figs. 8–13 (n. sp. description; key; distribution; dorsal view of male body; male genitalia. Holotype and 116 paratypes, QH, XJ. All deposited in DBIMNU). Host plant: *Artemisia* ssp.

Tuponia Reuter 1875

Tuponia (*Tuponia*) *arcufera* Reuter 1879; Qi and Bai 1997: 9, 14 (new record; distribution; IM). Host plant: *Tamarix* sp.

Tuponia (*Tuponia*) *brevicula* Qi and Bai 1997: 10–11, 14, figs. 1–7 (n. sp. description; distribution; dorsal view of male body; male genitalia. Holotype and 8 paratypes, XJ. All deposited in DBIMNU). Host plant: *Tamarix* sp.

Tuponia (*Tuponia*) *mongolica* Drapolyuk 1980; Qi and Bai 1997: 10–11, 14 (new record; description; IM). Host plant unknown.

Pilophorini Douglas & Scott 1876

Pilophorus Hahn 1826

Pilophorus clavatus (Linne 1767) (*Cimex*); Qi and Bai 1996a: 50, 51, fig. 2 (new record; list, distribution, brief description, male genitalia; IM). Host plant unknown.

Pilophorus lucidus Linnavori 1962; Qi and Bai 1996a: 50, 51–52, fig. 3 (new record; list, distribution, brief description, dorsal view of male body; IM). Host plant unknown.

Hypseloecus Reuter 1891

Hypseloecus camplus (Kulik, 1968) (*Pherolepis*); Qi and Bai 1996a: 50–51, fig. 1 (new record; list, distribution, brief description, male genitalia; IM). Host plant unknown.

Bryocorinae Baerensprung 1860

Bryocorini Baerensprung 1860

Bryocoris Fallén 1829

Bryocoris (*Bryocoris*) *bui* Hu and Zheng 2000: 244, 245–248, figs. 5, 10, 14, 26, 40, 41 (n. sp. description; key; distribution; dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype and 4 paratypes, YN. Deposited in DBNU). Host plant unknown.

Bryocoris (*Bryocoris*) *concavus* Hu and Zheng 2000: 244, 248–249, figs. 8, 30, 42 (n. sp. description; key; distribution; dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype and 36 paratypes, YN, SC, XZ. Deposited in DBNU, BML, ZIRASP, HUESJ). Host plant unknown.

Bryocoris (*Bryocoris*) *insuetus* Hu and Zheng 2000: 244, 249–251, figs. 13, 18, 24, 39, 44 (n. sp. description; key; distribution; dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype and 5 paratypes, YN, SC. Deposited in DBNU). Host plant unknown.

Bryocoris (*Bryocoris*) *xiongi* Hu and Zheng 2000: 244, 251–253, figs. 11, 12, 37, 38, 45 (n. sp. description; key; distribution, dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype and 12 paratypes, YN. Deposited in DBNU). Host plant unknown.

Bryocoris (*Cobalorrhynchus*) *lii* Hu and Zheng 2000: 244, 259–261, figs. 17, 23, 53 (n. sp. description; key; distribution; dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype and 21 paratypes, XZ, YN. Deposited in DBNU). Host plant unknown.

Bryocoris (*Cobalorrhynchus*) *lobatus* Hu and Zheng 2000: 244, 261–262, figs. 4, 31, 54 (n. sp. description; key; distribution, dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype and 7 paratypes, YN. Deposited in DBNU). Host plant unknown.

Bryocoris (*Cobalorrhynchus*) *sichunanensis* Hu and Zheng 2000: 244, 262–264, figs. 2, 9, 28, 55 (n. sp. description; key; distribution, dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype and 26 paratypes, SC. Deposited in DBNU, IZAS, ZIRASP). Host plant unknown.

Bryocoris (*Cobalorrhynchus*) *vittatus* Hu and Zheng 2000: 244, 264–265, figs. 6, 27, 56 (n. sp. description; key; distribution, dorsal view of body; lateral view of head and pronotum; male genitalia. Holotype, YN; 21 paratypes, YN, GX, SZ, TW. Deposited in DBNU, TNHM, BML). Host plant unknown.

Dicyphini Reuter 1883

Mansoniella Poppius 1915

Mansoniella annulata Hu and Zheng 1999a: 159–161, figs. 3, 15 (n. sp. description; dorsal view of body; lateral view of head. Holotype and 2 paratypes, SAX; 1 paratype, SC. Deposited in DBNU). Host plant unknown.

Mansoniella cinnamomi (Zheng and Liu 1992) (*Pachypeltis*); Zheng and Liu 1992: 170, fig. 19 (n. comb.; distribution;

male paramere; HUN). Host plant unknown.

Mansoniella cristata Hu and Zheng 1999a: 161–162, figs. 7, 12 (n. sp. description; distribution; dorsal view of body; lateral view of head-pronotum. Holotype, YN. Deposited in DBNU). Host plant unknown.

Mansoniella flava Hu and Zheng 1999a: 164–165, figs. 5, 8 (n. sp. description; distribution; dorsal view of body; male genitalia. Holotype and 1 paratype, SAX. Deposited in DBNU). Host plant unknown.

Mansoniella juglandis Hu and Zheng 1999a: 165–166, figs. 4, 13, 14, 18 (n. sp. description; distribution; dorsal view of body; lateral view of head-pronotum; male paramere. Holotype and 9 paratypes, SC. Deposited in DBNU). Host plant unknown.

Mansoniella rosacea Hu and Zheng 1999a: 166–167, figs. 2, 9, 17 (n. sp. description; distribution; dorsal view of body; lateral view of head-pronotum; male genitalia. Holotype, GS. Deposited in DBNU). Host plant unknown.

Mansoniella rubida Hu and Zheng 1999a: 167–169, figs. 1, 10 (n. sp. description; distribution; dorsal view of body; lateral view of head-pronotum. Holotype and 1 paratype, SAX. Deposited in DBNU). Host plant unknown.

Mansoniella sassafri (Zheng and Liu 1992) (*Pachypeltis*); Zheng and Liu 1992: 170, fig. 21 (n. comb.; distribution; left paramere; HHN). Host plant unknown.

Mansoniella wangi (Zheng and Li 1992) (*Pachypeltis*); Zheng and Li 1992: 170, fig. 20 (n. comb.; distribution; male paramere; HN). Host plant unknown.

Pachypeltis Signoret 1858

Pachypeltis biformis Hu and Zheng 1999b: 1–6, figs. 1–3, 5, 7 (n. sp. description; distribution; dorsal view of male body; lateral view of female head and pronotum; male genitalia. Holotype and 6 paratypes, GX; 6 paratypes, HN. Deposited in DBNU). Host plant unknown.

Eccritotarsini Berg 1883

Sinevia Kerzhner 1988

Sinevia pallidipes (Zheng and Liu 1992) (*Bryocoris*); Zheng and Liu 2000: 265–266, figs. 3, 49, 57 (n. comb.; distribution; key; dorsal view of head; male genitalia; HUN, GX, SAX. Material examined deposited in DBNU, TNHM). Host plant unknown.

Monaloniini Reuter 1892

Dimia Kerzhner 1988

Dimia Kerzhner 1988; Hu and Zheng 2001: 414–415 (new record, identification).

Dimia inexpectata Kerzhner 1988; Hu and Zheng 2001: 415 (new record; distribution; identification; HN). Host plant unknown.

Eupachypeltis Poppius 1915

Eupachypeltis unicolor Hu and Zheng 2001: 416–417, fig. 1 (n. sp. description; dorsal and lateral view of head and pronotum; front view of head. Holotype and 1 paratype, HN. Deposited in DBNU). Host plant unknown.

Felisacus Distant, 1904

Felisacus amboinae Woodward 1954; Hu and Zheng 2001: 417 (new record; key; distribution; fig. 3, dorsal view of head; HN). Host plant unknown.

Felisacus curvatus Hu and Zheng 2001: 417–419, fig. 2 (n. sp. description; dorsal view of body; paramere. Holotype and 1 paratype, HN. Deposited in DBNU). Host plant unknown.

Felisacus insularis Miyamoto 1965; Hu and Zheng 2001: 419 (new record; key; identification; distribution; FJ, YN, GD, HN). Host plant unknown.

Felisacus magnificus Distant 1904; Hu and Zheng 2001: 419 (new record; key; fig. 4, paramere; identification; distribution; FJ, YN, GD, HN). Host plant unknown.

Parapachypeltis Hu & Zheng 2001

Type species: *Parapachypeltis punctatus* Hu and Zheng 2001

Parapachypeltis Hu and Zheng 2001: 422–423 (new genus; description of general characters and the type species; identification).

Parapachypeltis punctatus Hu and Zheng 2001: 423–424, fig. 5 (n. sp. description; dorsal view of body; dorsal and lateral view of pronotum; antennal segments; paramere. Holotype and 2 paratypes, GD. Deposited in DBNU). Host plant unknown.

Ragwelellus Odhiambo 1962

Ragwelellus Odhiambo 1962; Hu and Zheng 2001: 424 (new record; identification).

Ragwelellus rubrinus Hu and Zheng 2001: 424–245, fig. 6 (n. sp. description; dorsal view of body, paramere. Holotype and 9 paratypes, HN, YN, GD. Deposited in DBNU). Host plant unknown.

Deraeocorinae Douglas & Scott 1865

Deraeocorini Douglas & Scott 1865

Alloeotomus Fieber 1858

Alloeotomus kerzhneri Qi and Bai 1994a: 458–459, figs. 1–5 (n. sp. description; distribution; male genitalia. Holotype, IM. Deposited in DBIMNU). Host plant unknown.

Alloeotomus montanus Qi and Bai 1995c: 13, 15–16, figs. 1–8 (n. sp. description; key; distribution; hemelytra; male phallotheca, genitalia. Holotype and 7 paratypes, IM. Deposited in DBIMNU). Host unknown.

Bothynotus Fieber 1864

Bothynotus Fieber 1864; Qi and Bai 1994a: 460 (new record).

Bothynotus pilosus (Boheman 1852); Qi and Bai 1994a: 460 (new record; distribution; IM). Host unknown.

Deraeocoris Kirschbaum 1856

Deraeocoris (Camptobrochis) brunneus Qi and Bai 1994a: 459–460, figs. 6–8 (n. sp. description; distribution; male genitalia. Holotype, IM. Deposited in DBIMNU). Host unknown.

Deraeocoris (Camptobrochis) lutescens (Schilling 1837); Qi and Bai 1994a: 460 (new record; distribution; IM). Host unknown.

Deraeocoris (Camptobrochis) onphoriensis Josifov 1992; Ma and Zheng 1997a: 3 (new record; distribution; GS, HEB, SX, JL). Host unknown.

Deraeocoris (Camptobrochis) zoui Ma and Zheng 1997b: 20–23, figs. 1–3 (n. sp. description; distribution; male genitalia. Holotype and 1 paratype, SC. Deposited in DBNU). Host unknown.

Deraeocoris (Deraeocoris) guizhouensis Ma and Zheng 1997a: 1–3, figs. 1–7 (n. sp. description; distribution; male genitalia. Holotype and 6 paratypes, GZ. Deposited in DBNU). Host unknown.

Deraeocoris (Deraeocoris) morio (Boheman 1852); Qi and Bai 1994a: 460 (new record; distribution; IM). Host unknown.

Deraeocoris (Deraeocoris) ventralis (Reuter 1904); Qi and Bai 1994a: 461 (new record; distribution; IM). Host unknown.

Deraeocoris fujianensis Ma and Zheng 1998: 36–38, figs. 1–8 (n. sp. description; distribution; male genitalia. Holotype and 5 paratypes, FJ. Deposited in DBNU). Host unknown.

Deraeocoris pallidicornis Josifov 1983; Qi and Bai 1994a: 460 (new record; distribution; IM). Host unknown.

Deraeocoris pseudokerzhneri Ma and Zheng 1998: 38–40, figs. 9–12 (n. sp. description; distribution; male genitalia. Holotype and 18 paratypes, SC. Deposited in DBNU). Host unknown.

Mirinae Hahn 1833

Mirini Hahn 1833

Allorhinocoris Reuter 1876

Allorhinocoris Reuter 1876; Lu 1994: 205 (new record).

Allorhinocoris chinensis Lu 1994: 205–208, figs. 1–5 (n. sp. description; distribution; key; male genitalia. Holotype and 6 paratypes, GS, SX, HEB. Deposited in DBNU). Host unknown.

Allorhinocoris flavus Sahlberg 1878; Lu 1994: 205 (new record; distribution; key; XJ). Host plant unknown.

Apolygus China 1941

Apolygus angustus (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; SC); Kerzhner and Josifov 1999: 62 (n. comb.). Host plant unknown.

Apolygus sinicus (Kerzhner and Schuh 1995) (*Lygocoris*); Lu and Zheng 1996: 134–135 (*Lygocoris* (*Apolygus*) *badius*) (n. nom. and n. comb.); Kerzhner and Josifov 1999: 67 (n. comb.). Host plant unknown.

Apolygus castaneus (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; SC); Kerzhner and Josifov 1999: 62 (n. comb.). Host plant unknown.

Apolygus concinnus (Wang and Zheng 1982) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; FJ); Kerzhner and Josifov 1999: 63 (n. comb.). Host plant unknown.

Apolygus curvipes (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 136 (*Lygocoris* (*Apolygus*)) (n. comb.; HB); Kerzhner and Josifov 1999: 63 (n. comb.). Host plant unknown.

Apolygus elegans (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 136 (*Lygocoris* (*Apolygus*)) (n. comb.; HN); Kerzhner and Josifov 1999: 63 (n. comb.). Host plant unknown.

Apolygus emeia (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; FJ, SC); Kerzhner and Josifov 1999: 63 (n. comb.). Host plant unknown.

Apolygus eous (Poppius 1915) (*Lygus*); Lu and Zheng 1998c: 186 (n. comb.; brief description and note; TW). Host plant unknown.

Apolygus evonymi (Zheng and Wang 1982) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; SAX); Kerzhner and Josifov 1999: 63 (n. comb.). Host plant unknown.

Apolygus fuhoshoensis (Poppius 1915) (*Lygus*); Lu and Zheng 1998c: 186 (n. comb.; brief description and note; TW). Host plant unknown.

Apolygus fujianensis (Wang and Zheng 1982) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; FJ); Kerzhner and Josifov 1999: 63 (n. comb.). Host plant unknown.

Apolygus gleditsiicola Lu and Zheng 1997a: 162–163, figs. 1–4 (n. sp. description; distribution; male genitalia. Holotype and 3 paratypes, HEN; 1 paratype, HB. Deposited in DBNU). Host plant unknown.

Apolygus hainanensis (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; HN); Kerzhner and Josifov 1999: 64 (n. comb.). Host plant unknown.

Apolygus kosempoensis (Poppius 1915) (*Lygus*); Lu and Zheng 1998c: 185–186, figs. 1–5 (n. comb.; brief description and note, male genitalia; TW). Host plant unknown.

Apolygus liaoningensis (Lu and Zheng 1996) (*Lygocoris* (*Apolygus*)); Lu and Zheng 1996: 131–132, figs. 1–6 (n. sp. description; distribution; anterior and lateral view of head; hemelytra; male genitalia. Holotype and 4 paratypes, LN. Deposited in DBNU. Host plant: *Euvonymus* sp.); Kerzhner and Josifov 1999: 65 (n. comb.).

Apolygus major (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; SC); Kerzhner and Josifov 1999: 65 (n. comb.). Host plant unknown.

Apolygus medionigritus Lu and Zheng 1997a: 163–165, figs. 5–8 (n. sp. description; distribution; male genitalia. Holotype and 58 paratypes, GS; 2 paratypes, SC. Deposited in DBNU). Host plant unknown.

Apolygus mosaicus (Zheng and Wang 1982) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; GD); Kerzhner and Josifov 1999: 66 (n. comb.). Host plant unknown.

Apolygus nigricans (Wang and Zheng 1982) (*Lygocoris*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; FJ); Kerzhner and Josifov 1999: 66 (n. comb.). Host plant unknown.

Apolygus nigricostalis Lu and Zheng 1997a: 165–166, figs. 9–11 (n. sp. description; distribution; male genitalia. Holotype and 6 paratypes, XZ. Deposited in IZAS). Host plant unknown.

Apolygus ornatus (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; HUB); Kerzhner and Josifov 1999: 66 (n. comb.). Host plant unknown.

Apolygus picturatus (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 136 (*Lygocoris* (*Apolygus*)) (n. comb.; GX); Kerzhner and Josifov 1999: 67 (n. comb.). Host plant unknown.

Apolygus triangulus (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; HUB); Kerzhner and Josifov 1999: 68 (n. comb.). Host plant unknown.

Apolygus ulmi (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*) *ulmicolus*) (n. nom. and n. comb.; BJ); Kerzhner and Josifov 1999: 68. Host plant unknown.

Apolygus wangi (Kerzhner and Schuh 1995) (*Lygocoris*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*) *signatus*) (n. comb.; SC); Kerzhner and Josifov 1999: 68 (n. comb.). Host plant unknown.

Apolygus yunnananus (Zheng and Wang 1983) (*Lygus*); Lu and Zheng 1996: 135 (*Lygocoris* (*Apolygus*)) (n. comb.; YN); Kerzhner and Josifov 1999: 68 (n. comb.). Host plant unknown.

Apolygus zhengianus Kerzhner and Schuh 1998: 171–172 (n. nom. for *Lygus* (*Apolygus*) *marginatus* Zheng and Wang 1983; SC); Kerzhner and Josifov 1999: 68 (n. comb.). Host plant unknown.

Apolygus zizyphi Lu and Zheng 1997a: 166–168, figs. 12–15 (n. sp. description; distribution; male genitalia. Holotype and 4 paratypes, AH. Deposited in DBNU and TNHM respectively). Host plant: *Zizyphus jujuba* var. *inermis* (Bunge).

Arbolygus Kerzhner 1979

Arbolygus ailaoensis Lu and Zheng 1998a: 82–83, figs. 1–5 (n. sp. description; key; list; distribution; male genitalia. Holotype, YN. Deposited in DBNU). Host plant unknown.

Arbolygus difficilis Lu and Zheng 1998a: 83–85, figs. 6–10 (n. sp. description; key; list; distribution; male genitalia. Holotype and 2 paratypes, SC; 9 paratypes, HUB; 2 paratypes, YN; 3 paratypes, XZ. Deposited in DBNU and IZAS respectively). Host plant unknown.

Arbolygus glaber (Kerzhner 1987) (*Lygocoris* (*Arbolygus*)); Miyamoto and Yasunaga 1989; Lu and Zheng 1998a: 80 (new record; list; distribution; SC. Deposited in DBNU). Host plant: *Quercus dentate* Thunberg.

Arbolygus himalayicus Lu and Zheng 1998a: 80, 81, 86–88, figs. 16–19 (n. sp. description; key; list; distribution; male genitalia. Holotype and 7 paratypes, XZ; 1 paratype, YN. Deposited in IZAS). Host plant unknown.

Arbolygus longustus Lu and Zheng 1998a: 80, 81, 88–89, figs. 20–25 (n. sp. description; key; list; distribution; male genitalia. Holotype and 12 paratypes, HUB. Deposited in DBNU). Host plant unknown.

Arbolygus picinus Lu and Zheng 1998a: 80, 81, 91–92, figs. 32–37 (n. sp. description; key; list; distribution; male genitalia. Holotype and 1 paratype, YN. Deposited in DBNU). Host plant unknown.

Arbolygus pronotalis (Lu and Zheng 1992)

(*Lygocoris* (*Arbolygus*)); Lu and Zheng 1998a: 81 (n. comb.; list; key; distribution; SC, HUN, FJ. Deposited in DBNU). Host plant unknown.

Arbolygus renae Lu and Zheng 1998a: 80, 81, 89–91, figs. 26–31 (n. sp. description; key; list; distribution; male genitalia. Holotype and 1 paratype, GS. Deposited in DBNU). Host plant unknown.

Arbolygus tibialis Lu and Zheng 1998a: 80, 81, 93–94, figs. 38–43 (n. sp. description; key; list; distribution; male genitalia. Holotype, SAX; 41 paratypes, SAX, NX, GS, HUB. Deposited in DBNU and HWAU respectively). Host plant unknown.

Arbolygus wuzhiensis Lu and Zheng 1998a: 80, 81, 85–56, figs. 11–14 (n. sp. description; key; list; distribution; male genitalia. Holotype, HN. Deposited in DBNU). Host plant unknown.

Arbolygus zhangi Lu and Zheng 1998a: 80, 81, 94–95, figs. 44–48 (n. sp. description; key; list; distribution; male genitalia. Holotype and 1 paratype, XZ. Deposited in IZAS). Host plant unknown.

Castanopsides Yasunaga 1992

Castanopsides dasypterus (Reuter 1906) (*Lygus*); Lu and Zheng 1998: 80, 81 (*Arbolygus*) (n. comb.; list; distribution; HUB, HUN, SC, GZ, YN, XZ. Deposited in DBNU). Host plant: *Hypericum* sp.

Castanopsides falkovitshi (Kerzhner 1979) (*Lygocoris* (*Arbolygus*)); Lu and Zheng 1998a: 80–81 (*Arbolygus*) (n. comb. and new record; list; key; distribution; HEB, FJ, SC. Deposited in DBNU). Host plant unknown.

Castanopsides kerzhneri (Josifov 1985) (*Lygocoris* (*Arbolygus*)); Miyamoto and Yasunaga 1989; Lu and Zheng 1998a: 80 (new record; list; key; distribution; SC. Deposited in DBNU). Host plant: *Quercus aliena* Blume, *Q. mongolicus* Fischer.

Castanopsides gotohi Yasunaga 1998a: 103, 106, figs. 11, 24–28 (n. sp. description; key; distribution; male genitalia. Holotype, TW. Deposited in HUES). Host plant unknown.

Castanopsides montanus Yasunaga 1998a: 103, 111, figs. 14, 33, 34, 37, 39, 41 (n. sp. description; key; distribution; male genitalia. Holotype, TW. Deposited in NSMT). Host plant unknown.

Castanopsides taiwanus Yasunaga 1998a: 103, 111, figs. 43, 47, 48 (n. sp. description; key; distribution; male genitalia. Holotype, TW. Deposited in NSMT). Host plant unknown.

Castanopsides takaii Yasunaga 1998a: 103, 105, figs. 3, 9, 10, 17, 18, 21, 23 (n. sp. description; key; distribution; male genitalia. Holotype, TW. Deposited in HUES). Host plant unknown.

Cheilocapsidea Poppius 1915

Cheilocapsidea pura (Yasunaga 1995) (*Carvalhopantilius*); Yasunaga and Kerzhner 1998: 88 (n. comb.; TW). Host plant unknown.

Cheilocapsidea rufescens (Yasunaga 1995) (*Carvalhopantilius*); Yasunaga and Kerzhner 1998: 88 (n. comb.; TW). Host plant unknown.

Dichrooscytus Fieber 1858

Dichrooscytus helanensis Qi and Bai 1996b: 300–301, 303–305, figs. 10–14 (n. sp. description; distribution; male genitalia. Holotype and 42 paratypes, IM. Deposited in DBIMNU). Host plant: *Sabina vulgaris* Antoine.

Heteropantilius Zheng & Liu 1992

Heteropantilius flavescens Yasunaga 1995a: 1 (n. sp. description; distribution. Holotype, TW). Host plant unknown.

Heteropantilius jinxiuensis Wang and Liu 2001: 320–322, figs. 1–3 (n. sp. description; distribution; male genitalia. Holotype and 3 paratypes, GX. Deposited in DBNU and IZAS). Host plant unknown.

Eurystylopsis Poppius 1911

Eurystylopsis angustatus Zheng and Lu 1995: 7–8, figs. 1, 3, 5, 7, 10, 13 (n. sp.

description; distribution; lateral view of head and pronotum; pubescence of antennal segment; male and female genitalia. Holotype and 4 paratypes, GS. Deposited in DBNU). Host plant unknown.

Eurystylopsis hiripes Zheng and Lu 1995: 8–9, figs. 2, 4, 6, 9, 11, 14 (n. sp. description; distribution; lateral view of head and pronotum; pubescence of antennal segment; male and female genitalia. Holotype and 11 paratypes, GS. Deposited in DBNU). Host plant unknown.

Parapantilius Reuter 1903

Parapantilius taiwanicus Yasunaga 1994: 688–691, fig. 4 (n. sp. description; distribution; key; vesica, posterior wall in anterior view, and paramere. Holotype and 8 paratypes, TW. Deposited in HUESJ). Host plant unknown.

Carvalhopantilius Yasunaga 1995

Type species: *Carvalhopantilius purus* Yasunaga 1995

Carvalhopantilius Yasunaga 1995b: 453–457, figs. 1–3 (new genus; description of general characters and the type species; identification).

Carvalhopantilius purus Yasunaga 1995b: 452–455, figs. 1–2 (n. sp. description; distribution; dorsal view of body; lateral view of head-pronotum; male genitalia. Holotype, TW. Deposited in NSMT). Host plant unknown.

Carvalhopantilius rufescens Yasunaga 1995b: 455–456, fig. 3 (n. sp. description; distribution; sclerotized rings in ventral view, posterior wall of bursa copulatrix in anterior view. Holotype and 1 paratype, TW. Deposited in NSMT). Host plant unknown.

Lygocorides Yasunaga 1991

Lygocorides affinis (Lu and Zheng 1997) (*Lygocoris* (*Lygocorides*)); Lu and Zheng, 1997b: 17–18, figs. 1–5 (n. sp. description; distribution; male genitalia. Holotype and 1 paratype, SAX. Deposited in DBNU). Host plant unknown.

Lygocorides rubricans Yasunaga 1996: 273 (n. sp. description; distribution; male genitalia. Holotype, TW. Deposited in HUES). Host plant unknown.

Lygocoris Reuter 1875

Lygocoris (*Lygocoris*) *calliger* Lu and Zheng 2001: 123–125, fig. 1 (n. sp. description; different views of male genitalia. Holotype and 5 paratypes, YN. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *chengi* Lu and Zheng 2001: 125–126, fig. 2 (n. sp. description; different views of male genitalia. Holotype and 25 paratypes, SC. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *diffusomaculatus* Lu and Zheng 2001: 126–128, fig. 3 (n. sp. description; different views of male genitalia. Holotype and 46 paratypes, GS, HUB. Deposited in DBNU, ZIRASP). Host plant unknown.

Lygocoris (*Lygocoris*) *dilutus* Lu and Zheng 2001: 128–129, fig. 4 (n. sp. description; different views of male genitalia. Holotype and 23 paratypes, GS, HUB. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *ferrugineus* Lu and Zheng 2001: 121–153, fig. 5 (n. sp. description; different views of male and female genitalia. Holotype and 35 paratypes, YN. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *fuscoscutellatus* (Reuter 1906) (*Lygus striicornis* var. *fuscoscutellatus*); Lu and Zheng 2001: 131–132, fig. 6 (description; different views of male genitalia; YN). Host plant unknown.

Lygocoris (*Lygocoris*) *guangxiensis* Lu and Zheng 2001: 132–134, fig. 7 (n. sp. description; different views of male genitalia. Holotype and 40 paratypes, GX. Deposited in DBNU, TNHM). Host plant unknown.

Lygocoris (*Lygocoris*) *idoneus* (Linnavuori 1963) (*Lygus*); Lu and Zheng 2001: 134–135, fig. 8 (new record; description and distribution; different views of male genitalia; GS, FJ, SC, YN). Host plant unknown.

Lygocoris (*Lygocoris*) *integricarinatus* Lu and Zheng 2001: 136–137, fig. 9 (n. sp. description; different views of male genitalia. Holotype and 3 paratypes, GS, SC. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *linnavuorii* Lu and Zheng 2001: 137–138, fig. 10 (n. sp. description; different views of male genitalia. Holotype and 19 paratypes, YN. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *maculiscutellatus* Lu and Zheng 2001: 139–141, fig. 11 (n. sp. description; different views of male and female genitalia. Holotype and 87 paratypes, SC. Deposited in DBNU, TNHM, ZIRASP, USNM and HNHM respectively). Host plant unknown.

Lygocoris (*Lygocoris*) *rufiscutellatus* Lu and Zheng 2001: 143–144, fig. 13 (n. sp. description; female genitalia. Holotype and 1 paratype, GS. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *rufomedialis* Lu and Zheng 2001: 144–146, fig. 14 (n. sp. description; different views of male genitalia. Holotype, YN. Deposited in DBNU). Host plant unknown.

Lygocoris (*Lygocoris*) *sichuanicus* Lu and Zheng 2001: 148–149, fig. 16 (n. sp. description; different views of genitalia. Holotype and 5 paratypes, SC. Deposited in DBNU and TNHM respectively). Host plant unknown.

Lygocoris (*Neolygus*) *bimaculatus* Lu and Zheng 1996: 134–135, figs. 12–16 (n. sp. description; distribution; male and female genitalia. Holotype and 22 paratypes, SC. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *bipuncticollis* (Poppius 1915) (*Lygus*); Lu and Zheng 1998c: 186–187, fig. 6 (n. comb.; brief description and note; right paramere; TW). Host plant unknown.

Lygocoris (*Neolygus*) *chinensis* Lu and Yasunaga 1994: 100–102, figs. 5–10 (n. sp. description; distribution; male and female genitalia. Holotype and 17 paratypes, IM, HLJ. Deposited in DBNU and HUESJ). Host plant unknown.

Lygocoris (*Neolygus*) *disciger* (Poppius 1915) (*Lygus*); Lu and Zheng 1998c: 187–188, figs. 7–11 (n. comb.; brief description and note; male genitalia; TW). Host plant unknown.

Lygocoris (*Neolygus*) *elongatulus* Lu and Zheng 1996: 205–206, 208–209, figs. 1–6 (n. sp. description; distribution; male genitalia and paramere; female genitalia. Holotype and 3 paratypes, GS. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *gansuensis* Lu and Zheng 1996: 206–207, 209, figs. 7–10 (n. sp. description; distribution; male genitalia. Holotype, GS. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *lativerticis* Lu and Wang 1997: 402–405, figs. 1–6 (n. sp. description; distribution; male genitalia. Holotype and 39 paratypes, GS. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *rufilorum* Lu and Zheng 1998b: 3, figs. 5–8 (n. sp. description; distribution; male genitalia. Holotype, FJ, GX, YN. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *salicicola* Lu and Zheng 1998b: 6, figs. 19–24 (n. sp. description; distribution; male genitalia. Holotype, GS. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *simillimus* Lu and Zheng 1998b: 8, figs. 25–28 (n. sp. description; distribution; male genitalia. Holotype, SC. Deposited in IZAS). Host plant unknown.

Lygocoris (*Neolygus*) *tilianus* Lu and Zheng 1996: 132–134, figs. 7–11 (n. sp. description; distribution; male and female genitalia. Holotype and 5 paratypes, NX. Deposited in DBNU). Host plant: *Tilia chinensis* Maximowicz.

Lygocoris (*Neolygus*) *v-nigrum* (Poppius

1915) (*Lygus*); Lu and Zheng 1998c: 187 (n. comb.; brief description and note; TW). Host plant unknown.

Lygocoris (*Neolygus*) *wuyiensis* Lu and Zheng 1998b: 2, figs. 1–4 (n. sp. description; distribution; male genitalia. Holotype, FJ, ZJ. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *xizangensis* Lu and Zheng 1998b: 9, figs. 19–32 (n. sp. description; distribution; male genitalia. Holotype, XZ. Deposited in IZAS). Host plant unknown.

Lygocoris (*Neolygus*) *yulongensis* Lu and Zheng 1998b: 5, figs. 13–18 (n. sp. description; distribution; male genitalia. Holotype, YN. Deposited in DBNU). Host plant unknown.

Lygocoris (*Neolygus*) *zhengi* Lu and Yasunaga 1994: 99–100, figs. 1–4 (n. sp. description; distribution; male genitalia. Holotype, SC. Deposited in DBNU). Host plant unknown.

Macrolygus Yasunaga 1992

Macrolygus viridulus Yasunaga 1992; Lu and Zheng 1997c: 286 (new record; HUB). Host plant unknown.

Metasequoiamiris Schwartz 1995

Type species: *Metasequoiamiris carvalhoi* Schwartz 1995

Metasequoiamiris Schwartz 1995: 401–408, figs. 1–19 (new genus; description of general characters and the type species; identification).

Metasequoiamiris carvalhoi Schwartz 1995: 401–408 figs. 1–19 (n. sp. description; distribution; male genitalia and paramere. Holotype, HUB). Host plant: *Cephalotaxus fortunei* Hooker, *Metasequoia glyptostroboides* Hu and Cheng, *Torreya* sp.

Orientomiris Yasunaga 1997

Orientomiris chinensis (Li and Zheng 1991) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; FJ). Host plant unknown.

Orientomiris pronotalis (Li and Zheng 1991) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; ZJ). Host plant unknown.

Orientomiris pseudopronotalis (Li and Zheng 1991) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; FJ). Host plant unknown.

Orientomiris rubripedus (Li and Zheng 1991) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; FJ). Host plant unknown.

Orientomiris tenuicornis (Li and Zheng 1991) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; GD). Host plant unknown.

Orientomiris yunnananus (Li and Zheng 1991) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; YN). Host plant unknown.

Orientomiris zoui (Li and Zheng 1991) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; YN). Host plant unknown.

Phytocoris Fallén 1814

Phytocoris elongatulus (Bai and Chen 1996); Aukema 1999 (n. nom. for *Phytocoris elongotus* Bai and Chen 1996: 182, 185, figs. 1–3 (n. sp. description; distribution; male genitalia. Holotype, allotype and 5 paratypes, GS. Deposited in DBIMNU)). Host plant unknown.

Phytocoris exohataensis Xu and Zheng 2001: 263–264, figs. 5, 32–40 (n. sp. description; distribution; hemelytra; male genitalia. Holotype, YN. Deposited in DBNU and DPPBAN). Host plant unknown.

Phytocoris macer Xu and Zheng 1997: 129–134 figs. 8–13 (n. sp. description; distribution; male genitalia. Holotype, NX, SAX. Deposited in DBNU). Host plant unknown.

Phytocoris ningxiaensis Bai and Chen 1996: 182–183, 185, figs. 4–7 (n. sp. description; distribution; male genitalia. Holotype and allotype, NX. Deposited in DBIMNU). Host plant unknown.

Phytocoris nitrariae Xu and Zheng 1997: 129–134 figs. 1–7 (n. sp. description; distribution; male genitalia. Holotype, NX. Deposited in DBNU). Host plant unknown.

Phytocoris wolongensis Xu and Zheng 2001: 257–259, figs. 2, 7–14 (n. sp. description; distribution; hemelytra; male genitalia. Holotype, SC. Deposited in DBNU). Host plant unknown.

Phytocoris wudingensis Xu and Zheng 2001: 260–263, figs. 4, 25–31 (n. sp. description; distribution; hemelytra, pronotum; male genitalia. Holotype, YN. Deposited in DBNU). Host plant unknown.

Phytocoris yongpinganus Xu and Zheng 2001: 259–260, figs. 3, 15–24 (n. sp. description; distribution; hemelytra, pronotum; male genitalia. Holotype, YN. Deposited in DBNU). Host plant unknown.

Poppiocapsidea Yasunaga 1998

Poppiocapsidea clypealis (Poppius 1915) (*Megacoelum*); Yasunaga 1998b: 63–70 (n. comb.; TW). Host plant unknown.

Sabactus Distant 1910

Sabactus sauteri (Poppius 1912) (*Lygus*); Lu and Zheng 1998c: 188, figs. 12–16 (n. comb.; brief description and note; male genitalia; TW). Host plant unknown.

Tinginotum Kirkaldy 1902

Tinginotum pini Kulik 1965; Lu and Zheng 1997c: 289 (new record; SC). Host plant unknown.

Stenodemini China 1943

Stenodema Laporte 1833

Stenodema (*Stenodema*) *deserta* Bai and Chen 1994: 86–87, figs. 1–6 (n. sp. description; distribution; dorsal view head and pronotum; antennae and leg; male genitalia. Holotype, allotype and 55 paratypes, IM. Deposited in DBIMNU). Host plant unknown.

Stenodema (*Stenodema*) *crassipes* Kiritshenko 1931; Bai and Chen 1994: 86 (new record; IM). Host plant unknown.

Stenodema (*Stenodema*) *mongolica* Bai and Chen 1994: 88–89, figs. 7–12 (n. sp. description; distribution; dorsal view head and pronotum; antennae and leg; male genitalia. Holotype, allotype and 3 paratypes, IM. Deposited in DBIMNU). Host plant unknown.

Stenodema (*Stenodema*) *sericanus* Fieber 1861; Bai and Chen 1994: 86 (new record; IM). Host plant unknown.

ACKNOWLEDGMENTS

We are very grateful to Prof. Zheng Leyi and Dr. Liu Guoqing, Department of Biology, Tiejin Nankai University, and Prof. Ma Enbo, Department of Biology, Shanxi University, for providing us with copies of their published papers.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 441–446

FLEA BEETLES (COLEOPTERA: CHRYSOMELIDAE) OCCURRING ON *AMARANTHUS RETROFLEXUS* L. IN ERZURUM PROVINCE, TURKEY, AND THEIR POTENTIAL AS BIOLOGICAL CONTROL AGENTS

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Abstract.—Species composition and abundance of flea beetles (Coleoptera, Chrysomelidae) associated with *Amaranthus retroflexus* L. (Amaranthaceae) were studied in Erzurum province, Turkey, to find potential candidates for biological control of this weed. Insects were collected by sweeping net and aspirator on plant foliage at eight localities four times during the growing season. During three years of exploration, ten species of flea beetles were collected *Chaetocnema breviuscula* (Faldermann), *Ch. concinna* (Marsham), *Ch. hortensis* (Geoffroy), *Ch. tibialis* (Illiger), *Longitarsus longipennis* Kutschera, *L. pellucidus* Foudras, *Phyllotreta atra* (F.), *Ph. cruciferae* (Goeze), *Ph. nigripes* (F.), and *Ph. vittula* (Redtenbacher). In all localities *Ch. tibialis* was more abundant than other species. Simple feeding tests in petri dishes showed that only the *Chaetocnema* species were actually feeding on leaves of *Amaranthus retroflexus.* Analysis of flea beetle species associated with this plant shows that it is probably not native to Turkey.

Key Words: flea beetles, biological control, *Amaranthus retroflexus* L., *Chaetocnema*

Amaranthus retroflexus L. (Amaranthaceae), or redroot pigweed, occurs throughout much of the world, including Europe, North and South America, Asia, Africa and Australia. In North America it is common from Canada to Mexico, and from the Atlantic to the Pacific coasts (Spencer 1957). It is a summer annual, commonly found in cultivated lands such as fields, gardens, and orchards; fallow land, stream valleys, beaches and streambanks, prairie ravines, roadsides, fence rows, and waste places (Roland and Smith 1969). *Amaranthus retroflexus* is harmful to livestock because it affects the kidneys of swine when animals consume large quantities of fresh material (Wohlgemuth et al. 1987), and it is considered an important exotic weed in North America (King 1966). However, the native range of this plant is unclear. Some authors believe it was introduced into the United States in the early 18th century (King 1966) and later to Eastern Europe and Russia (Nikitin 1983), but Auld and Medd (1987) considered it to be native to North America. Different sources provide opposing ideas on the history of its distribution. For example, according to Haughton (1978) it is native to Spain, from which it was brought to the New World by conquistadors. Bermejo and González (1994) suggest that the same conquistadors transported it in the opposite direction, from South America to Spain.

Three amaranth species occur in Turkey,

Amaranthus blitoides S. Wats, *A. graecizans* L., and *A. retroflexus*. However, only the latter species is common in Erzurum Province (Baytop 1994). *Amaranthus retroflexus* grows from 15 cm to 100 cm tall and becomes particularly abundant in vegetable fields (Baytop 1994). For this reason it is considered one of the most serious weeds in Turkey (Baytop 1994) as well as in Europe. Therefore it was chosen for biological control research within the framework of European Cooperation in the Field of Scientific and Technical Research (Müller-Scharer 1993, Schroeder et al. 1993).

Most of the biological control efforts regarding *Amaranthus retroflexus* are concentrated on the group of leaf beetles called flea beetles. It is the largest group within leaf beetles and is distributed throughout the world. The adults feed on the foliage of herbaceous plants, bushes and trees from a wide range of angiosperm families, as well as some gymnosperms. Larvae live in soil, plant tissues, or leaves. Many flea beetles cause severe damage to cultivated plants (Onat 1993; Naibo 1974; Kostromitin 1978; Aslan and Özbek 1998, 2000), however many other species have been successfully used as biological control agents of noxious weeds (Konstantinov and Vandenberg 1996). Aslan et al. (1999) and Aslan and Warchalowski (2001) recorded 244 flea beetle species and subspecies belonging to 21 genera in Turkey. Of these species, 21 cause extensive damage to various weeds in the vicinity of Erzurum (Aslan and Özbek 1999). Relatively few flea beetle species are recorded on *Amaranthus retroflexus* in Europe (Doguet 1994, Cagan et al. 2000).

The goal of our study was to collect flea beetles occurring on *Amaranthus retroflexus* in Erzurum Province of Turkey, assess their abundance, and provide information on their distribution and host range. Presence or absence of flea beetles limited in their host range to *Amaranthus retroflexus* would add valuable data to the ongoing discussion on the native range of this weed.

MATERIALS AND METHODS

Erzurum Province is located in the Eastern Anatolia region of Turkey at the average altitude of 1,850 m. It is a montane country with a variety of climatic conditions. A continental climate with hot and relatively dry summer and cold snowy winter dominates the eastern and western parts of Erzurum province at the altitude of 1500–1900 m. Northeastern parts of the province with altitudes close to 700 m have a less continental climate.

Field surveys of flea beetles associated with *Amaranthus retroflexus* were carried out in the first week of June, July, August and September at eight localities in different climatic regions of Erzurum province. Insects were collected by sweep net and by aspiration from plant foliage of 20 randomly chosen plants. Collected insects were taken to the laboratory, where they were sorted and identified. At the same time, ten adults of each species were put in petri dishes with leaves of *A. retroflexus*. During the following ten days petri dishes were checked for leaf damage caused by feeding.

RESULTS

Adults of the following species were collected on *Amaranthus retroflexus*: *Chaetocnema breviuscula* (Faldermann), *Ch. concinna* (Marsham), *Ch. hortensis* (Geoffroy), *Ch. tibialis* (Illiger), *Longitarsus longipennis* Kutschera, *L. pellucidus* Foudras, *Phyllotreta atra* (F.), *Ph. cruciferae* (Goeze), *Ph. nigripes* (F.), and *Ph. vittula* (Redtenbacher). *Chaetocnema* and *Phyllotreta* species were predominant in almost every locality.

Chaetocnema species were found in all observed localities. The most common among them was *Ch. tibialis* accounting for 78.8% of all flea beetles. In the northeastern towns of the province, Tortum, Oltu, Olur and Ņenkaya, *Ch. tibialis* and *Ch. concinna* were more abundant than in the eastern and western towns of the province. *Chaetocnema hortensis* and *Ch. breviuscula* were more abundant in the eastern and western

Table 1. Number of *Chaetocnema breviuscula* adults on *Amaranthus retroflexus* at different localities of Erzurum Province during 1998–2000.

Localities	1998				1999				2000			
	June	July	August	Sept.	June	July	August	Sept.	June	July	August	Sept
Aŗkale	11	14	17	2	5	12	17	1	15	12	11	2
Dumlu	2	1	7	1	2	5	4	2	6	5	7	0
Ilıca	9	7	8	2	8	4	9	1	11	6	12	4
Olur	2	0	5	0	3	1	3	1	1	3	2	0
Oltu	0	2	1	0	1	1	2	0	3	2	2	1
Pasinler	4	3	6	1	2	1	4	1	3	4	6	2
Ŗenkaya	0	2	1	0	1	0	3	1	3	0	2	0
Tortum	3	1	4	1	2	1	2	0	2	1	3	0

localities than in the northeastern parts of Erzurum Province. The number of *Chaetocnema* species collected in different localities of Erzurum Province is shown in Tables 1–4. *Phyllotreta* species were second in abundance after *Chaetocnema*, with *Phyllotreta atra* being the most abundant species of this genus (with 38.81% of individuals). *Longitarsus* species were least abundant with *L. pellucidus* being the most common species of this genus. The highest number of *L. pellucidus* was observed in Pasinler and Aŗkale. Very few specimens of *L. longipennis* were found in some localities.

Laboratory tests showed that only *Chaetocnema* species (*Ch. breviuscula* (Faldermann), *Ch. concinna* (Marsham), *Ch. hortensis* (Geoffroy), and *Ch. tibialis* (Illiger)) fed on *A. retroflexus*. The adults of other species did not feed on the leaves of *A. retroflexus*.

DISCUSSION

Chaetocnema tibialis is known to feed on amaranthus plants in Europe (Nonveiller 1960, 1978) and in Turkey (Aslan 1997). *Chaetocnema breviuscula*, *Ch. concinna* and *Ch. tibialis* are serious pests of sugar beet (*Beta vulgaris* L.) both in Turkey (Aslan and Özbek 1998, 2000; Yıldırım and Özbek 1992) and in some European countries (Gruev and Tomov 1986, Neves 1983, Slavchev 1984, Rimsa and Konecny 1983, Cooke 1992, Mostovaya 1994). However, our survey showed large numbers of them actively feeding on *Amaranthus retroflexus* causing significant damage to the plant. *Chaetocnema hortensis* commonly feeds on Gramineae species in Turkey (Aslan 1997) and some European countries (Mohr 1966, Gruev and Tomov 1986). Our survey confirms that it also feeds on *Amaranthus retroflexus*. It is important to note that all

Table 2. Number of *Chaetocnema concinna* adults on *Amaranthus retroflexus* at differnet localities of Erzurum Province during 1998–2000.

Localities	1998				1999				2000			
	June	July	August	Sept.	June	July	August	Sept.	June	July	August	Sept
Aŗkale	12	7	15	2	15	12	17	2	13	21	12	2
Dumlu	15	8	17	1	16	19	25	5	11	9	27	0
Ilıca	11	5	16	4	8	14	23	3	8	12	21	3
Olur	32	22	37	2	15	11	29	8	23	15	32	5
Oltu	28	22	38	5	24	16	37	4	18	13	18	3
Pasinler	16	14	16	7	22	11	32	9	13	17	26	5
Ŗenkaya	25	18	32	7	24	33	28	5	22	15	27	4
Tortum	23	14	31	1	12	15	29	2	24	19	32	0

Table 3. Number of *Chaetocnema hortensis* adults on *Amaranthus retroflexus* at different localities of Erzurum Province during 1998–2000.

	1998				1999				2000			
Localities	June	July	August	Sept.	June	July	August	Sept.	June	July	August	Sept.
Aŗkale	10	7	25	3	12	8	17	2	11	6	8	1
Dumlu	4	3	7	1	5	3	7	3	8	4	17	5
Ilıca	13	7	12	4	8	7	9	2	5	3	11	6
Olur	0	2	5	1	2	1	3	4	3	6	8	2
Oltu	3	0	2	0	4	2	7	1	2	3	2	0
Pasinler	11	5	16	7	12	6	14	7	11	7	16	4
Ŗenkaya	3	5	11	1	5	4	8	0	3	5	6	1
Tortum	0	2	5	0	2	4	9	1	2	8	5	2

aforementioned *Chaetocnema* species are widely polyphagous, feeding on plants from many families (Lopatin 1977). They also have wide geographic ranges throughout almost the entire Palearctic region (Konstantinov 1988).

The most common host plant of *Longitarsus longipennis* and *L. pellucidus* is *Convolvulus arvensis* (Gruev and Tomov 1986, Warchalowski 1996, Aslan 1997). Although commonly collected on *A. retroflexus* in Erzurum Province, they did not feed on this plant under laboratory conditions. Their presence on *A. retroflexus* is temporary and accidental. It happened only because of close coexistence of *Convolvulus arvensis* and amaranth. *Convolvulus arvensis* was often found climbing on *A. retroflexus* in many localities of Erzurum Province.

All *Phyllotreta* species generally feed on Cruciferae in Turkey (Aslan and Özbek 1988, 2000) and in Europe (Mohr 1966, Gruev and Tomov 1986, Kostromitin 1978). *Phyllotreta vittula* is known as important pest of crucifers, as well as sugar beets, cereals (Naibo 1974), and maize (Szoeke 1997). All collected *Phyllotreta* species are widely oligophagous or polyphagous. In laboratory tests they did not feed on *A. retroflexus.*

None of the species collected on *Amaranthus retroflexus* in Erzurum seems suited for biocontrol of this weed, although they collectively cause significant damage to the plant. The same results were obtained by Cagan et al. (2000) for *Amaranthus* species in Slovakia.

One of the biological features of a plant native to any particular region is the presence of phytophages (flea beetles in particular) closely associated with the plant. The host ranges of these phytophages are narrow (narrowly oligophagous or monophagous) and their distribution is often limited

Table 4. Number of *Chaetocnema tibialis* adults on *Amaranthus retroflexus* at different localities of Erzurum Province during 1998–2000.

	1998				1999				2000			
Localities	June	July	August	Sept.	June	July	August	Sept	June	July	August	Sept
Aŗkale	20	17	45	9	45	32	27	8	17	21	25	2
Dumlu	20	8	27	6	16	31	36	9	21	29	17	5
Ilıca	23	11	20	7	18	24	29	7	15	19	22	6
Olur	40	29	57	12	27	15	31	9	31	33	36	5
Oltu	35	25	28	9	14	21	27	11	28	30	24	8
Pasinler	16	14	16	7	22	11	32	9	13	17	26	7
Ŗenkaya	65	52	102	19	34	44	48	12	33	36	62	11
Tortum	30	21	41	10	26	28	29	5	22	29	33	9

to or does not exceed the range of the host plant. Absence of such oligophages or monophages on a given territory would suggest that it probably is not part of the native range of the plant. The fact that three years of exploration in Erzurum Province revealed no species of flea beetles specialized in feeding on *Amaranthus retroflexus* probably suggests that Erzurum Province of Turkey is not part of the native range of *Amaranthus retroflexus.*

ACKNOWLEDGMENTS

We thank E. E. Grisell and A. L. Norrbom (Systematic Entomology Laboratory, Washington, DC) and C. Staines (Department of Systematic Biology, Smithsonian Institution, Washington, DC) for reviewing this manuscript and providing valuable suggestions.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 447–451

SOME NEW GENERIC NAMES IN THE CICADELLIDAE (HEMIPTERA: DELTOCEPHALINAE, SELENOCEPHALINAE)

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Abstract.—**New replacement names** are proposed for eleven genera of deltocephaline and selenocephaline leafhoppers: ***Mehiphanes*** for *Hemiphanes* Emeljanov (subgenus of *Euscelis*), ***Ctenurellina*** for *Ctenurella* Vilbaste, ***Mocolinna*** for *Mocoa* Linnavuori & DeLong, ***Saadevra*** for *Saavedra* Linnavuori & DeLong, ***Salsocolila*** for *Salsolicola* Theron, ***Suarezilinna*** for *Suarezia* Linnavuori & DeLong, ***Idyinna*** for *Idyia* Linnavuori (subgenus of *Cicadulina*), ***Garusa*** for *Argusa* Emeljanov (subgenus of *Phlebiastes*), ***Dwightla*** for *Dwightia* Linnavuori & Al-Ne'amy, ***Bumka*** for *Kumba* Linnavuori & Al-Ne'amy, and ***Moluccazhangia*** for *Moluccasia* Zhang & Webb. The new generic names circumscribe 27 valid species, all of which, except three in the preoccupied subgenera, are here proposed in new combinations. The **new tribe Dwightlini** is proposed to replace Dwightiini.

Key Words: leafhoppers, Homoptera, Auchenorrhyncha, new genus, new tribe

Numerous generic homonyms were discovered while preparing a database of world leafhoppers that will be made available separately. The following changes in Deltocephalinae and Selenocephalinae are meant to correct cicadellid classification with respect to the International Code of Zoological Nomenclature (ICZN; International Commission on Zoological Nomenclature 1999). Taxa are listed alphabetically within their higher taxa.

It warrants mention that, if it is ever again thought to constitute a separate genus-group entity, a new replacement name would also be needed for *Insulanus* Linnavuori, 1960 (described as a subgenus of *Deltocephalus*). The subgenus was placed in synonymy under *Recilia* Edwards, 1922, by Knight (1975a) and is preoccupied by a beetle genus described in 1930.

Another preoccupied leafhopper genus-group name is *Bubulcus* Dlabola 1961b, which was described as a subgenus of *Paralimnus* and is preoccupied by the genus of the cattle egret, described in 1845. The type species of *Bubulcus* Dlabola is *Paralimnus cingulatus* Dlabola, 1960b, which was later designated as the type species of another monotypic genus, *Paralimnellus* Emeljanov 1972d. Hence, as Asche and Webb (1994) noted, the valid combination for the species is *Paralimnellus cingulatus*. No replacement name is needed. Note that *Bubulcus* Dlabola was treated as a full genus, separate from *Paralimnus*, in Hamilton's (1975b) review of tribal classification of Deltocephalinae.

Letter designations for literature citations through 1985 are consistent with the bibliographies by Metcalf (1964a) and Oman et al. (1990).

Subfamily Deltocephalinae

Tribe Athysanini

Ctenurellina McKamey, new name

Ctenurellina, nomen novum for *Ctenurella* Vilbaste 1968a: 140, preoccupied by *Ctenurella* Ørvig 1960 (Pisces, fossil). Type species: *Ctenurella paludosa* Vilbaste.

Ctenurellina paludosa (Vilbaste), **new combination**

Ctenurella paludosa Vilbaste 1968a: 141 [n. sp.].

Euscelis (*Mehiphanes*) McKamey, new subgeneric name

Mehiphanes, nomen novum for *Euscelis* (*Hemiphanes*) Emeljanov 1999b: 608, preoccupied by *Hemiphanes* Foerster 1868: 172 (Hymenoptera; Ichneumonidae). Type species: *Euscelis heptneri* Zachvatkin.

Euscelis (*Mehiphanes*) *heptneri* (Zachvatkin), **new subgeneric placement**

Euscelis heptneri Zachvatkin.

Euscelis (*Hemiphanes*) *heptneri*; Emeljanov 1999b: 608 [subgeneric placement].

The origin of the name *Euscelis heptneri* is uncertain as Emeljanov (1999b, c) did not cite its original description and attempts at finding it in other literature were unsuccessful. Zachvatkin described a *heptneri* in another athysanine taxon [*Hardya* (*Mimohardya*)], but it is highly unlikely that Emeljanov was referring to that species because in the same publication in which he described *Hemiphanes*, he elevated *Mimohardya* to full generic status, and there are no other species in that genus.

Mocolinna McKamey, new name

Mocolinna, nomen novum for *Mocoa* Linnavuori & DeLong 1978d: 236, preoccupied by *Mocoa* Gray 1845 (Reptilia). Type species: *Mocoa elegans* Linnavuori & DeLong.

Mocolinna elegans (Linnavuori & DeLong), **new combination**

Mocoa elegans Linnavuori & DeLong 1978d: 236 [n. sp.].

Saadevra McKamey, new name

Saadevra, nomen novum for *Saavedra* Linnavuori & DeLong 1978b: 122, preoccupied by *Saavedra* Girault 1933 (Hymenoptera). Type species: *Mesamia fasciata* Osborn.

Saadevra fasciata (Osborn), **new combination**

Mesamia fasciata Osborn 1923c: 47 [n. sp.].

Menosoma fasciata; Linnavuori 1959b: 185 [implicit n. comb.].

Saavedra fasciata; Linnavuori & DeLong 1978b: 122 [n. comb.].

Salsocolila McKamey, new name

Salsocolila, nomen novum for *Salsolicola* Theron 1979a: 80, preoccupied by *Salsolicola* Kuznetzov 1960 (Lepidoptera). Type species: *Salsolicola plana* Theron.

Salsocolila calvinia (Theron), **new combination**

Salsolicola calvinia Theron 1979a: 82 [n. sp.].

Salsocolila cristata (Theron), **new combination**

Salsolicola cristata Theron 1979a: 82 [n. sp.].

Salsocolila plana (Theron), **new combination**

Salsolicola plana Theron 1979a: 80 [n. sp.].

Suarezilinna McKamey, new name

Suarezilinna, nomen novum for *Suarezia* Linnavuori & DeLong 1978b: 121, preoccupied by *Suarezia* Budde-Lund 1904 (Crustacea). Type species: *Eutettix reflexus* Osborn.

Suarezilinna reflexa (Osborn), **new combination**

Eutettix reflexus Osborn 1923c: 55 [n. sp.].

Menosoma reflexa; Linnavuori 1959b: 186 [n. comb.].

Suarezia reflexa; Linnavuori & DeLong 1978b: 121 [n. comb.].

Tribe Macrostelini

Cicadulina (*Idyinna*) McKamey, new subgeneric name

Idyinna, nomen novum for *Cicadulina* (*Idyia*) Linnavuori 1960b: 58, preoccupied by *Idyia* Rafinesque 1814 (Crustacea). Type species: *Cicadulina* (*Idyia*) *fijiensis* Linnavuori.

Cicadulina (*Idyinna*) *fijiensis* (Linnavuori), **new subgeneric placement**

Cicadulina (*Idyia*) *fijiensis* Linnavuori 1960b: 59 [n. sp.].

Tribe Paralimnini

Phlebiastes (*Garusa*) McKamey, new subgeneric name

Garusa, nomen novum for *Phlebiastes* (*Argusa*) Emeljanov 1999b: 608, preoccupied by *Argusa* Kelham 1881: 530, *nomen novum* for *Argus* Temmink 1907 (Aves). Type species: *Arocephalus elymi* Emeljanov 1962a: 183.

Phlebiastes (*Garusa*) *elymi* (Emeljanov), **new subgeneric placement**

Arocephalus elymi Emeljanov 1962a: 183 [n. sp.].

Phlebiastes (*Argusa*) *elymi*; Emeljanov 1999b: 608 [n. comb.].

Subfamily Selenocephalinae

Dwightlini McKamey, new tribe

The tribe Dwightiini was proposed by Linnavuori & Al-Ne'amy (1983a). Names of family group taxa based on junior homonyms are to be replaced (ICZN Art. 39), in this case by a name based on the valid name of the former type genus *Dwightia*. The tribe contains only *Dwightla*, the new replacement name for *Dwightia*.

Dwightla McKamey, new name

Dwightla, nomen novum for *Dwightia* Linnavuori & Al-Ne'amy 1983a: 24, preoccupied by *Dwightia* Wilson 1924 (Crustacea). Type species: *Dwightia acutipennis* Linnavuori & Al-Ne'amy.

Dwightla acutipennis (Linnavuori & Al-Ne'amy), **new combination**

Dwightia acutipennis Linnavuori & Al-Ne'amy 1983a: 26 [n. sp.].

Dwightla alecto (Linnavuori & Al-Ne'amy), **new combination**

Dwightia alecto Linnavuori & Al-Ne'amy 1983a: 26 [n. sp.].

Dwightla angolana Linnavuori & Al-Ne'amy), **new combination**

Dwightia angolana (Linnavuori & Al-Ne'amy 1983a: 25 [n. sp.].

Dwightla hercules (Linnavuori & Al-Ne'amy), **new combination**

Dwightia hercules Linnavuori & Al-Ne'amy 1983a: 26 [n. sp.].

Tribe Selenocephalini

Bumka McKamey, new name

Bumka, nomen novum for *Kumba* Linnavuori & Al-Ne'amy 1983a: 85, preoccupied by *Kumba* Marshall 1973 (Pisces). Type species: *Selenocephalus armatissimus* Linnavuori.

Bumka agesilaus (Linnavuori & Al-Ne'amy), **new combination**

Kumba agesilaus Linnavuori & Al-Ne'amy 1983a: 90 [n. sp.].

Bumka albunea (Linnavuori & Al-Ne'amy), **new combination**

Kumba albunea Linnavuori & Al-Ne'amy 1983a: 89 [n. sp.].

Bumka amphitryon (Linnavuori & Al-Ne'amy), **new combination**

Kumba amphitryon Linnavuori & Al-Ne'amy 1983a: 87 [n. sp.].

Bumka armatissima (Linnavuori), **new combination**

Selenocephalus armatissimus Linnavuori 1969a: 1165 [n. sp.].

Kumba armatissima; Linnavuori & Al-Ne'amy 1983a: 86 [n. comb.].

Bumka asera (Linnavuori & Al-Ne'amy), **new combination**

Kumba asera Linnavuori & Al-Ne'amy 1983a: 90 [n. sp.].

Bumka bifalcata (Linnavuori & Al-Ne'amy), **new combination**
  Kumba bifalcata Linnavuori & Al-Ne'amy 1983a: 89 [n. sp.].

Bumka graphica (Linnavuori & Al-Ne'amy), **new combination**
  Kumba graphica Linnavuori & Al-Ne'amy 1983a: 89 [n. sp.].

Bumka leimonias (Linnavuori), **new combination**
  Selenocephalus leimonias Linnavuori 1969a: 1166 [n. sp.].
  Kumba leimonias; Linnavuori & Al-Ne'amy 1983a: 89 [n. comb.].

Bumka pylaon (Linnavuori), **new combination**
  Selenocephalus pylaon Linnavuori 1969a: 1167 [n. sp.].
  Kumba pylaon; Linnavuori & Al-Ne'amy 1983a: 85 [n. comb.].

Bumka thyestes (Linnavuori), **new combination**
  Selenocephalus thyestes Linnavuori 1969a: 1168 [n. sp.].
  Kumba thyestes; Linnavuori & Al-Ne'amy 1983a: 86 [n. comb.].

Bumka varia (Signoret), **new combination**
  Selenocephalus varius Signoret 1858 [in Fairmaire & Signoret 1858a: 343] [n. sp.].
  Kumba varia; Linnavuori & Al-Ne'amy 1983a: 86 [n. comb.].

Moluccazhangia McKamey, new name

Moluccazhangia, nomen novum for *Moluccasia* Zhang & Webb 1996a: 8, preoccupied by *Moluccasia* Rehn 1948 (Orthoptera). Type species: *Selenocephalus marmoreus* Walker.

Moluccazhangia marmorea (Walker), **new combination**
  Selenocephalus marmoreus Walker 1870b: 325 [n. sp.].
  Moluccasia marmorea; Zhang & Webb 1996a: 8 [n. comb.].

Moluccazhangia notula (Walker), **new combination**
  Selenocephalus notulus Walker 1870b: 326 [n. sp.].
  Moluccasia notula; Zhang & Webb 1996a: 8 [n. comb.].

ACKNOWLEDGMENTS

J. Dorsey assisted in the search for generic homonyms. R. Linnavuori encouraged the replacement of the junior homonyms. M. D. Webb (The Natural History Museum, London) and F. C. Thompson (USDA/ARS Systematic Entomology Laboratory) provided helpful comments on an earlier draft of the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 452–459

BIOLOGY AND IMMATURE STAGES OF THE CRANE FLY *PTILOGYNA* (*PLUSIOMYIA*) *HERRONI* (ALEXANDER) (DIPTERA: TIPULIDAE) FROM NEW CALEDONIA, WITH DISCUSSION OF ITS PHYLOGENETIC PLACEMENT

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Abstract.—The last instar larva and pupa of the crane fly *Ptilogyna* (*Plusiomyia*) *herroni* (Alexander) (Diptera: Tipulidae: Tipulinae) are described and illustrated from specimens collected in New Caledonia. The microhabitat of the last larval instar and pupa is discussed. Comparisons are made with larvae and pupae of other Tipulinae. This represents the first detailed description with illustrations for the larva and pupa of *Ptilogyna* Westwood. Pupal characters indicate a basal phylogenetic placement for this genus within the Tipulinae.

Key Words: Diptera, Tipulidae, crane fly, *Ptilogyna,* larva, pupa, New Caledonia

The crane fly genus *Ptilogyna* Westwood (Tipulidae: Tipulinae) comprises 30 species and subspecies placed in three subgenera. Both *Ctenogyna* Macquart and *Ptilogyna* Westwood are subgenera endemic to the Australasian and Oceanian regions (Oosterbroek and Jonas 1986). The third subgenus, *Plusiomyia* Skuse, apparently has a trans-Antarctic or trans-Pacific distribution with 18 species in Australia, 4 in New Caledonia (Oosterbroek 1989), and 1 in Brazil (Alexander and Alexander 1970). Of the four *Ptilogyna* species recorded from New Caledonia, the adult of *P. herroni* (Alexander) has the least wing coloration, and the male has the longest antennal flagellar branches (Alexander 1948: Fig. 7).

Features of the immature stages are important for interpreting phylogenetic relationships within Tipuloidea (Oosterbroek and Theowald 1991). Knowledge of the immature stages of tipulid genera is very incomplete and this is especially true for genera in the Southern Hemisphere. Lack of information on immatures for genera in the Southern Hemisphere has hindered their placement in phylogenetic classifications. Of 30 genera and subgenera of Tipulinae recorded from the Australasian and Oceanian Regions (Oosterbroek 1989), we know larvae for only ten (33%), and even those primarily are known from species occurring in the Nearctic Region (Alexander 1920, Rogers 1949, Byers 1961, Gelhaus 1986). The greatest number of genera and subgenera with unknown larval and pupal stages occur in the Australasian and Neotropical Regions. Recent detailed descriptions of immature stages of *Brachyprema* Osten Sacken (Gelhaus and Young 1991), *Leptotarsus* Guérin-Méneville (subgenera *Limoniodes* Alexander, *Pehlkea* Enderlein, and *Longurio* Loew) (Gelhaus and Young 1995), and *Tipula* Linnaeus (subgenus *Tipulodina* Enderlein) (Young 1999) has contributed information of phylogenetic significance. The successful rearing of several last instar larvae to adults by C. Dennis Hynes while conducting research on the crane fly fauna of New Caledonia (Hynes 1993) allows the first complete, illustrated description of both last instar larva and pupa for the genus *Ptilogyna.* Morphological characters of the pupa observed suggest a possible basal phylogenetic position for the genus within the Tipulinae.

Terminology of larval and pupal characters follows that of Byers (1961) and Gelhaus (1986). The term Tipulidae used here follows Alexander and Byers (1981) with three subfamilies (Tipulinae, Cylindrotominae, and Limoniinae). Catalogue of Palaearctic Diptera recognizes three families: Tipulidae (Oosterbroek and Theowald 1992), Cylindrotomidae (Soós and Oosterbroek 1992), and Limoniidae (Savchenko, Oosterbroek and Starý 1992) that correspond to the subfamilies just mentioned (Byers 1992). Starý (1992) proposed the fourth family Pediciidae, formerly a subfamily within the Limoniidae. Accordingly, the term Tipulinae used here refers to all Tipulidae sensu stricto.

Ptilogyna (*Plusiomyia*) *herroni*
(Alexander)
(Figs. 1–13)

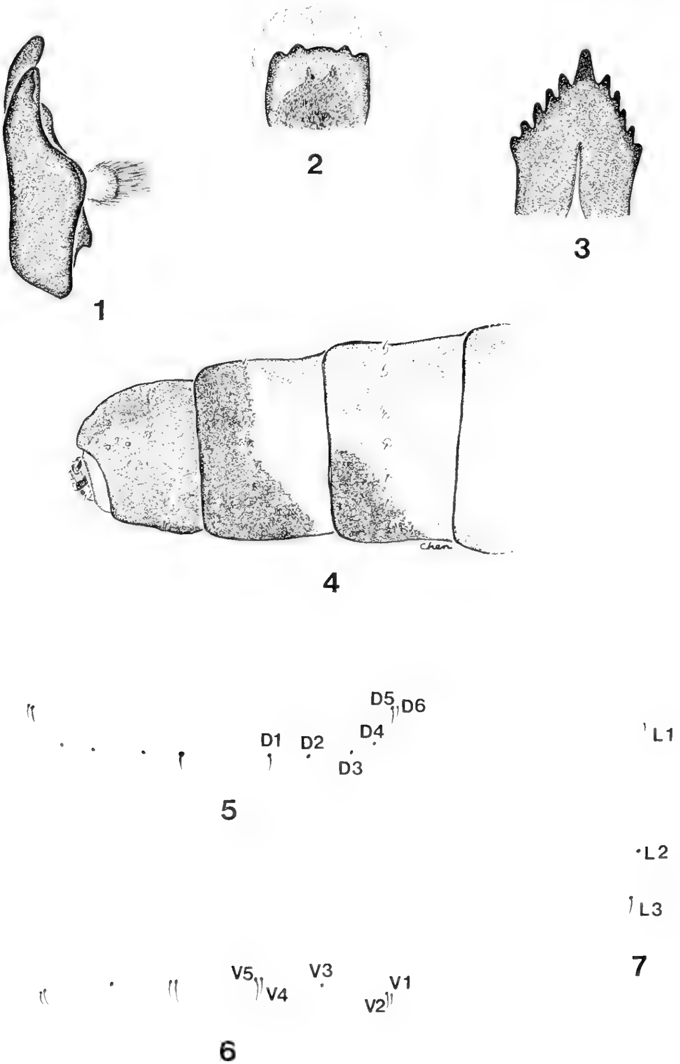
Larval description.—Mature larva: Body 35–38 mm long and 5–6 mm wide, tapering gradually toward both ends. Body sordid yellow, darker laterally.

Head: Broad, massive, well sclerotized, oval-shaped and slightly depressed, typical tipuline head capsule (Byers 1961, Young 1981, Gelhaus and Young 1991); antenna with cylindrical basal segment and apical sensory peg, about three times as long as its basal width, slightly tapering apically; mandible bifurcate with distinct, large ventral tooth and smaller dorsal tooth, two smaller teeth subapically along inner margin of ventral tooth, an additional tooth and hair tuft near base of mandible (Fig. 1); maxilla with hairy galea and lacinia; hypopharynx with five teeth, median tooth lowest and broad (Fig. 2); hypostomal bridge with one large, acute central tooth and four smaller ones and one corner tooth on each side (Fig. 3).

Thorax: All segments covered with short microscopic hairs; prothoracic segment brown; meso- and metathoracic segments with well-defined patches of short, brown with silvery iridescence, microscopic hairs (Fig. 4); macrosetae short.

Abdomen: All segments covered with short, brownish, microscopic hairs; macrosetae short to no visible hair on socket; setae D1 and D5 long, D6 slightly shorter and finer, D2–D4 represented by bare sockets (Fig. 5); setae V2 and V5 long, V1 and V4 slightly shorter, V3 represented by bare socket (Fig. 6); seta L3 long, L1 pale and shorter, L2 represented by bare socket, L4 absent (Fig. 7); abdominal cuticular outgrowths absent. Spiracular disc (Fig. 8) surrounded by six fleshy lobes, each about as long as its basal width; lateral pair slightly longer than others; all lobes not fringed with long hair or setae; dorsal and lateral lobes unsclerotized; ventral lobes with anterior surface sclerotized and each with a long apical seta; spiracles large, circular, dark brown with blackish centers; conspicuous black spot below each spiracle, surrounded by short microscopic hairs; microscopic hairs also forming other dark patches and streaks at bases of all lobes; anal segment large, anal opening transverse; four anal papillae, lateral pair conical, ventral pair broadly rounded (Fig. 9).

Remarks.—The larva of *P. herroni* resembles superficially species in the most terrestrial subgenera of genus *Tipula,* specifically the Nearctic subgenera *Lunatipula* Edwards, *Pterelachisus* Rondani, *Trichotipula* Alexander, and *Triplicitipula* Alexander, and the Neotropical subgenus *Eumicrotipula* Alexander. They all share the following morphological characters: body heavily covered with short microscopic hairs; spiracular lobes fleshy or partially sclerotized without border of setae; four or fewer distinct papillae (Gelhaus 1986). Notable dif-



Figs. 1–7. *Ptilogyna herroni* larva. 1, Mandible, dorsal. 2, Hypopharynx, dorsal. 3, Hypostomal bridge, ventral. 4, Thorax, lateral. 5–7, Abdominal macrosetal arrangements. 5, Dorsal setae. 6, Ventral setae. 7, Lateral setae.

ferences of *P. herroni* from the above subgenera are the brown with silvery iridescence band around the anterior portion of the mesothoracic segment, the brown with silvery iridescence patches on the lateroventral part of the meso- and metathoracic segments, the unsclerotized dorsal and lateral spiracular lobes, and abdominal macrosetae D2, D3, D4, V3, and L2 represented only by bare sockets.

Pupal description.—Male: Length 26 mm, width 4.5 mm. Female: Length 25 mm, width 4.5 mm. Body brown, slightly darker on head and thorax.

Head: Antenna greatly expanded at base and antennal branches readily visible in male (Figs. 10–11); apex of antenna reaching about two-thirds length of mesothoracic tibia in male, reaching slightly beyond prothoracic tibia in female; paired short, wrinkled ridges between bases of antennae; maxillary palpus short, slightly curved at base, then curved upward toward apex; apex of maxillary palpus not recurved, reaching prothoracic tibia (Fig. 10).

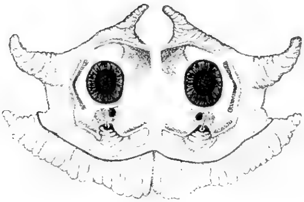
Thorax: Length of respiratory horn 2 mm, minute annulations along its entire length; apex of wing nearly reaching end of abdominal segment II; apices of fore, middle, and hind tarsi in oblique alignment, with fore tarsus shortest and adjacent to each other at ventral midline; in female apex of fore tarsus reaching anterior edge of segment IV, apices of middle and hind tarsi reaching middle of segment IV; in male, apex of fore tarsus reaching middle of segment IV, apices of middle and hind tarsi reaching posterior end of segment IV; middle tarsus slightly longer than hind tarsus in both sexes.

Abdomen: Segments III–VII with well-defined anterior and posterior annuli; small hooked spines present laterally and along posterior margins of all segments; three spines laterally on segment III–VII; 10–12 dorsal spines along posterior margin of segments II–VII (Fig. 11); two ventral spines on segments III–IV and six ventral spines on segments V–VII; terminal segments (VIII and IX in male, VIII–X in female) with five pairs of elongate spines (Figs 12–13); dorsal two pairs slightly blunt or acutely tipped, each with several smaller spines along their length; male genital sheaths (Fig. 12) curved dorsad with a lateral spine on each near bend beyond base; female with distinct cercal and hypovalvular sheaths, a single spine laterally near one-third length from each cercal apex (Fig. 13).

Remarks.—The pupa of *P. herroni* is recognizable as Tipulinae by the wrinkles on the thoracic cuticle, the spines along posterior margins of the abdominal segments, and a small spine near base of each male genital sheath (Gelhaus and Young 1995). The external structures of both male and female genital sheaths with lateral spine on the sheaths resemble those of *Leptotarsus (Limoniodes) sulphurellus* (Alexander). The distinct branches of the antennal sheath found in *Ptilogyna* are also observed in pupae of several subgenera of *Ctenophora* Meigen. This is possibly a convergent condition. The pupa of *P. herroni* can be distinguished from other tipulines by the combined characters of the ridges between the bases of the antennae, the nearly straight (not recurved) maxillary palpal sheaths, and the distinct branches of male antennae.

HABITAT AND BIOLOGY

All specimens used in this study were collected in the Rivière Bleue Preserve during the months from September to December of 1988. The preserve is primary lowland rain forest located about 20–30 km north of Ouénarou. The larvae were collected in three different localities assigned as Stations No. 5, No. 6, and No. 7 within the preserve (Hynes 1993). Station No. 5 (150 m) is located in the flood plain near the banks of the Rivière Bleue. This area is flooded many times during the rainy season, and water remains standing for long periods of time after such flooding. Station No. 6 (160 m), located near the edges of the river, is essentially the same vegetational type as Station No. 5, but the river does not peri-



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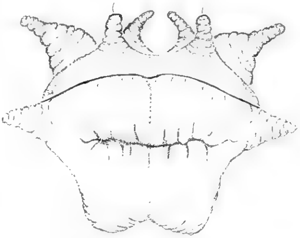

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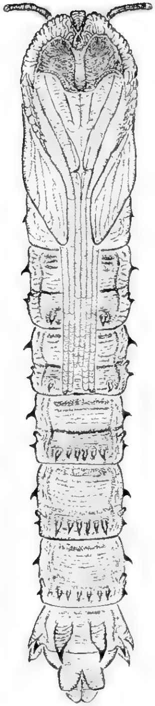

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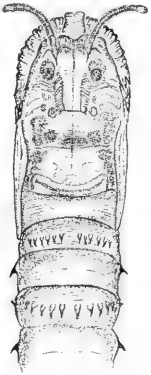

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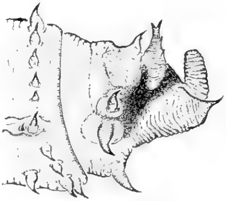

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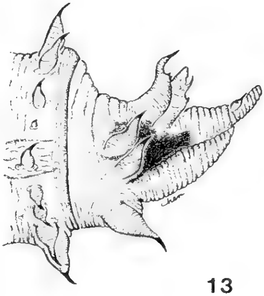

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Figs. 8–13. 8–9, *Ptilogyna herroni* larva. 8, Spiracular area. 9, Anal papillae, ventral posterior view. 10–13, *P. herroni* pupa. 10, Habitus, male ventral aspect. 11, Habitus, male anterodorsal aspect. 12, Male terminal abdominal segments, lateral. 13, Female terminal abdominal segments, lateral.

odically flood it during the rainy season. Station No. 7 (170 m) is on a steep hillside and differs greatly in vegetation and aridity from Stations No. 5 and No. 6.

The soil in the general collecting sites is typical of southern New Caledonia, the product of degradation of ultramafic rock. The soil consists of relatively small, nearly spherical particles, reddish in color and unable to hold enough organic material or moisture for the development of the immature stages of most Tipulidae. Fallen trees in various stages of decay, along with numerous small branches entrapping leaves from various trees, form a mat of decaying organic material accumulated on the forest floor. These accumulations attain lengths of 2–3 m and widths of 1–2 m. Many remain wet or damp for long periods of time. Larvae of *Ptilogyna* were collected mainly from fallen tree trunks, especially the interior sections with large amounts of dark brown, decomposed material. This material remains damp throughout extended dry periods. Occasionally the larvae were collected within other decaying organic material, especially between layers of leaves on the forest floor.

Larvae of *Ptilogyna* are considered as terrestrial species based on microhabitats in rotting logs away from aquatic situations, or in leaf debris on the forest floor. Larvae for rearing were kept within organic debris from rotten logs. Larvae pupated soon after capture, and adults started emerging in about eight days. Larvae, intact pupae of each sex, and exuviae of larvae and pupae were preserved in ethanol.

DISCUSSION

Hypotheses of phylogenetic relationships of genera within the Tipulidae have traditionally relied exclusively on morphological characters of adults. Oosterbroek and Theowald (1991) proposed a phylogenetic scheme for the Tipuloidea (families Limoniidae, Cylindrotomidae, and Tipulidae) based on larval and pupal characters. They provided informative characters in support of phylogenetic relationships within the then proposed subfamilies of Limoniidae (Eriopterinae, Hexatominae, Pediciinae, and Limoniinae), and also presented strong support for a sister group relationship between the Cylindrotomidae and Tipulidae s.s. However, the analysis of the family Tipulidae s.s. was excluded from their study due to the likely paraphyly of the currently recognized subfamilies (Dolichopezinae, Ctenophorinae, and Tipulinae). Starý (1992) has since elevated Pediciinae to family Pediciidae, and replaced Eriopterinae with Chioneinae, and Hexatominae with Limnophilinae due to the rules concerning priority. Meager knowledge of the immature stages of Tipulidae has also placed limitations on the larval key of Alexander and Byers (1981) for the Nearctic fauna. The genera in this key do not appear in a phylogenetic sequence. The most recent larval key for Tipulinae is that of Gelhaus (1986), who presents a detailed taxonomic study of the genus *Tipula* in North America. No existing generic key is available for immature stages of Tipulinae.

The larva of *P. herroni* cannot be confused with other tipuline genera based on its distinct brown with silvery iridescence band and patches on the meso- and metathoracic segments. However, the arrangement of characteristic features around the spiracular disc with 1) unsclerotized dorsal and lateral spiracular lobes, 2) all lobes not fringed with long hairs, and 3) four reduced anal papillae, does bear a superficial resemblance to similar structures in several species of the most terrestrial subgenera of *Tipula*; thus the larva of *P. herroni* cannot be easily distinguished from larvae of those subgenera, as indicated above in remarks following the larval description.

Oosterbroek (personal communication) indicated that 11 teeth (nine teeth and two corners) on the hypostomal bridge of *P. herroni* is interesting because it is the highest number (5–11) found in Tipulidae s.s. In Cylindrotomidae, the supposed sister group of the Tipulidae s.s., there are about

17 teeth. Many teeth may be considered plesiomorphic for the Tipulidae s.s. However, larvae of *Ctenophora* and *Dendrotipula* apparently have retained this plesiomorphic number though they are not considered primitive, but the larvae live in dead or decaying wood, as do those of *P. herroni.*

Alexander (1927) proposed some presumed primitive generic lineages, including *Ptilogyna,* within Tipulinae based on the radial field of the wing. Other workers have attempted to place various lineages within Tipulinae based on pupal characters such as the shape of the maxillary palpal sheath, the length of the distal section of the antennal sheath, and the position of the antennal sheath. A straight or curved maxillary palpal sheath, short distal section of antennal sheath, and apices of antennal and palpal sheaths closely approximated (for example, *Megistocera* Wiedemann, *Brachypremna* Osten Sacken, and *Leptotarsus* Guérin-Méneville) are considered plesiomorphic within the Tipulinae (Oosterbroek and Theowald 1991, Gelhaus and Young 1995). A strongly recurved apex of the maxillary palpal sheath, an extended distal section of the antennal sheath, and apices of antennal and palpal sheaths widely separated (for example, *Dolichopeza* Curtis, *Nobilotipula* Alexander, *Platytipula* Matsumura, *Tipulodina* Enderlein, and most other Tipulinae) are considered apomorphic (Gelhaus and Young 1995).

In *Ptilogyna,* the shape of the maxillary palpal sheath is slightly curved without a strongly recurved apex (plesiomorphic), the distal section of the antennal sheath is elongated (apomorphic), and the apices of antennal and palpal sheaths are widely separated (apomorphic). Based on this limited information we postulate that the genus *Ptilogyna* is a member closes to the basal assemblage (*Brachypremna, Leptotarsus, Megistocera, Ozodicera* Macquart, *Clytocosmus* Skuse) of the subfamily Tipulinae and suggest a possible phylogenetic placement of it between the primitive and the advanced genera within Tipulinae.

The discovery of the immature stages of *P. herroni* provides much-needed information in order to narrow the gap in our knowledge of the immature stages of Southern Hemisphere crane fly taxa. Our findings concur with several previous studies by various authors that many of the larval characters (including spiracular disc, spiracular lobes, anal papillae, hypostomal teeth), and the size and form of the respiratory horns of the pupa provide taxonomically important information for identification and probably have a close correlation of structure to habitats. These larval characters probably have evolved in their specific habitat to such a degree that they show a greater divergence than do some of the more conservative pupal characters such as maxillary palpal sheath, antennal sheath, and spines on genitalial sheaths. It is likely that the similarities of larval characters have evolved convergently because of habitat requirements, while the similarities of pupal characters have evolved by reason of common ancestry. This must be considered when using these characters in the placement of the genus within the subfamily Tipulinae. Chaetotaxy and additional pupal characters as mentioned in Gelhaus and Young (1995) may have applicability for establishing relationships but are not yet evaluated phylogenetically against a broad range of tipuline taxa. Further work is needed on the morphology of the immature forms of Tipulinae before such information can contribute to the understanding of the postulated relationships among these lineages.

ACKNOWLEDGMENTS

This paper is based on specimens collected by Dennis Hynes while conducting research in New Caledonia. We thank Jean Chazeau (French Institute of Scientific Research and Development through Cooperation, Nouméa, New Caledonia) for his support during Hynes' studies in New Caledonia. Thanks are due to Pjotr Oosterbroek, John E. Rawlins, and Robert Davidson for suggestions on an earlier draft of the manuscript; also to three anonymous reviewers for their comments.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 460–466

ERICAPHIS LOUISAE, N. SP. (HEMIPTERA: APHIDIDAE: APHIDINAE: MACROSIPHINI) ON *LUETKEA PECTINATA* (PURSH) (ROSACEAE), AND A KEY TO *ERICAPHIS* SPECIES

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Abstract.—***Ericaphis louisae*** **Pike, n. sp.** (Hemiptera: Aphididae: Aphidinae: Macrosiphini) is described and illustrated. The aphid is holocyclic monoecious, found on *Luetkea pectinata* (Pursh) (Rosaceae) in subalpine settings in the Cascade and Olympic Mountains of Washington, USA, and in the Coastal Mountains of northwestern British Columbia, Canada. A key to the species of *Ericaphis* is also provided.

Key Words: aphid, *Ericaphis, Luetkea,* new species

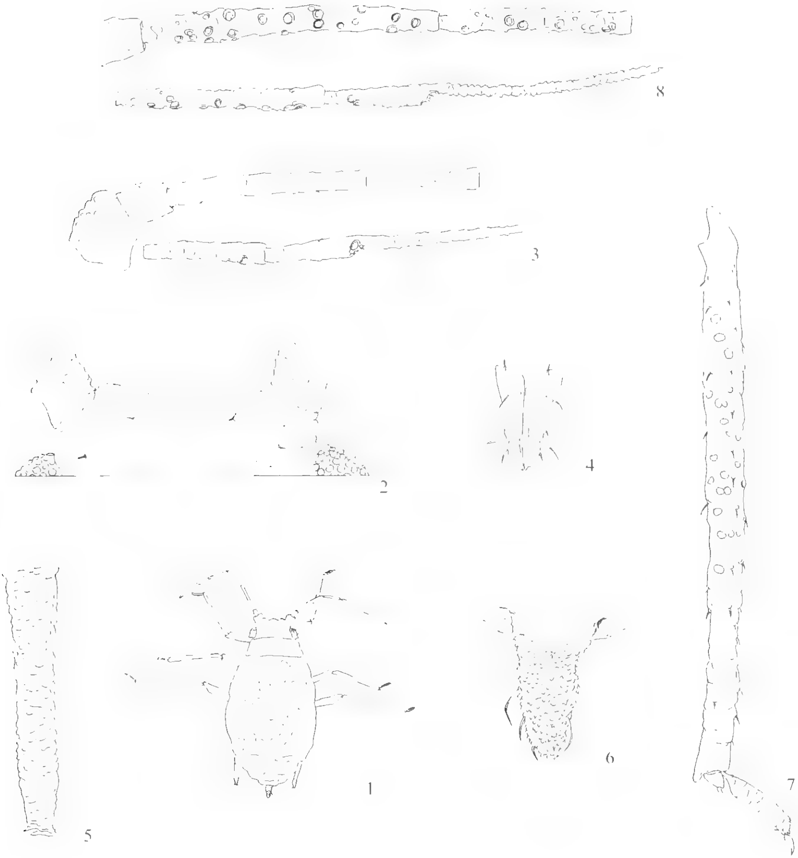
Research on aphid parasitoids in northwestern North America (Pike et al. 2000) led to the discovery of a new species of aphid on *Luetkea pectinata* (Pursh) (Rosaceae) in subalpine settings near timberline in the Cascade and Olympic Mountains of Washington and Coastal Mountains of northwestern British Columbia. Diagnosis, descriptions, and illustrations are provided, together with a key to *Ericaphis* species.

Material and Methods

The aphid was collected through Berlese extractions of *Luetkea pectinata,* and by hand shaking plants over a white surface. The aphid was found at five sites in the Cascades Mountains of Washington, from Mt. Baker to Mt. Rainier, at elevations ranging from about 1,600 to 1,800 m; at one site in the Olympic Mountains at 1,750 m; and at one site in northwestern British Columbia, Tormented Valley near Fraser at 940 m.

Material was cleared and mounted on slides in Canada balsam; part was processed using techniques published by Hille Ris Lambers (1950) with modifications by D. Voegtlin of the Illinois Natural History Survey (see Pike et al. 1991), and part was cleared and mounted following techniques by Foottit and Maw (http://www.zoology.ubc.ca/~mawe/bcaphid). The aphid description is attributed to the first author.

Line illustrations were hand drawn from images taken with a Nikon Coolpix 990 digital camera. Scanning electron microscopy (SEM) was used to illustrate antennal rhinaria of the male. SEM procedures were as follows: aphids were placed in Kahle's solution overnight, then progressively dehydrated through an ethanol series (70, 80, 90, 95, 100%), 30 minutes per dilution. Specimens were transferred to 12 ml screwcap vials containing 3 ml undiluted HMDS (hexamethyldisilazane) and left to soak for 1 hour. HMDS was decanted and 3 ml of fresh, undiluted HMDS was added. Specimens were removed after 1 hour and allowed to air-dry overnight. Specimens were mounted on aluminum SEM stubs and



Figs. 1–8. Various features of *Ericaphis louisae*. 1–6, Apterous vivipara. 1, Whole mount. 2, Median and frontal tubercles of head. 3, Antenna. 4, Ultimate rostral segment. 5, Siphunculus. 6, Cauda. 7, Ovipara, hind tibia and tarsus. 8, Apterous male, antenna. Bar scale: Fig. 1 = 0.4 mm; Figs. 2–8 = 0.05 mm.

gold-coated to a thickness of 15–20 nm using a Technics Hummer V sputtercoater. These were scanned at an accelerating voltage of 15kV on a Hitachi S-570 scanning electron microscope. Photographs were taken using Polaroid™ Type 55 film. The SEM work was performed at the Electron Microscopy Center, Washington State University (WSU), Pullman.

Ericaphis louisae **Pike, new species**

(Figs. 1–9)

Etymology.—The species was named after the type locality, Louise Lake, Mount Rainier National Park, Washington, USA.

Description.—*Apterous vivipara* (Figs. 1–6): Coloration in life, green. Adult: body length 1.22 to 1.81 mm. Body pale, appendages pale or sometimes slightly darker than body, especially tarsi and distal portions of tibiae. Dorsal integument faintly to moderately wrinkled. Dorsal and ventral cephalic sutures sometimes vaguely indicated. Setae on head short, pointed or blunt, usually less than half the basal diameter of antennal segment III. Frontal tubercles (= antennal tubercles) moderately developed, diverging, rugose, particularly inner margins; median tubercle moderately developed, with similar height and surface sculpturing as frontal tubercles. Antenna short, 0.40–0.67 × body length; 6-segmented without secondary rhinaria; primary rhinaria with conspicuous ciliate margins. Antennal segment III 0.13–0.22 mm, IV 0.05–0.15 mm, V 0.07–0.15 mm, base of VI 0.08–0.11 mm, processus terminalis 0.09–0.19 mm. Ultimate rostral segment (0.06–0.08 mm) tapering, rounded distad of preapical primary setae, with 2 accessory setae. Hind tibia 0.46–0.65 mm; setae pointed, length of longest about ⅔ width of segment at widest point. Tarsal I chaetotaxy 3,3,3. Claws simple; empodial setae acuminate, not quite reaching to tip of claws. Abdominal segments I–V apparently fused; spiracles reniform to subcircular without opercula, except abdominal segments VI–VII spiracles with some marginal anterior overlap. Siphunculus 0.19–0.30 mm, imbricated throughout, subcylindrical, and distal ⅙ to ⅕ part narrowing slightly to pre-flange constriction. Cauda 0.10–0.18 mm, triangular, with 4–6 setae. For additional measurements, see Table 1.

Ovipara (Fig. 7): Adult: body length 1.41–1.79 mm. Similar to apterous vivipara, but typically slightly larger (see Table 1 for complete range of measurements). Integument faintly to moderately wrinkled. Lateral ocelli absent or sometimes with a trace indicated. Hind tibia with 21 to 64 pseudorhinaria. Abdominal dorsum membranous, pale, sometimes with very light pigmentation on marginals, less frequently on posterior terga. Marginals sometimes with small flat subcircular tubercles, usually one per marginal when present.

Apterous male (Figs. 8–9): Adult: body length 1.17 to 1.35 mm. Body somewhat elongate compared with vivipara and ovipara. Dorsal integument faintly or moderately wrinkled. Abdominal dorsum sometimes partially pigmented, antenna and tarsi darkened, femora and tibiae partially darkened, siphunculi and cauda usually slightly darker than abdomen. Small median and lateral ocelli present. Antenna with secondary rhinaria on III (15–22), IV (7–16), and V (5–12). Primary antennal rhinaria with distinct marginal cilia; secondary antennal rhinaria without marginal cilia (Fig. 9). For additional measurements, see Table 1.

Material.—Holotype: apterous viviparous ♀—USA, Washington, Lewis Co., Mt. Rainier National Park, Louise Lake, 15-IX-1994, on *Luetkea pectinata* (Pursh) (WSU Code 94R227–4), collectors K. S. Pike and R. Miller. Paratypes (all from *Luetkea pectinata*): 6 viviparae and 2 oviparae collected with holotype; 2 ♂ and 5 oviparae collected on 29-IX-1994 at type locality; 11 viviparae collected on 1-VII-1995, 16-VIII-1995, and 8-IX-1995 at type locality; 1 ♂ collected on 8-IX-1995 at Chinook Pass, Yakima Co., Washington; 3 oviparae collected on 17-X-1995 at Mt Baker near ski area, Whatcom Co., Washington; 12 viviparae, 11 oviparae, and 3 ♂ collected on 11 and 27-IX-1996 at Chinook Pass, Dewey Lake Trail, Yakima Co., Washington; 1 vivipara collected 9-X-1996, Yakima Nation, Goat Butte, Yakima Co., Washington; 1 vivipara collected on 6-IX-2001 at Quartz Mountain, Kittitas Co., Washington; 15 oviparae, and 15 ♂ collected on 25-IX-2001 at Chinook Pass, Dewey Lake Trail, Yakima Co., Washington; 3 vivipara collected on 22-VIII-2002, Olympic National Park, Hurricane Ridge, Clallam Co., Washington; and 2 ovipara and 1 ♂ collected on 14-VIII-2002, Tormented Valley near Fraser, British Columbia. Holotype deposited in National Museum of Natural History, Smithsonian Institution, aphid collection, Beltsville, MD (USNM). Paratypes, two each of the viviparae, oviparae, and males, deposited in

USNM; Canadian National Collection, Ottawa; The Natural History Museum, London; and Muséum National d'Histoire Naturelle, Paris. Additional paratypes deposited in the Washington State University aphid collection.

Biology and distribution.—*Ericaphis louisae* is holocyclic monoecious on *Luetkea pectinata* (Pursh) (Rosaceae). Based on present collections, it is known only from subalpine areas in the Cascades and Olympic Mountains of Washington and at one site in the Coastal Mountains of British Columbia. Its distribution is likely more extensive, probably covering the full range of its host; *L. pectinata* is found from the Alaska/Yukon region southward in the Coastal Mountains to southern British Columbia, in the Cascades to northern California, in the Rocky Mountains to southern British Columbia, southwestern Alberta, and the Bitterroot Mountains of western Montana and eastern Idaho (Hitchcock and Cronquist 1973), and in the Olympic Mountains of Washington. The plant is found in moist or shaded areas, usually in sandy soil, mostly where snow persists until late into the season, from subalpine to well above timberline (Hitchcock and Cronquist 1973).

Two species of primary parasitic wasps (Hymenoptera, Braconidae, Aphidiinae) were found attacking *Ericaphis louisae*: *Aphidius* sp. and *Lysiphlebus testaceipes* (Cresson); associated secondary parasitoids (Hymenoptera, Pteromalidae) included *Asaphes californicus* Girault and an undetermined pteromalid. Other confirmed parasitoid associations with members of the genus *Ericaphis* include: *Aphidius* nr. *hortensis* Marshall, *Aphidius* sp., *Ephedrus lacertosus* (Haliday), *Lysaphidus* sp., *Praon unicum* Smith and *Praon* sp. on *E. gentneri*; *Aphidius* sp. on *E. scammelli*; and *Aphidius polygonaphis* (Fitch), and *Aphidius* sp. on *E. wakibae* (Pike et al. 2000).

With the addition of the new species, the genus *Ericaphis* is comprised of about 12 species in North America, 3 of which are of European origin. Members of the genus collectively are associated with plants in six families: Ericaceae, Rosaceae, Liliaceae, Empetraceae, Scrophulariaceae and Caprifoliaceae [from the latter, only the alatae of *E. harmstoni* are known from a single collection (Knowlton 1943)—possibly errant specimens].

Diagnosis—The new species shares some similarities (moderately developed, divergent, rough sculptured frontal tubercles; wrinkled integument; and short processus terminalis) with *Ericaphis latifrons* (Börner 1942) a European species (Remaudière 1952 [*Myzodium lagarriguei* = *latifrons*], Ossiannilsson 1954 [*E. empetri* = *latifrons*], Heie 1992), but differs from the latter in the shape of the siphunculus (with *E. louisae,* siphunculus distally narrows slightly; with *E. latifrons,* siphunculus is more or less cylindrical, curving outward apically), cilia in antennal secondary rhinaria (absent in *E. louisae*), and number of ultimate rostral segment accessory setae (2 in *E. louisae* vs 4–6). The new species shares the peculiar shaped siphunculus with *Abstrusomyzus* (Jensen and Stoetzel 1999), but differs from the latter in body integument (*E. louisae* is wrinkled throughout, with tergum unpigmented in apterous viviparae, while *Abstrusomyzus* spp. are distinctly pentagonal/hexagonal reticulate, with tergum often completely pigmented), number of ultimate rostral segment accessory setae (2 vs. 3–9), and tarsal I chaetotaxy (3,3,3 vs. 3,3,2). The new species shows some resemblance to *Myzodium* spp. (Smith and Robinson 1975) in shape and sculpturing of the frontal tubercles, but differs from the latter in the shape of the cauda (triangular vs. abruptly narrowed apically) and host plant association (*Luetkea* vs. moss). Other genera, i.e. *Aulacorthum, Elatobium, Hyalomyzus, Myzus, Ovatus, Phorodon,* and *Rhodobium,* which bear some slight resemblance to *E. louisae,* differ in the shape of the siphunculus, usually in the lack of development of the median tubercle,

Table 1. Morphological measurements (mm) and comparisons for adult morphs of *Ericaphis louisae*.

	Apterous Vivapara n = 35		Ovipara n = 23
	Mean	(Range)	Mean
Body (length)	1.42	(1.15–1.81)	1.61
Head			
Head (width)	0.37	(0.32–0.43)	0.40
Antenna (length)	0.76	(0.60–0.93)	0.90
III	0.18	(0.13–0.22)	0.21
IV	0.11	(0.05–0.15)	0.13
V	0.11	(0.07–0.15)	0.14
Base of antennal segment VI	0.09	(0.08–0.11)	0.10
Processus terminalis	0.15	(0.09–0.19)	0.17
Setal length (antennal segment III)	0.005	(0.004–0.007)	0.006
Ultimate rostral segment (length)	0.07	(0.06–0.08)	0.07
Ultimate rostral segment (width)	0.05	(0.04–0.06)	0.05
Antenna III secondary rhinaria	0	—	0
Antenna IV secondary rhinaria	0	—	0
Antenna V secondary rhinaria	0	—	0
Antenna socket ventral margin setae	2.1	(1–4)	2.3
Ultimate rostral segment assessory setae	2	—	2
Thorax			
Hind tibia (length)	0.55	(0.46–0.65)	0.61
Hind tarsus II (length)	0.09	(0.07–0.10)	0.09
Tibial rhinaria	0	—	36.3
Abdomen			
Siphunculus (length)	0.24	(0.19–0.30)	0.27
Cauda (length)	0.14	(0.10–0.18)	0.16
Cauda (width)	0.12	(0.11–0.14)	0.12
Abdominal VIII dorsal setae	2.5	(2–4)	4.0
Caudal setae	5.0	(4–6)	5.6
Comparisons			
Antenna/body	0.54	(0.40–0.67)	0.56
Processus terminalis/base of antenna VI	1.56	(1.00–2.11)	1.69
Ultimate rostral segment (length/basal width)	1.51	(1.17–1.94)	1.60
Ultimate rostral segment/hind tarsus II	0.81	(0.67–1.00)	0.83
Ultimate rostral segment/body	0.05	(0.04–0.06)	0.05
Siphunculus/body	0.17	(0.13–0.20)	0.17
Siphundulus/antennal segment VI	1.01	(0.81–1.32)	1.00
Cauda/body	0.10	(0.08–0.12)	0.10
Cauda/siphunculus	0.60	(0.42–0.79)	0.58

and usually in the shape of the frontal tubercles.

With regard to the genus *Ericaphis*, some species currently in the genus may belong elsewhere, and some species currently in other myzine genera may belong in *Ericaphis*. A comprehensive study and revision of the genus is needed. The key below is provided as a tool for identification of the apterous viviparae of the species presently included in *Ericaphis* by Remaudière and Remaudière (1997).

Key to *Ericaphis* (Apterous Viviparae) [*Ericaphis harmstoni* not in key, since apterous viviparae are unknown (Knowlton 1943)]

1. Abdominal dorsum with sclerotic pigmentation 2
– Abdominal dorsum membranous 3

Table 1. Extended.

Ovipara n = 23	Apterous Male n = 9	
(Range)	Mean	(Range)
(1.41–1.79)	1.18	(1.09–1.34)
(0.36–0.44)	0.37	(0.34–0.42)
(0.80–1.00)	1.19	(1.09–1.26)
(0.19–0.25)	0.27	(0.26–0.29)
(0.10–0.16)	0.20	(0.18–0.21)
(0.11–0.17)	0.20	(0.17–0.21)
(0.09–0.13)	0.12	(0.11–0.14)
(0.14–0.20)	0.24	(0.21–0.30)
(0.005–0.007)	0.006	(0.005–0.007)
(0.06–0.08)	0.07	(0.07–0.08)
(0.04–0.06)	0.05	(0.04–0.06)
—	18.6	(15–22)
—	10.4	(7–16)
—	9.8	(5–12)
(1–5)	2.3	(1–5)
—	2	—
(0.55–0.65)	0.69	(0.66–0.73)
(0.08–0.10)	0.09	(0.08–0.10)
(21–64)	0	—
(0.25–0.30)	0.21	(0.18–0.23)
(0.14–0.19)	0.10	(0.08–0.11)
(0.10–0.13)	0.11	(0.09–0.12)
(3–5)	3.3	(2–4)
(3–6)	5.7	(4–7)
(0.51–0.64)	1.02	(0.91–1.06)
(1.27–2.00)	2.01	(1.67–2.50)
(1.21–2.05)	1.59	(1.21–1.80)
(0.70–0.91)	0.79	(0.78–0.88)
(0.04–0.05)	0.06	(0.05–0.06)
(0.15–0.19)	0.17	(0.15–0.21)
(0.83–1.17)	0.57	(0.43–0.66)
(0.06–0.11)	0.08	(0.07–0.10)
(0.52–0.70)	0.48	(0.40–0.54)

Fig. 9. *Ericaphis louisae*, apterous male. Secondary rhinaria on antennal segment III (SEM photo). Bar scale = 0.005 mm.

2(1). Tarsal I chaetotaxy 5,5,5; on Ericaceae (*Erica*); distribution: Europe (single record from California) . . . . *ericae* (Börner)

– Tarsal I chaetotaxy 3,3,3; on Ericaceae (*Kalmia*), Rosaceae (*Fragaria, Rosa,* and *Rubus*) and Scrophulariaceae (*Pedicularis*); distribution: N. Amer., England . . . . *wakibae-siphunculata* group

3(1). Siphunculus distally narrowing (distal $^1/_6$ to $^1/_5$ narrowed) to pre-flange constriction, without reticulation (Fig. 5); on Rosaceae (*Luetkea pectinata*). Distribution: Washington and British Columbia . . . . . *louisae* Pike

– Siphunculus more or less cylindrical, sometimes curved outward distally, with or without reticulation; not on *Luetkea pectinata* . . 4

4(3). Processus terminalis/base of antennal segment VI < 4.5 5

– Processus terminalis/base of antennal segment VI > 4.5 7

5(4) Processus terminalis/base of antennal segment VI ≤ 2.2; antenna not reaching to base of siphunculus; on Empetraceae (*Empetrum*) and Ericaceae (*Calluna, Vaccinium*). Distribution: Europe, Iceland . . . . *latifrons* (Börner)

– Processus terminalis base of antennal segment VI > 2.4; antenna reaching to or beyond base of siphunculus; on Ericaceae (*Andromeda, Arctostaphylos, Pernettya, Vaccinium*), and Rosaceae (*Fragaria, Rosa*). Distribution: N. Amer., Europe 6

6(5). Ultimate rostral segment/hind tarsus II >1.4; on Ericaceae, *Arctostaphylos*; distribution: France, French Alps (Remaudière 1971) . . . . *leclanti* (Remaudière)

– Ultimate rostral segment/hind tarsus II <1.0; reported from various Ericaceae (*Andromeda, Arctostaphylos, Pernettya, Vaccinium*), and Rosaceae (*Fragaria, Rosa*).

Distribution: N. Amer., Europe . . . . *fimbriata-scammelli* group

7(4). Ultimate rostral segment with 2 secondary or accessory setae; on Rosaceae (*Amelanchier, Crataegus, Photinia, Mespilus, Pyrus, Sorbus*). Distribution: N. Amer. . . . . *gentneri* (Mason)

– Ultimate rostral segment with 6–8 secondary or accessory setae; on Liliaceae (*Lilium, Scoliopus, Smilacina, Streptopus*). Distribution: western N. Amer. . . . *lilii-scoliopi* group

Note that although *E. harmstoni* was not keyed, inter-morph comparisons with *E. louisae* indicate clear distinctions between the species, with differences in such characters as siphuncular distal shape and sculpturing, processus terminalis/base of antennal segment VI (4.6–4.7 in *E. harmstoni* vs. 1.0–2.5 in *E. louisae*) and overall size (2.3–2.5 mm in *E. harmstoni* vs. 1.2–1.8 mm in *E. louisae*) (see Knowlton 1943 for original description of *E. harmstoni*).

ACKNOWLEDGMENTS

We express thanks to the D. Allison, L. Boydston, G. Graf, and D. Graf (Washington State University Technical Support Staff), R. Miller (University of Guam, formerly with Washington State University), and L. Pike for assistance in collecting, parasitoid rearings, mounting, and/or illustrations; R. F. Foottit and E. Maw (Agriculture and Agri-Food Canada, Ottawa), G. Remaudière (Muséum National d'Histoire Naturelle, Paris), and M. Stoetzel (Systematic Entomology Laboratory, USDA, Beltsville, MD), A. Jensen (formerly with the Systematic Entomology Laboratory, Beltsville, MD), Cho-Kai Chan (Vancouver, BC), and P. Jepson (Department of Entomology, Oregon State University, Corvallis) for loan or access to *Ericaphis* spp.; and R. F. Foottit, E. Maw, and A. Jensen for manuscript reviews. We thank G. Ahlstrand and R. Lechleitner for facilitating collections at Mt. Rainier National Park; B. Baccus and G. Hunter for facilitating collections at the Olympic National Park; and the Yakama Nation for allowing access to their lands. We also thank J. Rumph (Washington State University, graduate student) for scanning electron micrographs.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 467–483

STEPHANIDAE (HYMENOPTERA) OF AMERICA NORTH OF MEXICO

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Abstract.—Eight species of the family Stephanidae are found in Canada and the continental United States. Two new species are described, ***Megischus annectens* Aguiar, n.sp.,** and ***Megischus brevicaudatus* Aguiar, n.sp.,** from the western U.S.A. *Megischus bicolor* Westwood is redescribed, and regional color forms are not recognized as formal subspecies. A key to species is provided. Data on geographical distribution, flight period, and biological associations are summarized.

Key Words: Hymenoptera, Stephanidae, *Schlettererius* Ashmead, *Megischus* Brullé, new species, Nearctic

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The family Stephanidae is a basal group of apocritan Hymenoptera that are idiobiont parasitoids of the larvae of wood-boring Coleoptera (Cerambycidae, Buprestidae) and Hymenoptera (Siricidae). The family is fairly small, encompassing only 290 described species around the world. Our objective here is to discuss the taxonomy of stephanids from the United States and Canada, an area last treated by Townes (1949). We include a review and update of the species covered by Townes as well as the description of two new species.

The first Nearctic species of stephanid to be described was *Megischus bicolor* Westwood (1841). Cresson (1872, 1880) later described two additional species, one of which, *Stephanus cinctipes* Cresson, was designated as the type species of *Schlettererius* Ashmead (Ashmead 1900a). Three species described by Schletterer (1889) and Davis (1897) are synonyms of *M. bicolor.* Townes (1949) described two species and recorded the Cuban species *Megischus brunneus* Cresson for the first time in the U.S.A. In total, Townes recognized six Nearctic species and divided *M. bicolor* into two subspecies. Carlson (1979) did not recognize of the validity of these subspecies.

MATERIAL AND METHODS

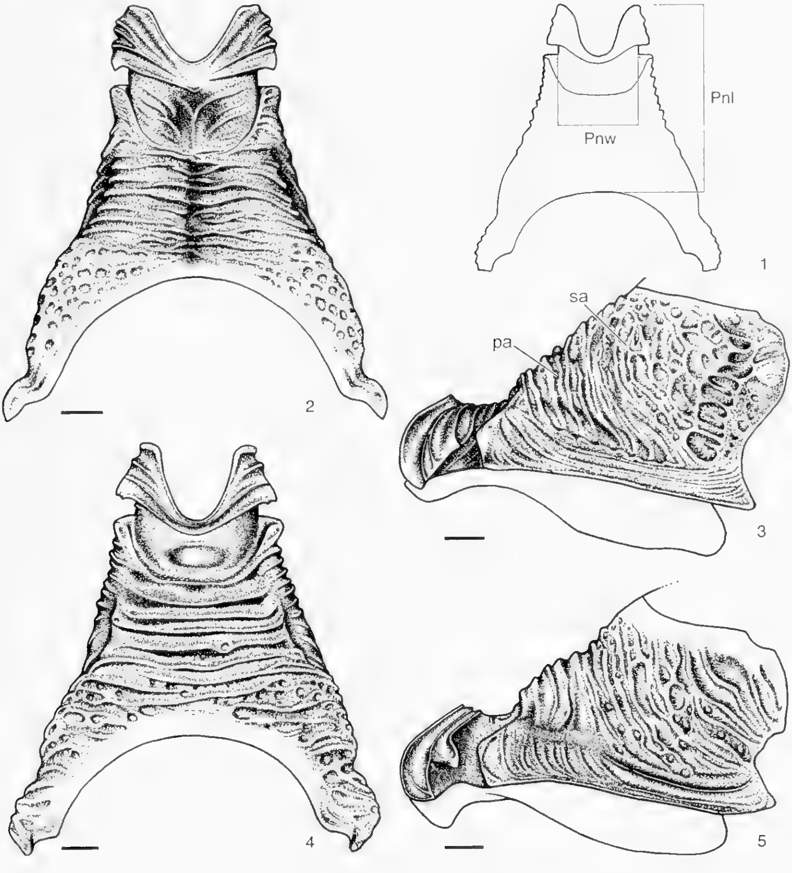
A total of 833 specimens were studied from North American and European museums. The Mexican fauna of Stephanidae is both more diverse in species, and the species are more variable in structure and color. Therefore we have deferred a consideration of the specimens found in Mexico until they can be considered in the context of the full diversity of that fauna. Morphological terminology and generic concepts generally follow Aguiar (1998). Measurements of total length are made from the base of the anterior tubercle on the head to the apex of the abdomen. The ratio of pronotal length to width compares the maximum length to minimum width (Fig. 1). The terms semiannular and preannular refer to differentiated parts of the pronotum (Elliott 1922). The semiannular (Fig. 3, sa) is the large, inflated posterior part of the pronotum. The preannular (Fig. 3, pa) is the short transverse area between the pronotal fold and the semiannular. The scientific and common names of plants follow the Plants Database of the U.S. Department of Agriculture (plants.usda.gov). The graphs of phenology display the number of specimens for each week of the year as well as the number of collecting events from which specimens are derived. A collecting event is defined as the unique combination of time, place, collector, and method of collection.

Specimens were kindly loaned by the following institutions and individuals alphabetized by codens used in the text: ABSC, Archbold Biological Station Collection, Lake Placid, FL; AEIC, American Entomological Institute, Gainesville, FL; AMNH, American Museum of Natural History, New York, NY; ANSP, Academy of Natural Sciences, Philadelphia, PA; CDAE, California State Collection of Arthropods, Sacramento, CA; CHAH, Henry A. Hespenheide collection, Los Angeles, CA; CIDA, Alberston College of Idaho, Caldwell, ID; CMNH, Carnegie Museum of Natural History, Pittsburgh, PA; CNCI, Canadian National Collection of Insects, Ottawa, Ontario; CSUC, Colorado State University, Ft. Collins, CO; EDNC, North Carolina Department of Agriculture, Raleigh, NC; EMEC, University of California, Berkeley; EMUS, Utah State University, Logan, UT; FCDA, Fresno County Department of Agriculture, Fresno, CA; FMNH, Field Museum of Natural History, Chicago, IL; FSCA, Florida State Collection of Arthropods, Gainesville, FL; IRCW, University of Wisconsin, Madison, WI; ISUI, Iowa State University, Ames, IA; LACM, Natural History Museum, Los Angeles, CA; LSUC, Louisiana State University, Baton Rouge, LA; MCPM, Milwaukee Public Museum, Milwaukee, WI; MEMU, Mississippi State University, Mississippi State, MS; MTEC, Montana State University, Bozeman, MT; NCSU, North Carolina State University, Raleigh, NC; NHMW, Naturhistorisches Museum, Vienna, Austria; ODAC, Oregon Department of Agriculture, Salem, OR; OSEC, Oklahoma State University, Stillwater, OK; OSUC, Ohio State University, Columbus, OH; PMNH, Peabody Museum of Natural History, New Haven, CT; PPCD, West Virginia Department of Agriculture, Charlestown, WV; PSUC, Pennsylvania State University, University Park, PA; ROME, Royal Ontario Museum, Toronto, Ontario; RUIC, Rutgers State University, New Brunswick, NJ; RWSC, Robert W. Surdick collection; SEMC, University of Kansas, Lawrence, KS; SFVS, San Fernando Valley State University, Northridge, CA; TAMU, Texas A&M University, College Station, TX; UADE, University of Arkansas, Fayetteville, AR; UAIC, University of Arizona, Tucson, AZ; UCDC, University of California, Davis; UCFC, University of Central Florida, Orlando, FL; UCMC, University of Colorado, Boulder, CO; UCMS, University of Connecticut, Storrs, CT; UCRC, University of California, Riverside; UGCA, University of Georgia, Athens, GA; ULKY, University of Louisville, Louisville, KY; UMMZ, University of Michigan, Ann Arbor, MI; UMRM, University of Missouri, Columbia, MO; UNSM, University of Nebraska State Museum, Lincoln, NE; USNM, National Museum of Natural History, Smithsonian Institution, Washington, DC; WFBM, University of Idaho, Moscow, ID; ZSMC, Zoologische Staatssammlung, Munich, Germany.

KEY TO NEARCTIC SPECIES OF STEPHANIDAE

1. Tergite and sternite of first metasomatic segment distinctly separated, both relatively short (see Fig. 1 in Townes 1949); pronotum short, in lateral view with distinct 90° break in profile immediately in front of mesonotum to form a flat, polished wall; fore wing with vein 1M arched; hind tibia white basally . . . . . . *Schletterius cinctipes* (Cresson)

– Tergite and sternite of petiole fused, petiole distinctly longer than wide (see Fig. 2 in Townes 1949); pronotum long, evenly subconical; fore wing vein 1M straight; hind



Figs. 1–5. Pronotum. 1, Dorsal measurements: Pnl = length; Pnw = width. 2, *Megischus annectens,* dorsal. 3, Same, left side, pa = preannular, sa = semiannular. 4, *M. brevicaudatus,* dorsal. 5, Same, left side. Scale bars: 0.25 mm. Drawings by Gláucia Marconato.

tibia black or brown basally (*Megischus* Brullé) 2

2(1). Petiole and pronotum polished; petiole with conspicuous transverse strigation 3

– Petiole and pronotum microreticulate; petiole otherwise smooth, without transverse strigation 7

3(2). Hind femur matte laterally; pronotum in dorsal view with deep polished constriction, interrupting gradual convergence of sides anteriorly; semiannular weakly swollen; hind tibia moderately constricted medially (Fig. 10) 4

– Hind femur polished laterally; pronotum appearing conical in dorsal view, without anterior constriction; semiannular distinctly swollen; hind tibia with distinct nearly semicircular constriction medially (Fig. 11) . . . 6

4(3). Ovipositor sheath with distinct preapical white band; gena usually smooth, sometimes with sparse, shallow foveolae; femoral sulcus distinct on pronotum; petiole relatively long, length 0.62–0.77 × length of metasoma beyond petiole 5

– Ovipositor sheath uniformly dark; gena usually foveolate, in small specimens foveolae may be sparse, but deep, distinct; femoral sulcus on pronotum absent or inconspicuous; petiole short, length 0.49–0.62 × length of metasoma beyond petiole (California) . . . . *Megischus annectens* Aguiar, n.sp.

5(4). Ovipositor longer than body, length 1.08–1.28 × body length; hind basitarsus brownish-yellow; median femoral tooth inclined towards apex, triangular (Fig. 8); inter- and postfoveolar areas of mesopleuron (see Aguiar 1998) distinctly transversely strigate; length of dilated part of hind tibia 1.5 × length of compressed basal portion; wings weakly infuscate; dorsal portion of metapleuron smooth only in narrow central area . . . . *Megischus bicolor* Westwood

– Ovipositor shorter than body, length 0.80–0.99 × body length; hind basitarsus reddish; median femoral tooth long perpendicular, round (Fig. 9); inter- and postfoveolar areas of mesopleuron usually smooth or weakly transversely strigate, only rarely distinctly strigate; length of dilated part of hind tibia 2–3 × length of compressed basal portion; wings clear; dorsal portion of metapleuron entirely smooth, polished . . . . *Megischus brevicaudatus* Aguiar, n.sp.

6(3). Ovipositor sheath with preapical white band; pronotum anteriorly with pair of short carinae on each side (Townes 1949: Plate 25, Fig. 6); mesopleuron (Fig. 6) and prosternum with scattered foveolae, generally separated by distance greater than their diameter . . . . *Megischus arizonicus* Townes

– Ovipositor sheath uniformly dark; pronotum with four sharp transverse carinae anteriorly (Townes 1949: Plate 25, Fig. 7); mesopleuron (Fig. 7) and prosternum with dense foveolae, each separated by less than their diameter . . . . *Megischus brunneus* Cresson

7(2). Posterior half of pronotum with fine transverse strigation; mesopleuron rugulose; metapleuron nearly or entirely glabrous; maxillary palp short, reaching approximately to apex of mandible; vein 2-1A darkly pigmented, tubular or nebulous; body dark brown in color . . . . *Megischus californicus* Townes

– Posterior half of pronotum microreticulate, without transverse strigation; mesopleuron with large shallow foveolae; metapleuron with dense tuft of setae; length of maxillary palp subequal to height of head; vein 2-1A very weakly pigmented, nebulous; body light brown in color . . . . *Megischus texanus* Townes

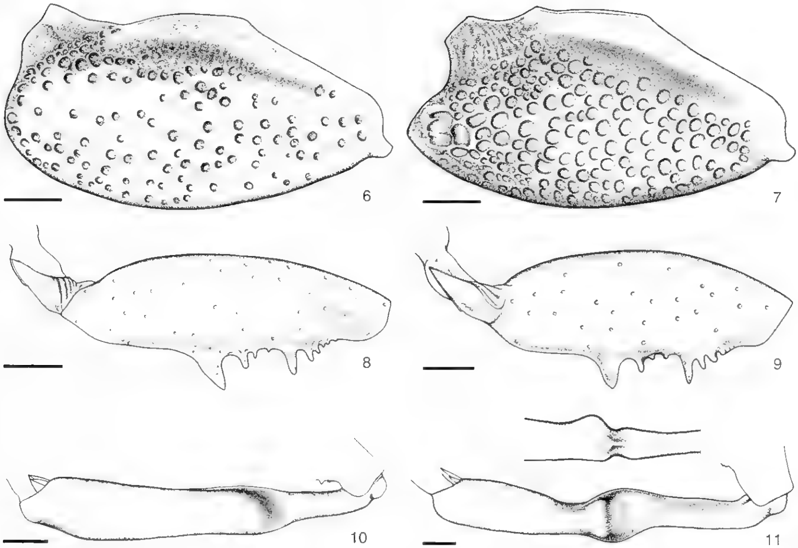
Schlettererius cinctipes (Cresson)
(Figs. 12, 17)

Stephanus cinctipes Cresson 1880: XVIII (original description); Cresson 1887: 52 (keyed); Schletterer 1889: 156 (repeat of Cresson (1880), distribution, keyed); Ashmead 1900b: 597 (listed).

Schlettererius cinctipes: Ashmead 1900a: 150 (generic transfer, keyed); Dalla Torre 1902: 5 (listed); Enderlein 1905: 474 (listed); Enderlein 1906: 290 (listed, keyed); Viereck 1914: 132 (type species); Elliott 1922: 714 (description, taxonomic discussion, keyed); Leonard 1928: 961 (listed); Townes 1949: 362, fig. 1 (description, distribution, ecology, keyed); Kirk, 1975: 59, 60 (hosts, seasonality); Meyer et al. 1978: 326 (biology, behavior); Carlson 1979: 741 (listed, distribution, biology, ecology); Mason 1990: 94, 95 (wing venation nomenclature, figure); Madl 1991: 120 (redescription, figure, keyed); Smith 1997: 377, 378 (distribution, rearing records, keyed).

Distribution.—We have seen 227 specimens from southern British Columbia, Washington, Idaho, Montana, South Dakota, Oregon, Utah, California, and southeastern Arizona, Fig. 12 (AEIC, CNCI, FSCA, IRCW, AMNH, UCRC, ANSP, EMUS, ROME, WFBM, EMEC, CIDA, UCDC, LACM, MTEC, ODAC, FCDA, CDAE, USNM). A single specimen in the USNM was collected in northern Virginia by D. R. Smith (Smith 1997). This specimen was from a Malaise trap in a suburban yard and may have emerged from wood from the western U.S. or Canada. Most likely it is not yet an indication of an expansion of its range to the East. It was also introduced into Australia (Victoria, New South Wales, Tasmania).

Biological associations.—Kirk (1975) reared this species from ponderosa pine (*Pi-*



Figs. 6–11. Mesopleuron, left. 6, *Megischus arizonicus*. 7, *M. brunneus*. 8–9, Hind left femur, lateral. 8, *M. bicolor*. 9, *M. brevicaudatus*. 10–11, Hind left tibia, lateral. 10, *M. bicolor*. 11, *M. arizonicus* (detail shows posterior view). Scale bars: 0.5 mm. Drawings by Gláucia Marconato.

nus ponderosa P. & C. Lawson), Engelmann spruce (*Picea engelmannii* Parry ex Engelm.), and white fir (*Abies concolor* Lindl. ex Hildebr.) infested by species of *Sirex* Linnaeus, *Urocerus* Geoffroy, and *Xeris* Costa (Hymenoptera: Siricidae); and it has also been reared from Douglas-fir, *Pseudotsuga menziesii* (Mirbel) Franco. According to Townes (1949), *S. cinctipes* has a range similar to that of Douglas-fir and seems to be most common in forests of this tree.

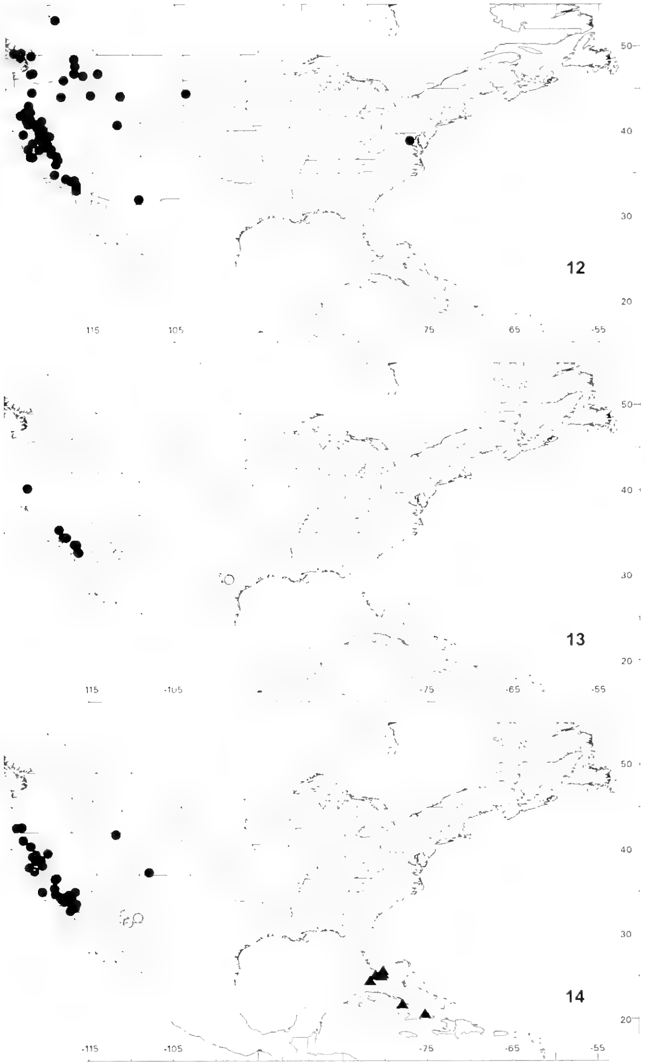
Taylor (1967) established a laboratory culture of *Schlettererius cinctipes* on *Sirex noctilio* Fabricius from adults collected in California. Additional material was later imported from Arizona and New Mexico, and the parasitoid was established in Tasmania (Taylor 1976). However, *Sirex noctilio* does not occur within the natural range of *S. cinctipes* (Carlson 1979). Meyer et al. (1978) suggested that *Monochamus oregonensis* (LeConte) (Coleoptera: Cerambycidae) may also serve as a host. Collection dates for populations in the U.S.A. and Canada extend from June 1 to August 29 (Townes 1949, see Fig. 17).

Label data on specimens additionally record specimens collected on or near grand fir, *Abies grandis* (Douglas ex D. Don) Lindl; specimens emerging from Jeffrey pine, *Pinus jeffreyi* Grev. et Balf., and sugar pine, *P. lambertiana* Douglas; as well as a possibly erroneous record of a rearing from thistle, *Cirsium* sp. (Asteraceae).

Megischus annectens **Aguiar, new species**
(Figs. 2–3, 13, 17)

Etymology.—From the Latin to link, to join; in reference to the intermediate taxonomic status of this species.

Description of ♀.—Reddish black, including ovipositor sheaths. Gena ventrally



Figs. 12–14. Geographic distribution. Only localities recorded more precisely than counties are illustrated. Maps drawn with units of latitude and longitude of equal size. 12, *Schlettererius cinctipes.* 13, *Megischus annectens* (solid circles) and *M. brevicaudatus* (open circles). 14, *M. californicus* (closed circles), *M. arizonicus* (open circles), *M. brunneus* (triangles).

with yellowish spot. Fore- and midtibiae, and hind tarsus reddish. Fore- and midtarsi, and hind second trochanter reddish brown. Wings hyaline or weakly infuscate.

Gena centrally produced into round, smoothly polished callosity, distinctly foveolate ventrally. Vertex laterally and temples areolate rugose. Pronotum (Figs. 2–3) distinctly transversely rugose, rugae finer ventrally and becoming more longitudinally oriented; anteriorly with deep, transversely rugose constriction. Preannular smoothly merging with semiannular, with shallow medial longitudinal sulcus dorsally (normally visible only with tangential light); femoral sulcus inconspicuous or absent. Apex of scutellum with mesal line of foveolae. Mesopleuron distinctly rugose-foveolate, especially anteriorly. Metapleuron centrally distinctly areolate rugose, sparsely pilose, with 1–2 long hairs within each cell of sculpture; dorsally polished smooth centrally, rugulose anteriorly and posteriorly; with narrow channel originating from pleuropropodeal fovea, running alongside line of fusion of metapleuron and propodeum, ending at posterior margin. Interfoveolar area of mesopleuron distinctly transversely strigate; postfoveolar area polished smooth or with very weak strigation. Propodeal sculpture varying from areolate rugose to densely foveolate, otherwise polished smooth; with distinct longitudinal or, rarely, transverse rugulae near petiolar foramen and sometimes along midline. Posterior spiracular plate indistinct; area behind spiracle areolate rugose. Hind femur and tibia distinctly microreticulate. Basal tooth long, distinctly inclined toward apex, blunt apically, with 1–2 subapical hairs; apical tooth distinctly smaller, blunt apically. Metasomatic T2–T8 microreticulate, becoming more distinct toward T8. Pygidial sulcus Y-shaped, i.e., extended basally along dorsal midline of T8.

Total length 13.8–20.5 mm; ovipositor length/total length 1.00–1.16; ovipositor length/length of metasoma beyond petiole 2.40–2.71; ovipositor length/petiole length 4.29–5.58; ovipositor length/length mesosoma 3.66–4.31; length of petiole/length of metasoma beyond petiole 0.49–0.62; length/minimum width of pronotum 2.41–2.85 (N = 6 for all measurements).

Description of ♂.—Similar to ♀; gena with weaker sculpture, not as distinctly projected; dorsal longitudinal sulcus on pronotum less conspicuous; scutellum without mesal line of foveolae; metapleural channel inconspicuous. Color usually as in ♀, but often much lighter; head and pronotum light reddish brown; fore- and hind tibiae and tarsi sometimes yellowish brown; hind tibia and petiole light reddish brown or yellowish brown; very small specimens sometimes entirely yellowish brown, including wing veins.

Diagnosis.—*Megischus annectens* may be distinguished from the similar species *M. bicolor* and *M. brevicaudatus* by the following combination of characters: gena and temple distinctly foveolate; pronotum without femoral sulcus, with a dorsal longitudinal sulcus, preannular smoothly merging with semiannular; metapleural channel present; propodeum areolate rugose; ovipositor sheaths without preapical white band.

Biological associations.—Collected on site dominated by birchleaf mountain mahogany, *Cercocarpus montanus* Raf. var. *glaber* (S. Wats.) F. L. Marting (Rosaceae, recorded on label as *Cercocarpus betuloides* Nutt.); collected on site dominated by oak. Emerged from coastal sage scrub oak, *Quercus dumosa* Nutt. (Fagaceae).

Material examined.—Holotype ♀. CALIFORNIA: Jacumba [San Diego Co.]; 3-VII-1956; D. J. and J. N. Knull; OSUC 0020401 (OSUC). Paratypes. Same data as holotype, except collected 26-V-1960, OSUC 0020301, ♂; 23-VI-1954, OSUC 0020521, ♀; 27-VI-1952, OSUC 0020295, ♂; 27-VI-1958, OSUC 0020519, ♂; 27-VI-1958, OSUC 0020522, ♂; 3-VII-1956, OSUC 0020300, ♂; 3-VII-1956, OSUC 0020302, ♂ (all OSUC). CALIFORNIA: *Riverside Co.*, Pinyon Flats; 21-V-1962; D. S. Verity; *Megischus bicolor sickmanni*, det. R. R. Snelling; OSUC 0020215; ♂ (FSCA). Pinyon Flats; 23-VII-1962; R. L. Westcott; OSUC 0020534; ♂ (ODAC). Piñon Flats; 30-VI-1958; G. H. Nelson; OSUC 0020548; ♂ (UCDC). Santa Rosa Mountains, Hwy. 74, elev. 3,500′; collected 2-IV-1978, emerged 1-13-V-1979; D. S. Verity; ex *Quercus dumosa*; OSUC 0020404; ♂ (CHAH). Santa Rosa Mountains, Hwy. 74, elev. 3,500′ ; 2-IV-1978; Emg.? ; D. S. Verity; reared ex *Quercus dumosa* (*Acmaeodera*?); OSUC 0020405; ♂ (CHAH). *San Bernardino Co.,* Wrightwood, 1 mile E; 10-VII-1965; D. S. Verity; OSUC 0020403; ♀ (CHAH). *San Diego Co.,* Boulevard; 20-V-1984; B. K. Dozier; collected on *Cercocarpus betuloides*; OSUC 0020402; ♀ (FSCA). South Indian Canyon; 8-VII-1948; G. A. Marsh; *Megischus* n. sp. Townes 1956; OSUC 0020399; ♀ (AEIC). *Tehama Co.,* Red Bluff; 17-IX-1970; D. L. Wilson; oak foothills; *Megischus bicolor sickmanni,* det. M. Wasbauer, 1975; OSUC 0020400; ♀ (CDAE). CALIFORNIA: Anza; VI-1955; Simonds; *Megischus bicolor sickmanni* det. Marsh; OSUC 0020044; ♂ (UCDC).

Other material.—The following specimens are all small males. We believe that they belong to this new species, but we have not designated them as paratypes because their small size and associated loss of characters reduces our confidence in their correct identification. CALIFORNIA: Kern Co., 18 mi S Bodefish; 21-VIII-1967; reared *Chryso'nus nauseosus*; F. M. Beer; OSUC 0020068; ♂ (CHAH). [probably rubber rabbitbrush, *Ericameria nauseosa* (Pallas ex Pursh) Nesom & Baird (Asteraceae)]. CALIFORNIA: Santa Rosa Mountains; 25-VI-1946; D. J. and J. N. Knull; *Megischus bicolor sickmanni,* Townes 1947; OSUC 0020307; ♂ (OSUC); 15-VI-1948; *Megischus bicolor bicolor,* Townes 1949; OSUC 0020294; ♂ (OSUC). CALIFORNIA: Jacumba; 16-VI-1954; D. J. and J. N. Knull; OSUC 0020299; ♂ (OSUC); 3-VI-1956; OSUC 0020303; ♂ (OSUC).

Megischus arizonicus Townes
(Figs. 6, 11, 14)

Megischus arizonicus Townes 1949: 364, 368, fig. 6 (original description, pronotum figured, distribution, keyed); Carlson 1979: 741 (listed, distribution); Gauld 1995: 184 (listed, distribution south of U.S.A.).

Distribution.—Southeastern Arizona, Fig. 14 (15 specimens: AEIC, AMNH, CNCI, EMEC, FSCA, OSUC, UAIC, UCDC, UCRC, USNM).

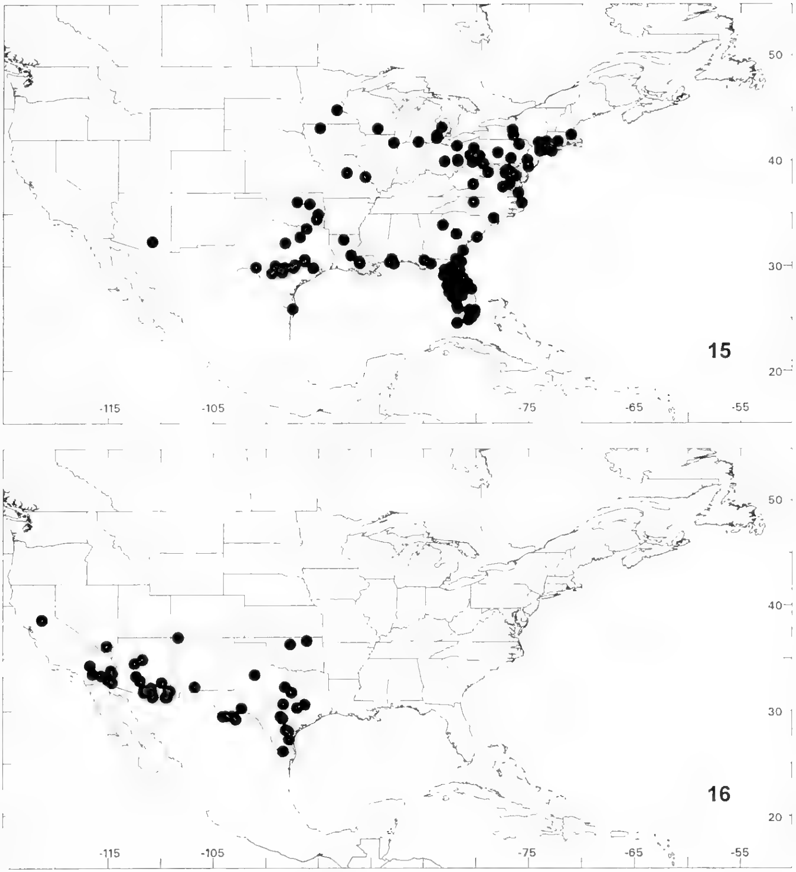
Biological associations.—Townes (1949) recorded the holotype from "white oak" in Arizona. The species with the common name "white oak," *Quercus alba* L., does not occur in that state. The record perhaps refers to Arizona white oak, *Quercus arizonicus* Sarg. (Fagaceae).

Comments.—A distinct species in the U.S.A., further characterized by the absence or only short basal extension of the pygidial sulcus, while the sulcus is distinctly Y-shaped in *M. bicolor* and *M. annectens*; metasomatic T2 polished smooth, but matte in *M. bicolor, M. brevicaudatus, M. annectens.*

Megischus bicolor (Westwood)
(Figs. 8, 10, 15, 17)

Stephanus bicolor Westwood 1841: 538 (original description); Westwood 1843: 276 (complementary description, distribution); Schletterer 1889: 90, 154 (redescription, distribution, figure, keyed); Dalla Torre 1902: 6 (listed, distribution); Enderlein 1905: 475 (listed, distribution); Kieffer 1908: 4 (listed, distribution); Elliott 1922: 716, 732 (description, distribution, keyed).

Megischus bicolor: Townes 1949: 364, 366, figs. 2, 5 (redescription, generic transfer, distribution, pronotum and habitus figured, keyed, division into subspecies); Carlson 1979: 741 (listed, distribution, synonymy); Aguiar and Sharkov 1997: 422 (collection with blue pan traps);



Figs. 15–16. Geographic distribution. Only localities recorded more precisely than counties are illustrated. Maps drawn with units of latitude and longitude of equal size. 15, *Megischus bicolor*. 16, *M. texanus*.

Smith 1997: 377 (distribution, rearing records, seasonality, keyed).

Megischus bicolor bicolor: Townes 1949: 364, 367 (diagnosis, distribution, synonymy, keyed).

Stephanus sickmanni Schletterer 1889: 90, 152 (original description, distribution, figure, keyed, transferred as subspecies of *M. bicolor* by Townes 1949); Enderlein 1905: 475 (listed, distribution); Kieffer 1908: 4 (listed, distribution, figure); Elliott 1922: 716, 727 (description, distribution, keyed).

Stephanus sickmannii: Dalla Torre 1902: 9 (lsted, distribution, incorrect subsequent spelling).

Megischus bicolor sickmanni: Townes 1949: 364, 367 (diagnosis, generic transfer, biological notes, distribution, synonymy, keyed); Halstead 1986: 103 (distribution and seasonality in California).

Megischus canadensis Davis 1897: 349 (original description, synonymized by Townes 1949); Elliott 1922: 827 (repeat of Davis 1897, classified as "doubtful species").

Stephanus Canadensis: Dalla Torre 1902: 6 (listed, distribution, generic transfer).

Megischus floridanus Davis 1897: 349 (original description, synonymized by Townes 1949). Elliott 1922: 828 (repeat of Davis 1897).

Stephanus Floridanus: Dalla Torre 1902: 7 (listed, distribution, generic transfer).

Distribution.—368 specimens (ABSC, AEIC, AMNH, ANSP, CMNH, CNCI, CSUC, EDNC, EMEC, FMNH, FSCA, IRCW, ISUI, LACM, LSUC, MEMU, NCSU, NHMW, OSEC, OSUC, PMNH, PPCD, PSUC, RUIC, RWSC, TAMU, UADE, UCDC, UCFC, UCMC, UCMS, UGCA, ULKY, UMMZ, UMRM, UNSM, ZSMC). Generally limited to eastern U.S.A., from Massachusetts, Connecticut, New York, Michigan, Wisconsin and Minnesota south to the Gulf Coast states, west to Iowa, Missouri, Oklahoma, Texas and southeastern Arizona (Fig. 15). No specimens found from Mississippi, Kentucky, Tennessee, Rhode Island, Vermont, New Hampshire, Maine. Recorded in Townes (1949) from Canada (southern Ontario) and Kansas, but we have not seen these specimens. Most material recorded by Townes from the western U.S.A. is now placed in *M. annectens* and *M. brevicaudatus*.

Description of ♀.—Head, prothorax, mesothorax varying from bright red to dark brown, red color sometimes extending onto propodeum, mesopleuron, legs; remaining mesosoma, metasoma dark brown; gena with yellowish spot near base of mandible; legs sometimes with yellow markings, tarsi usually yellowish brown.

Gena polished smooth or with few, very small foveolae. Temples, central portion of vertex, posterior portion toward occiput with distinct transverse, parallel raised ridges. Pronotum with deep anterior, smoothly polished constriction. Preannular smoothly merging with semiannular, without median longitudinal sulcus; femoral sulcus distinct, straight, smoothly polished. Apical margin of scutellum with fine, shallowly impressed lines or distinct, alutaceous microsculpture. Mesopleuron with distinct, separated foveolae, surface between foveolae polished smooth. Metapleuron foveolate, with long seta arising from each foveola, otherwise covered with dense pile; dorsal portion polished smooth centrally, foveolate or rugulose anteriorly, punctate posteriorly. Inter-, postfoveolar areas with distinct uniform, transverse strigae. Propodeum with widely separated foveolae, surface between foveolae alutaceous. Posterior spiracular plate foveolate, area between foveolae polished smooth or finely alutaceous. Hind femur weakly microreticulate, sculpture more distinctly visible apically, weaker than sculpture on dilated part of tibia. Basal tooth forming obtuse angle with longitudinal axis of femur, laterally compressed, keel-shaped; apical tooth short, rounded; margin straight or convex beyond apical tooth (Fig. 8). Metasomatic T2–T8 very finely, distinctly microreticulate, becoming more distinct apically. Pygidial sulcus normally distinctly Y-shaped.

Total length 11.1–27.2 mm; ovipositor length/total length 1.08–1.28; ovipositor length/length of metasoma beyond petiole 2.94–3.31; ovipositor length/petiole length 3.94–4.97 ; ovipositor length/length mesosoma 3.90–5.00; length of petiole/length of metasoma beyond petiole 0.63–0.77; length/minimum width of pronotum 2.72–3.34 (N = 10 for all measurements).

Diagnosis.—Closely related to *M. brevicaudatus,* from which it may be most easily separated by having a longer ovipositor (length 1.08–1.28 × body length), yellowish brown hind tarsi, and the oblique basal and short apical tooth on the hind femur (Fig. 8). Additional differences include the

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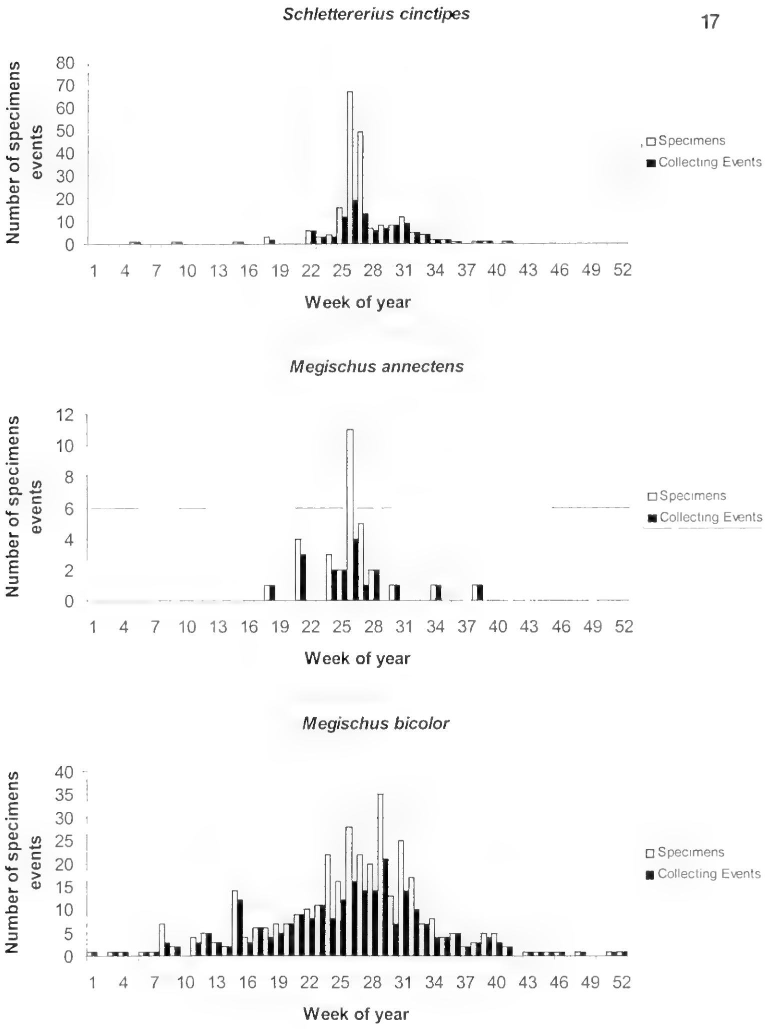

Fig. 17. Seasonal flight periods as indicated by total number of specimens collected and number of independent collecting events. Collecting events are unique combinations of localities, dates, collectors, and methods. Only specimens or events with the date recorded as a single day are illustrated.

straight femoral sulcus, and the presence of fine alutaceous sculpture or lines along the apical margin of the scutellum. *Megischus bicolor* may be distinguished from *M. annectens* by the polished smooth or sparsely punctate gena, the alutaceous microsculpture between the propodeal foveolae, and the white subapical band on the ovipositor sheaths. Males are very similar, in some cases indistinguishable, from males of *M. brevicaudatus*. They differ from males of *M. annectens* by the distinctly foveolate propodeum, with the foveolae widely separated from one another. Very small specimens have the propodeal sculpture similar to *M. annectens*.

Biological associations.—Collected on scrub hickory, *Carya floridana* Sarg.; pecan, *Carya illinoinensis* (Wangenh.) K. Koch; unspecified *Carya* Nutt. sp. (Juglandaceae); juniper, *Juniperus* L. (Cupressaceae); pond pine, *Pinus serotina* Michx. (Pinaceae); unspecified pine, *Pinus* sp.; swamp white oak, *Quercus bicolor* Willd.; sand live oak, *Quercus geminata* Small; unspecified oak, *Quercus* (Fagaceae). Emerged from papaya, *Carica papaya* L. (Caricaceae); shagbark hickory, *Carya ovata* (P. Mill.) K. Koch; unspecified *Carya* sp.; beech, *Fagus* L. (Fagaceae); swamp white oak; bur oak, *Quercus macrocarpa* Michx. (Fagaceae). Recorded by Townes (1949) in association with bigtooth aspen, *Populus grandidentata* Michx. (Salicaceae) and American beech, *Fagus grandifolia* Ehrh. (Fagaceae).

Comments.—Townes (1949) recognized two subspecies: *M. bicolor bicolor* Westwood from the southeastern U.S.A. and *M. bicolor sickmanni* (Schletterer) throughout the more northern portion of the distribution (Fig. 15). We have found no structural characters that can be used to substantiate their formal nomenclatural differentiation. The two color forms overlap but little in their geographic distribution, but significant gaps in our knowledge remain. For example, we have not seen specimens from Tennessee, Kentucky, Mississippi, and most of Illinois, Indiana, West Virginia, Virginia, South Carolina, and Alabama. We see no practical reason to continue to recognize subspecies solely on the basis of color with such relatively poor sampling of the species. Therefore, we concur with Carlson's (1979) treatment of this as a single undifferentiated species.

Megischus brevicaudatus Aguiar, n. sp.

(Figs. 4, 5, 9, 13, 18)

Etymology.—From the Latin *brevis*, short; *cauda*, tail; in reference to the relatively short ovipositor.

Description of ♀.—Dark brown or black, with yellowish spot ventrally on gena under eye. Reddish on pronotal lobe, trochanters, fore- and midtibiae, compressed portion of hind tibia, hind tarsus, apex of petiole; sometimes also reddish near petiolar foramen, base of petiole. Lighter reddish to yellowish on basal half of flagellum; fore- and midfemora basally; fore- and midtarsi; sometimes hind trochantellus. Wing veins dark brown, membrane clear.

Gena moderately foveolate on ventral half, polished smooth dorsally. Vertex laterally areolate rugose, posteriorly transversely strigate, sculpture not or barely reaching temple. Pronotum (Figs. 4–5) distinctly rugose, without median longitudinal sulcus, with deep, anterior, smoothly polished constriction. Semiannular weakly distinguished from preannular; femoral sulcus distinct, narrow, polished smooth, sinuous or with at least posterior apex curved (Fig. 5). Apex of scutellum normally polished smooth. Mesopleuron distinctly foveolate, sometimes partially rugose foveolate. Metapleuron distinctly areolate rugose centrally, densely pilose posteriorly, polished smooth dorsally from posterior margin to pleuropropodeal fovea. Interfoveolar area polished smooth to moderately transversely strigate; postfoveolar area polished smooth or with very weak strigation; very rarely both areas distinctly transversely strigate. Propodeum deeply foveolate, area between foveolae distinctly, finely alutaceous;

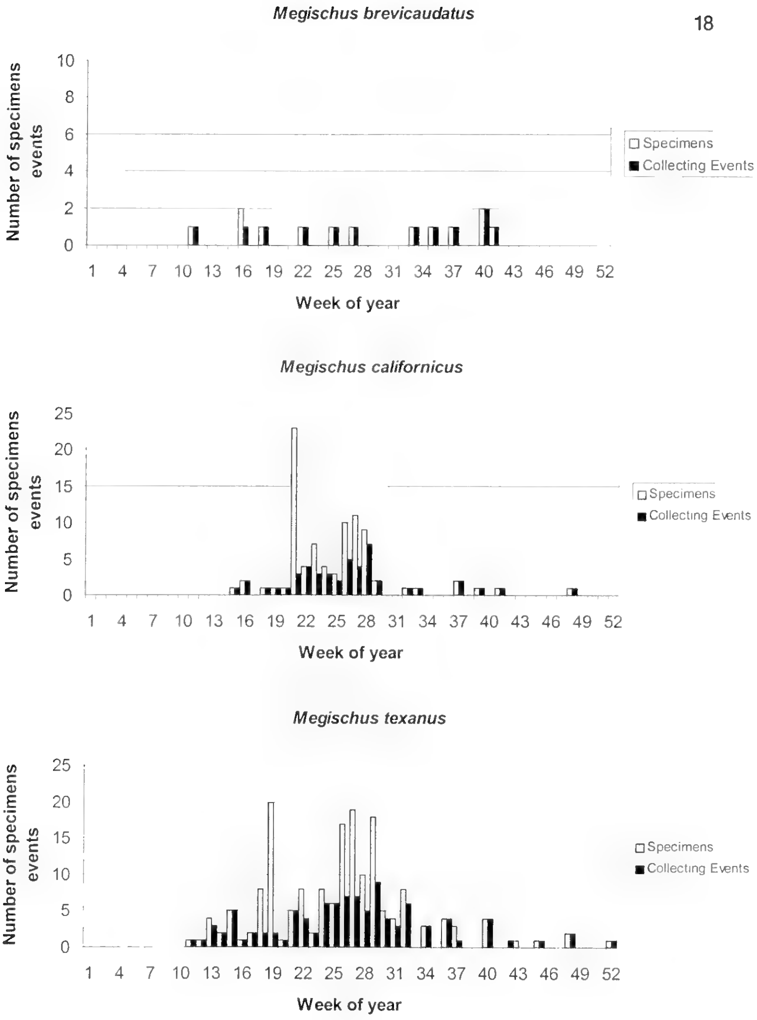

Fig. 18. Seasonal flight periods as indicated by total number of specimens collected and number of independent collecting events. Collecting events are unique combinations of localities, dates, collectors, and methods Only specimens or events with the date recorded as a single day are illustrated.

coarsely transversely rugose near petiolar foramen. Posterior spiracular plate densely foveolate, foveolae contiguous or fused together. Hind femur weakly microreticulate, nearly smooth basally, progressively more distinct toward apex, sculpture much less distinct than that on dilated part of tibia. Basal tooth nearly perpendicular to long axis of femur, elongate in lateral view, rarely triangular, rounded in cross-section, apex blunt; apical tooth long, acute; margin of femur concave beyond apical tooth (Fig. 9). Metasomatic T2—T8 very finely microreticulate, sculpture progressively more distinctly developed apically. Pygidial sulcus distinctly V-shaped, without basal extension; T8 sometimes depressed at base of "V" formed by sulcus.

Total length 17.6–22.8 mm; ovipositor length/total length 0.80–0.99; ovipositor length/length of metasoma beyond petiole 2.09–2.66; ovipositor length/petiole length 3.26–3.96 ; ovipositor length/length mesosoma 2.89–3.68; length of petiole/length of metasoma beyond petiole 0.62–0.73; length/minimum width of pronotum 2.17–3.15 (N = 11 for all measurements).

Description of ♂.—Generally similar to female, but diagnostic characters less conspicuous because of significantly smaller body size.

Diagnosis.—*Megischus brevicaudatus* may be separated from the closely related *M. bicolor* by the distinctly shorter ovipositor, reddish hind tarsi, V-shaped pygidial sulcus, perpendicular basal tooth, and presence of a distinct concavity on the femur beyond its apical tooth in the former species. The reddish color, especially on the hind tarsi, is the only stable diagnostic feature found for male *M. brevicaudatus.* This new species may be distinguished from *M. annectens* by the lack of a median longitudinal sulcus dorsally on the pronotum, the V-shaped pygidial sulcus, and the presence of a white preapical band on the ovipositor sheaths. Some species in Central and South America also have the deep constriction in the pronotum. *Megischus brevicaudatus* may be distinguished from these by the distinctly sculptured semiannular and hind coxa, the presence of punctures or foveolae on the ventral half of the gena, and the densely foveolate sculpture of the mesopleuron.

Biological associations.—Collected on ash, *Fraxinus* L. (Oleaceae); sweetpotato cactus, *Cereus* P.Mill. (Cactaceae); mesquite, *Prosopis juliflora* (Sw.) DC. (Fabaceae); and blue paloverde, *Parkinsonia florida* (Benth. ex Gray) S. Wats. (Fabaceae).

Material examined.—Holotype ♀: ARIZONA: Chiricahua Mts., 2-VI-1935, J. N. Knull; OSUC 0020309 (OSUC). Paratypes. ARIZONA: *Pima Co.*, Tucson; 10-X-1959; F. Werner; *Megischus bicolor sickmanni* ♀, det. F. Werner, 1960; OSUC 0020156; ♀ (UAIC). Tucson, vic. Ina/Oracle; 7-X-1985; on *Cereus* bloom; 2200 h; L. Nutting; OSUC 0020154; ♂ (UAIC). IBP Research Area, Silver Bell, 10 mi W Marana; 1-IX-1972; D. S. Chandler; *Megischus bicolor sickmanni* det. D. S. Chandler; OSUC 0020123; ♀ (UCDC). *Maricopa Co.*, Rainbow Valley Rd., 2–5 mi S Gila R.; 3-V-1990; ex flowers of *Cercidium floridum* Benth.; *Megischus arizonicus* Townes, det. J. R. Wiley, 1995; OSUC 0020211; ♀ (FSCA). TEXAS: *Bexar Co.*, Fort Sam Houston; 15-IX-1953; B. J. Adelson; OSUC 0020157; ♀ (UCMS). San Antonio; 6-X-1968; W. H. Tyson; OSUC 0020119; ♀ (LACM). *Dickens Co.*, White River Reserve, Fert. Bait, 7-11-VII-1988, R. Morris; OSUC 0020363; ♀ (UGCA). *Hidalgo Co.*, Bentsen Rio Grande Valley S. P. near Mission; 10-VII-1981; C. Porter; OSUC 0020180; ♀ (FSCA). *Karnes Co.*; 12-III-1934; C. E. Heard; 5443; *Megischus bicolor sickmani* det. H. M. Greenbaum 1974; OSUC 0020153; ♂ (TAMU). *Real Co.*, Rio Frio, Hwy. 90; 14-VIII-1959; OSUC 0020314; ♀ (CNCI). *Starr Co.*, Salineño, along Rio Grande; spring 1992; reared from dead ash limbs; E. G. Riley; OSUC 0020202; ♂ (TAMU). *Uvalde Co.*, 10 mi N of Uvalde; 19-VI-1968; G. H. Nelson; on dead limbs; on *Prosopis juliflora* (Sw.)DC;

OSUC 0020209; ♂ (FSCA). *Val Verde Co.*, Devil's River, Dolan Falls area, elev. 360 m; 18-V-1993; Gelhaus No. 589, Nelson, Koenig; OSUC 0020311; ♀ (ANSP). One additional non-type female without locality labels from UAIC.

Megischus brunneus Cresson
(Figs. 7, 14)

Megischus brunneus Cresson 1865: 84 (original description); Townes 1949: 364, 369 (generic transfer, redescription, distribution, figure, keyed); Carlson 1979: 141 (listed, generic transfer, distribution); Gauld, 1995: 184 (listed, distribution south of U.S.A.).

Stephanus bruneus: Dalla Torre 1902: 6 (listed, generic transfer, distribution, unjustified emendation).

Stephanus brunneus: Enderlein 1905: 475 (listed, distribution); Kieffer 1908: 4 (listed, distribution); Elliott 1922: 716, 718, 725 (description, keyed); Orfila 1951: 273 (generic transfer, keyed).

Distribution.—Seven specimens from southernmost Florida (Monroe, Dade counties: AEIC, FSCA, USNM); extralimital material from Cuba, Fig. 14.

Biological associations.—Collected on dead white mangrove, *Laguncularia racemosa* (Linnaeus) Gaertn. f. (Combretaceae); "at" American sycamore, *Platanus occidentalis* L. (Platanaceae); resting on dead fig, *Ficus* L. (Moraceae). Recorded in literature in association with buttonwood (Townes 1949), possibly *Conocarpus erectus* L. (Combretaceae); and "diseased Jalia" (Cresson 1865).

Megischus californicus Townes
(Figs. 14, 18)

Megischus californicus Townes 1949: 364, fig. 3, ♂, ♀. (original description, pronotum figured, keyed); Carlson 1979: 741 (listed, distribution); Halstead 1986: 101 (distribution, seasonality in California, cited as *californica*).

Distribution.—Oregon, California, Nevada, Utah, Colorado (56 specimens: AEIC, CDAE, CNCI, EMEC, EMUS, LACM, ODAC, OSUC, UCDC, UCRC, USNM).

Biological associations.—Emerged from buckbrush, *Ceanothus cuneatus* (Hook.) Nutt. (Rhamnaceae); interior live oak, *Quercus wislizeni* A. DC.; and an unspecified oak, *Quercus* L. (Fagaceae). Collected on mule's fat, *Baccharis salicifolia* (Ruiz & Pavón) Pers. (cited as *B. glutinosa*) (Asteraceae); *Ceanothus cuneatus*, and *Ceanothus* L.

Megischus texanus Cresson
(Figs. 16, 18)

Megischus texanus Cresson 1872: 190, ♀ (original description); Elliott 1922: 761 (possible placement in *Hemistephanus* Enderlein); Townes 1949: 364 (figure, description, distribution); Carlson 1979: 741 (listed, distribution); Halstead 1986: 103 (distribution, seasonality in California; biology); Gauld 1995: 184 (distribution south of U.S.A.).

Stephanus texanus: Dalla Torre 1902: 9 (generic transfer, distribution); Elliott 1922: 716, 730 (description, distribution, keyed).

Stephanus (Hemistephanus) texanus: Roman 1917: 14 (keyed, subgeneric assignment).

Hemistephanus texanus: Elliott 1922: 755 (generic transfer, similar to *Parastephanellus pictipes* Roman).

Distribution.—California, Nevada, Arizona, New Mexico, Colorado, Oklahoma, Texas, Louisiana, Fig. 16 (124 specimens: AEIC, AMNH, ANSP, CHAH, CNCI, CSUC, EMEC, EMUS, FCDA, LACM, LSUC, MCPM, ODAC, OSUC, SEMC, SFVS, TAMU, UAIC, UCDC, UCRC, UGCA, USNM, WFBM).

Biological associations.—Reared as a larval parasitoid of *Acmaeoderopsis junki* (Thery) (Coleoptera: Buprestidae). Emerged from paloverde species, *Parkinsonia* Linnaeus, (Fabaceae; recorded on label as *Cerci-*

dium Tulasne); blue paloverde, *P. florida* (Benth. ex Gray); desert ironwood, *Olneya tesota* Gray (Fabaceae); mesquite, *Prosopis* Linnaeus (Fabaceae), interior live oak, *Q. wislizeni*. Collected on paloverde; pine, *Pinus* Linnaeus (Pinaceae), mesquite; oak; and sumac, *Rhus* Linnaeus (Anacardiaceae). Collected on site dominated by pine.

Comments.—Small specimens of *M. texanus* do not have the sculpture and color patterns typical of the species. They tend to be darker and have coarser pronotal sculpture, and they may easily be mistaken for *M. californicus*. The relative length of the maxillary palp and the pilosity on the metapleuron are stable, size-independent characters not mentioned in Townes (1949). *Megischus texanus* may be distinguished from *M. californicus* by having the maxillary palp as long as the height of the head and the presence of a dense tuft of hairs centrally on the metapleuron.

ACKNOWLEDGMENTS

Thanks to the many curators for the loan of specimens for study; Luciana Musetti provided important help with the databasing of specimens and useful suggestions to the manuscript, and Gláucia Marconato skillfully prepared all drawings. This material is based upon work supported by the National Science Foundation under Grant No. DEB-9521648 and by a scholarship from CAPES ("Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior"), Brazil.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 484–498

SEVEN NEW SPECIES OF POLYCENTROPODIDAE (TRICHOPTERA) FROM NICARAGUA AND COSTA RICA

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Abstract.—Seven new species of Polycentropodidae (Trichoptera) are described and illustrated from collections made in Nicaragua and Costa Rica: ***Cernotina riosanjuanensis, Cyrnellus zapateriensis, Polycentropus garfio, Polycentropus hamiltoni, Polycentropus phraterus, Polyplectropus maesi,*** and ***Polyplectropus nicaraguensis. Polycentropus holzenthali*** Bueno-Soria and Hamilton also is illustrated and redescribed.

Key Words: Trichoptera, Polycentropodidae, Nicaragua, Costa Rica, new species, Central America

The family Polycentropodidae is comprised of 372 species in 26 genera worldwide (Morse 2001). Six genera occur in the Neotropics: *Antillopsyche* Banks 1941, with 4 extant and 1 extinct species from the Greater Antilles; *Cernotina* Ross 1938 with 50 species and *Cyrnellus* Banks 1913 with 9 species are distributed only in the New World; and *Nyctiophylax* Brauer 1965, *Polycentropus* Curtis 1835, and *Polyplectropus* Ulmer 1905 with 4, 64, and 42 species, respectively, in the Neotropics (Flint et al. 1999). Costa Rica and Nicaragua have representatives of all these genera, except *Antillopsyche* and *Nyctiophylax.* Thirty-five species of Polycentropodidae have been recorded for Costa Rica and 19 for Nicaragua: *Cernotina,* 2 species in Costa Rica, 4 in Nicaragua; *Cyrnellus fraternus,* (Banks) found in both countries; *Polycentropus,* 12 species in Costa Rica, 6 in Nicaragua; and *Polyplectropus,* 8 species in Costa Rica, 7 in Nicaragua (Flint et al. 1999). In this paper, I describe two new species of *Polycentropus* from Costa Rica and five new species in the genera *Cernotina, Cyrnellus, Polycentropus,* and *Polyplectropus* from Nicaragua. In addition, *Polycentropus holzenthali* Bueno-Soria and Hamilton 1986 is illustrated and redescribed, and a new distribution record is provided.

Dr. Ralph W. Holzenthal, University of Minnesota, and colleagues collected the new species from Costa Rica during an inventory of the caddisflies of that country conducted from 1986 through 1995. Dr. Jean-Michel Maes, Museo Entomológico, León, Nicaragua, provided the Nicaraguan caddisflies, which he collected during an ongoing inventory of Coleoptera and nocturnal Lepidoptera of Nicaragua. I collected the remaining Nicaraguan caddisflies during two trips from June through August 2000 and from July through August 2001.

Types are deposited in the University of Minnesota Insect Collection, 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 follows that of Hamilton (1986) for *Polycentropus* and *Polyplectropus,* and Flint (1971) for *Cernotina* and *Cyrnellus,* with minor modifications.

Cernotina riosanjuanensis
Chamorro-Lacayo, new species

(Fig. 1)

This new species appears to be closest to *Cernotina zanclana* Ross 1951, but differs in the more slender shape of the dorsal branches of the intermediate appendages, in the evenly rounded apex of the inferior appendages, and in the medial origin of the basodorsal lobes of the inferior appendages.

Male.—Length of forewing 4.5 mm. Color in alcohol, yellowish brown. Genitalia as in Fig. 1. Sternum IX short, produced anterolaterally; anterior margin, in ventral view, deeply excavated. Tergum X semimembranous, long, narrow, setose; in lateral view, curved posterad; in dorsal view, curved posteromesally. Intermediate appendages bipartite; dorsal branches with bases broad, curved mesally and tapering into pigmented acute apices; ventral branches setose, in lateral view, digitate with broad bases and rounded thumblike apices, in dorsal view, square, mesal margins deeply convex, posterior margins truncate, excavated, expanded posterolaterally. Preanal appendages apparently absent. Inferior appendages elongate, oval, in lateral view, posterolateral margins rounded, apicoventral and apicomesal lobes concealed; basodorsal lobes clublike each with long, thick apical setae and a small posteriorly directed submedial process; apicoventral lobes pigmented, in dorsal and ventral views triangular; apicomesal lobes, in dorsal view, square, transparent with posterior margins lightly pigmented. Phallus long, slender, tubular, membranous internally.

Female.—Unknown.

Type material.—Holotype, ♂. NICARAGUA: Río San Juan, Refugio Bartola, small creek, 300 m NW of station, 10°58′N, 84°21′W, el. 35 m, 7.viii.2000, Chamorro, Dobbins (UMSP) (UMSP000066732).

Etymology.—This species is named for the magnificent national treasure that is the San Juan River (Río San Juan), Nicaragua, by which this species was collected.

Cyrnellus zapateriensis
Chamorro-Lacayo, new species

(Fig. 2)

This new species is closely related to *Cyrnellus fraternus* (Banks 1905). *Cyrnellus zapateriensis*, can be distinguished from *C. fraternus* by the smaller size and truncate apices of the inferior appendages, and by the membranous ventrolateral margins of the intermediate appendages.

Male.—Length of forewing 4.5 mm. Color in alcohol, body and legs yellowish brown; wings brown. Male genitalia as in Fig. 2. Sternum IX, in lateral view, reversed L-shaped, apparently fused with intermediate appendages dorsally. Tergum IX and X membranous, fused with setose intermediate appendages; fused structure, in lateral view, nearly square with ventrolateral margins membranous and expanded posterad (in some specimens not as expanded, but reduced to a narrow apex), in dorsal view, trapezoidal. Body of bipartite preanal appendages digitate, setose, not exceeding intermediate appendages, produced mesally into digitate, posteroventrally curved mesobasal processes, with pigmented apex, bordering phallus. Inferior appendages, in lateral view, broad basally, curved posterodorsally and narrowing to rounded apices; in ventral view, posterior margins truncate, apicomesal lobes a narrow, acute mesally directed spine with pigmented apex; mesal margin concave basad of apicomesal lobes, expanding into medial setose circular lobes. Phallus short; phallic sclerite in lateral view somewhat indistinct, basally broad, slightly curved; in dorsal view distinct, Y-shaped. Subgenital plate digitate, fused basally, uniform width throughout, apex lightly pigmented, slightly curved ventrally, almost same size as mesobasal processes of preanal appendages.

Female.—Unknown.

Type material.—Holotype: ♂. NICARAGUA: Granada: Isla Zapatera, El

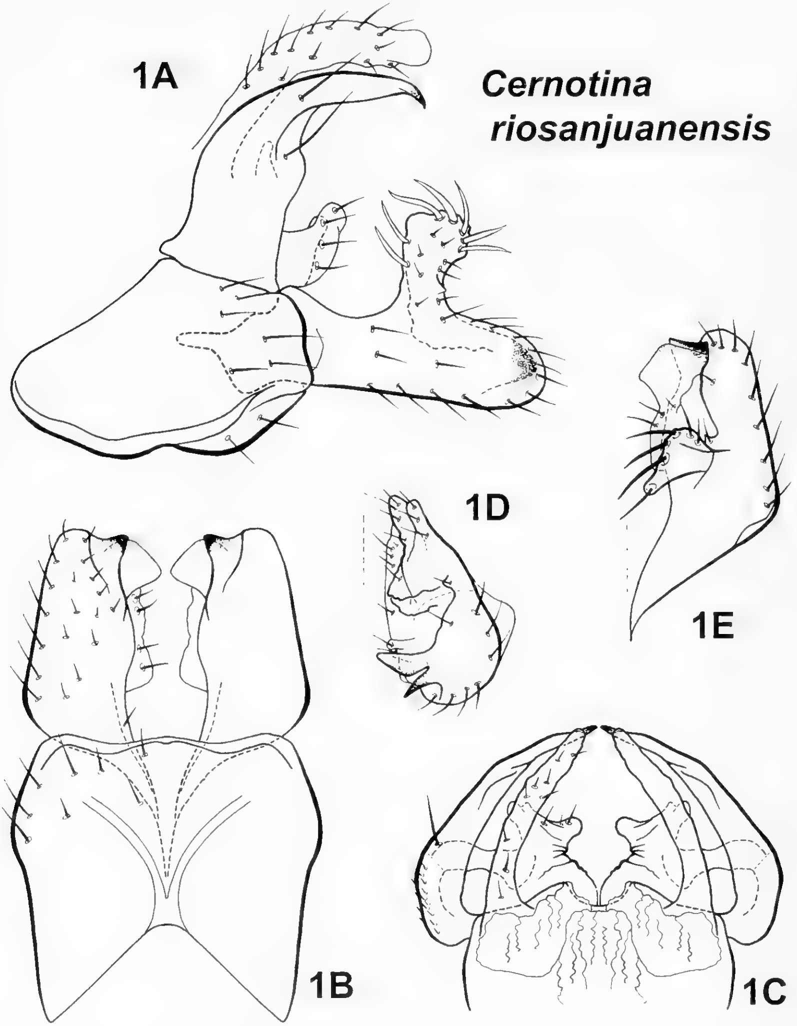

Fig. 1. *Cernotina riosanjuanensis*, male genitalia. A, Lateral view. B, Ventral view. C, Dorsal view. D, Inferior appendage, caudal view. E, Inferior appendage, dorsal view.

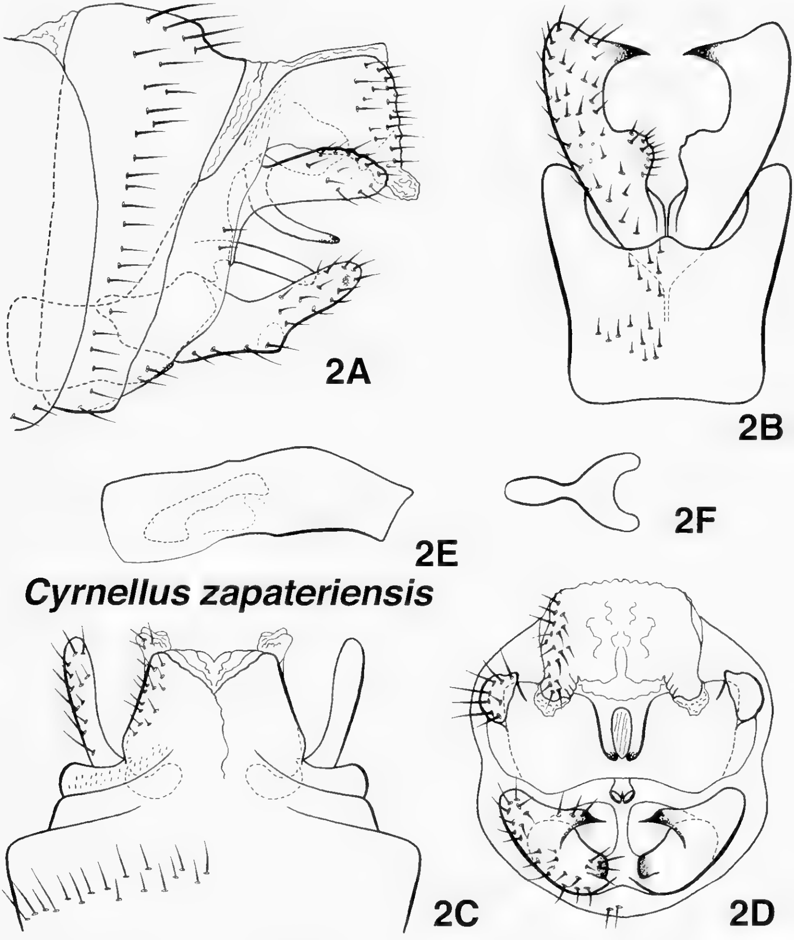

Fig. 2. *Cyrnellus zapateriensis*, male genitalia. A, Lateral view. B, Ventral view. C, Dorsal view. D, Caudal view. E, Phallus. F, Phallic sclerite, dorsal view.

Bambú, Frente a Lago de Nicaragua, 11°45.829′N, 85°51.991′W, el. 42 m, 19.vii.2001, Chamorro, Martinez, Ruiz (UMSP) (UMSP000066725). Paratypes: Same as holotype, 1 ♂ (NMNH); Granada: Isla Zapatera, 20.v.1988, S. Valle, 1 ♂ (UMSP).

Etymology.—This species is named for

the type locality, Isla Zapatera, located in Lake Nicaragua, Granada, Nicaragua.

Polycentropus garfio Chamorro-Lacayo, new species

(Fig. 3)

This new species is a member of the *gertschi* group, as defined by Hamilton (1986). *Polycentropus garfio,* is similar to *Polycentropus spicatus* Yamamoto 1967 and *Polycentropus zurqui* Holzenthal and Hamilton 1988 (both unplaced species within the *gertschi* group) in that the intermediate appendages have laterally directed apices and bear a large basodorsal tooth, and in the overall shape of the preanal appendages. *Polycentropus garfio* is distinguishable from these species by the tight curvature of the intermediate appendages, the overall shape of the inferior appendages, the presence of paired plates within the phallus, and by the shape of the mesoventral process of the preanal appendages.

Male.—Length of forewing 7.5–8.0 mm. Color of body brown, legs with darker setae on femora and tarsi; dorsum of head brown with long, erect, dark brown setae; forewings covered by brown setae and scattered patches of golden setae. Male genitalia as in Fig. 3. Sternum IX, in lateral view, with anterior margin nearly straight, broad ventrally, tapered posterodorsally and posterior margin moderately sinuate; in ventral view, rectangular. Tergum X membranous, basal margin broad in dorsal view, trapezoidal. Intermediate appendages thick basally, with basodorsal tooth, main body tightly curved anterolaterally tapering into acute apex. Preanal appendages dorsally positioned and apically truncate, tapering into narrow mesoventral processes; processes curved posteroventrally, apices thin and pointed. Inferior appendages, in lateral view, triangular, bearing dorsally directed mesoventral tooth, mesal ridge with numerous thick spine-like setae, in ventral view, oval shaped, expanded laterally, mesoventral tooth directed medially. Phallobase long; apicoventral process broad basally, sharply narrowed apically with pair of small subapicolateral teeth; four to ten phallic spines embedded in endothecal membrane; phallic sclerite, in dorsal view, rectangular, broad anteriorly, anterior margin concave; endothecal membrane with pair of large dorsal internal triangular plates meeting dorsomesally. Subphallic sclerite broad.

Female.—Unknown.

Type material.—Holotype: ♂. COSTA RICA: Alajuela: Río Agrio, ca. 3.5 km NE Bajos del Toro, 10.243°N, 84.279°W, el. 1,290 m, 20.viii.1990, Holzenthal, et al. (UMSP) (UMSP000049376). Paratypes: Same data as holotype, 57 ♂ (UMSP); COSTA RICA: Alajuela: Río Toro, 3.0 km (road) SW Bajos del Toro, 10.204°N, 84.316°W, el. 1,530 m, 3–4.ix.1990, Holzenthal, Blahnik, Huisman, 2 ♂ (INBIO); Heredia: Parque Nacional Braulio Carrillo, Estación Magsasay, Río Peje, 10.402°N, 84.050°W, el. 130 m, 25–26.viii.1990, Holzenthal, Blahnik, Huisman, 8 ♂ (UMSP), 3 ♂ (NMNH); San José: Parque Nacional Braulio Carrillo, Estación Carrillo, Quebrada Sanguijuela, 10.160°N, 83.963°W, el. 800 m 27.iii.1987, Holzenthal, Hamilton, Heyn, 1 ♂ (UMSP).

Etymology.—This species is named for the diagnostic, sharply curved body and acute apex of the intermediate appendage, which resembles a *garfio,* Spanish for hook. Used as a noun in apposition.

Polycentropus hamiltoni Chamorro-Lacayo, new species

(Fig. 4)

Polycentropus n.sp. 10: Hamilton 1986: 110; Holzenthal and Hamilton 1988: 335.

This new species is a member of the *bonus* complex of the *gertschi* group and is closely related to *Polycentropus fortispinus* Holzenthal and Hamilton 1988. *Polycentropus hamiltoni* differs from *P. fortispinus* in that the bodies of the preanal appendages are approximately equal in size to the inferior appendages. It also differs in the

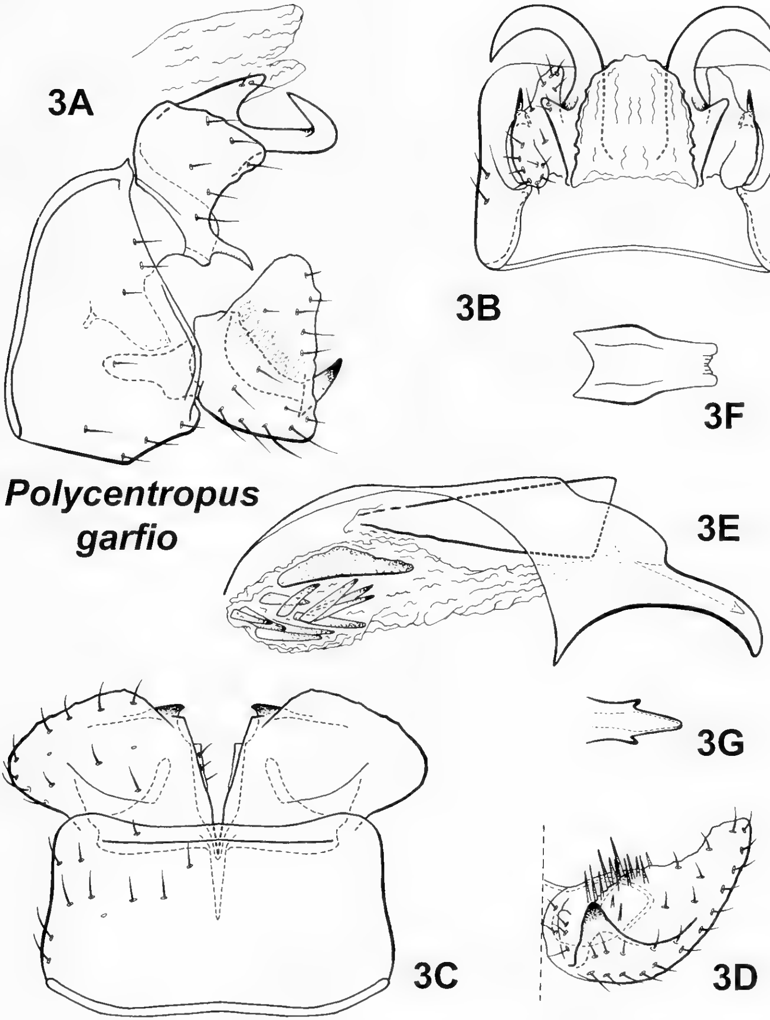

Fig. 3. *Polycentropus garfio*, male genitalia. A, Lateral view. B, Dorsal view. C, Ventral view. D, Inferior appendage, caudal view. E, Phallus. F, Phallic sclerite, dorsal view. G, Apex of apicoventral process of phallus, dorsal view.

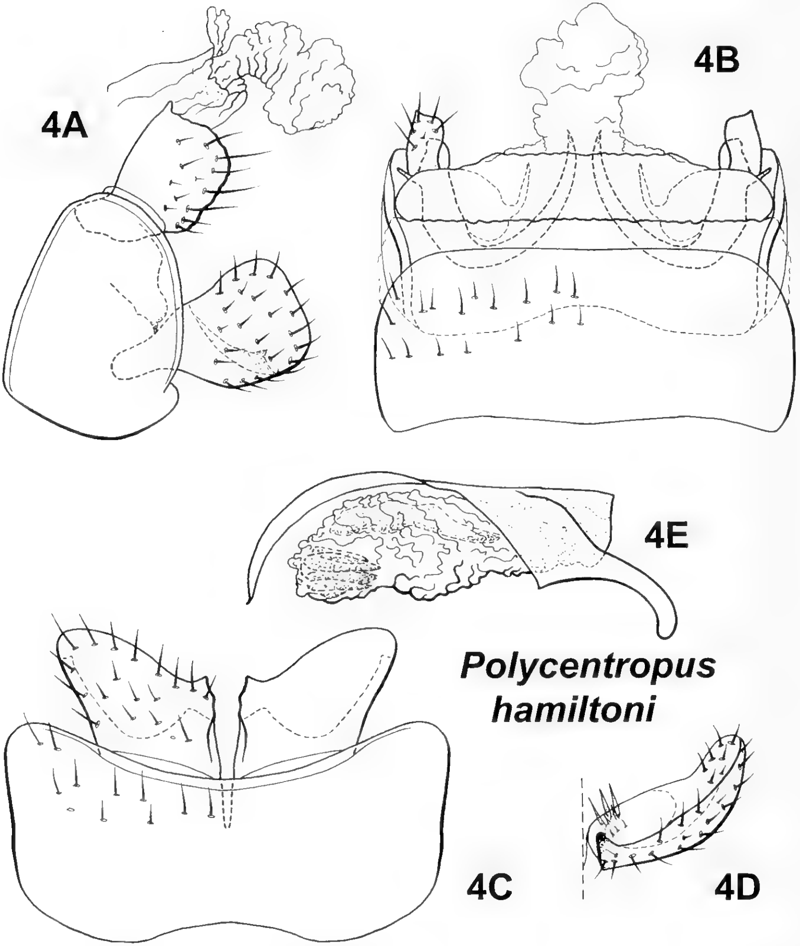

Fig. 4. *Polycentropus hamiltoni,* male genitalia. A, Lateral view, everted tergum X. B, Dorsal view everted tergum X. C, Ventral view. D, Inferior appendage, caudal view. E, Phallus.

smaller and more medially positioned mesoventral processes of the preanal appendages, the slightly smaller intermediate appendages, and the strongly ovoid and less angularly shaped inferior appendages. Finally, the numerous phallic spines of *P. hamiltoni* are longer and thinner than in *P. fortispinus.*

Male.—Length of forewing 5.0–6.6 mm. Body generally pale brown to yellow below, dorsum of head and thorax dark brown with long, dark setae and some paler setae between antennal bases; forewing bases with long erect setae, with general vestiture of fine, dark brown setae, and numerous patches of fine golden setae scattered over wing. Male genitalia as in Fig. 4. Sternum IX in lateral view nearly rounded; in ventral view, rectangular, anterior and posterior margin broadly and shallowly concave. Tergum X membranous; short, in dorsal view rectangular. Intermediate appendages broad, fused basally to membrane below tergum X, tapering posteromesally to very thin apices, each with single apical seta; length not exceeding preanal appendages. Body of preanal appendages, in lateral view, nearly square, mesoventral process rod-like, originating laterally, then directed anteriorly and then curving posteromesally. Inferior appendages short, in lateral view, nearly square appearing subquadrate; in ventral view appearing nearly elliptical, expanded posterolaterally; mesal surfaces irregular with broad mesoventral tooth. Phallobase short with projecting ventral apex; apicoventral process tapering to rounded ventrally directed apex; group of phallic spines embedded in endothecal membrane; phallic sclerite, in lateral view, broad anteriorly, curved posteroventrad to narrow apex, in ventral view narrow posteriorly and broad anteriorly. Subphallic sclerite extending laterally to contact preanal appendages basoventrally.

Female.—Unknown.

Type material.—Holotype: ♂. NICARAGUA: Jinotega: Cerro Mazú, 14°33′N, 85°07′W, el. 220 m, 7–10.ix.1997, J. M. Maes and B. Hernández (UMSP) (UMSP000066734). Paratypes: MÉXICO: Chiapas: Río Contento, 7 km N. of Ocosingo, 20.v.1981, C. M. and O. S. Flint, Jr., 2 ♂ (NMNH).

Etymology.—Named in honor of Dr. Steven W. Hamilton for his contribution to the study of Neotropical caddisflies, especially in the family Polycentropodidae.

Polycentropus phraterus Chamorro-Lacayo, new species

(Fig. 5)

This new species is a member of the *bartolus* complex of the *gertschi* species group and is closely related to *Polycentropus nebulosus* Holzenthal and Hamilton 1988. *Polycentropus phraterus,* differs from *P. nebulosus* in the triangular shape and the acute posteromesal point of the inferior appendages and the gradual curvature of the intermediate appendages. After close examination of the 5 paratypes of *P. nebulosus* in UMSP, it became apparent that 3 of these paratypes differ from the holotype and are actually *P. phraterus.* Consequently, these 3 paratypes are here assigned as the paratypes series for *P. phraterus.*

Male.—Length of forewings 6.0–6.5 mm. Body sclerites and setae generally pale brown to yellow; legs, especially femora and tarsi, with fine, dark brown setae; dorsum of head and thorax dark brown with long, erect, golden-brown setae; forewings covered with fine, brown setae and with scattered patches and mottled areas of golden and brown setae; forewing bases with long erect, golden-brown setae. Genitalia as in Fig. 5. Sternum IX, in lateral view, with anterior margin nearly straight, ventral margin broad, tapering posterodorsally, posterior margin moderately sinuate, posteroventral corner rounded, in ventral view, rectangular. Tergum X membranous, trapezoidal. Intermediate appendages broad basally, tapering into acute apices, gently curved mesoventrally. Preanal appendages in lateral view, nearly semicircular, mesoventral processes absent. Inferior appendages, in lateral view, triangular, ventral margins nearly straight, posteroventral corners angulate and bearing acute posteromesal pigmented point; in ventral view, nearly triangular, posteromesal margins irregular, posterolateral margins straight, mesal margins nearly straight, expanded laterally, with mesobasal spines. Phallobase short, apicoventral process broad basally, nar-

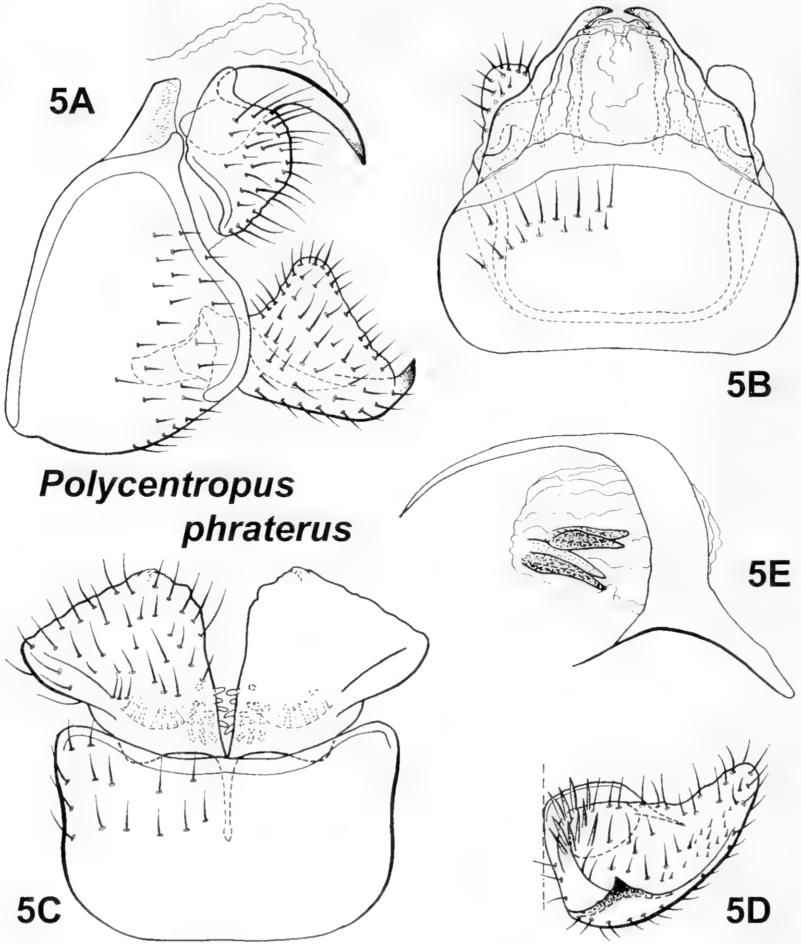

Fig. 5. *Polycentropus phraterus*, male genitalia. A, Lateral view. B, Dorsal view. C, Ventral view. D, Inferior appendage, caudal view. E, Phallus.

rowed apically; four phallic spines embedded in the endothecal membrane. Subphallic sclerite weakly developed.

Female.—Unknown.

Type material.—Holotype: ♂. COSTA RICA: Alajuela: Reserva Forestal San Ramón, Río San Lorencito and tributaries, 10.216°N, 84.606°W, el 980 m, 6–10.iii.1991, Holzenthal, Muñoz, Huisman (UMSP) (UMSP000049471). Paratypes: Guanacaste: Parque Nacional Guanacaste, Río San Josecito, Estación Mengo, 10.922°N, 85.470°W, 28–29.vii.1987, el. 960 m, Holzenthal, Morse, Clausen, 1 ♂ (NMNH), 1 ♂ (UMSP), 1 ♂ (INBIO).

Etymology.—This species is named *phraterus* from the Greek *phratero,* brothers, in honor of Dr. Ralph W. Holzenthal and Dr. Steven W. Hamilton for their contributions to the study of Neotropical caddisflies.

Polyplectropus maesi **Chamorro-Lacayo, new species**

(Fig. 6)

This new species is a member of the *thilus* group of Yamamoto (1967), which includes *Polyplectropus deltoides* (Yamamoto 1967), *P. carolae* Bueno-Soria 1990, *P. denticulus* Bueno-Soria 1990, and *P. thilus* (Denning 1962), as defined by Bueno-Soria (1990). *Polyplectropus maesi* differs from the other members of this group in the following ways: the ventrolateral processes of the preanal appendages are expanded posterad, each bearing two ventrally directed short subapical lobes; in the posterior margins of the dorsolateral lobes of the inferior appendages are bilobed; and the inferior appendages have broadly triangular spine bearing ventromesal lobes.

Male.—Length of forewing 5.0 mm. Color in alcohol, yellowish brown. Genitalia as in Fig. 6. Sternum IX, in lateral view, short, deltoid, posterior margin sinuate, anterior margin produced ventrally; in ventral view, rectangular, anterior margin concave. Tergum X membranous, broad and elongate. Intermediate appendages digitate, setose, not exceeding inferior appendages. Preanal appendages tripartite; dorsolateral processes heavily sclerotized, long, directed anteromesally, from base recurved posterolaterally, then mesoventrally, finally posteromesally tapering into acute point; mesolateral processes rectangular, broad, setose, lightly sclerotized, produced into ventrolateral processes meeting mesally to form narrow bridge below phallus; ventrolateral processes directed posteriorly, subapically each bearing two fused ventrally-directed highly sclerotized lobes. Inferior appendages divided into two lobes; dorsolateral lobes, in lateral view, club-shaped with posterior margins bilobed, setose; ventromesal lobes short, in lateral view, triangular with rounded ventral margins, setose, in ventral view, broadly triangular tapering mesally; mesal margins scalloped bearing robust sclerotized spines, seven visible, in caudal view. Phallobase short, apically membranous; dorsal phallic sclerite cylindrical, narrowing apically; endophallus cylindrical, ventrally located, embedded in endothecal membrane.

Female.—Unknown.

Type material.—Holotype, ♂. NICARAGUA: Zelaya: Río Las Latas, 14°04′N, 88°33′W, el. 220 m, 2.vi.1998, J. M. Maes and B. Hernández (UMSP) (UMSP000066724).

Etymology.—It gives me great pleasure to name this species in honor of Dr. Jean-Michel Maes, Belgian entomologist, in recognition of the many years he has dedicated to the study of Nicaraguan insects, for his unrelenting efforts, and for his wholehearted support, collaboration, and friendship.

Polyplectropus nicaraguensis **Chamorro-Lacayo, new species**

(Fig. 7)

This new species is a member of the *charlesi* group, as defined by Bueno-Soria (1990) and is closely related to *Polyplectropus mignonae* Bueno-Soria 1990. *Polyplectropus nicaraguensis* resembles *P. mignonae* in the overall shape of the inferior appendages, in the reduction of the dorsolateral processes of the preanal appendages, and in the shape of the intermediate appendages and phallus. *Polyplectropus nicaraguensis* can be distinguished from *P. mignonae* by the shape and position of the ventrolateral processes of the preanal appendages and by the lack of spines on the posterior margins of the ventromesal lobes of the inferior appendages.

Male.—Length of forewing 4.5–5.0 mm. Color in alcohol yellowish brown. Genitalia

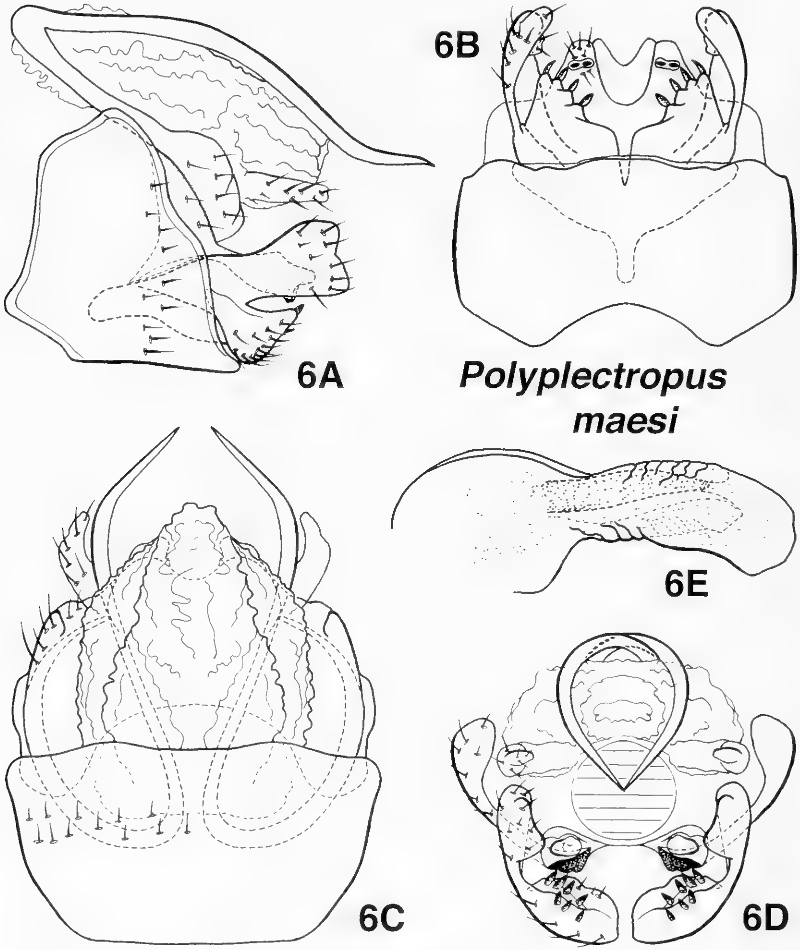

Fig. 6. *Polyplectropus maesi,* male genitalia. A, Lateral view. B, Ventral view. C, Dorsal view. D, Caudal view. E, Phallus.

as in Fig. 7. Sternum IX, in lateral view, short, deltoid, posterior margin sinuate, anterior margin nearly straight. Tergum X membranous, short, in dorsal view, rectangular, in lateral view deltoid. Intermediate appendages digitate, setose, directed dorsolaterally. Preanal appendages bipartite and migrated dorsally; mesolateral processes short, setose, oval, broadly tapering posterodorsally, produced into ventromesal processes which meet mesally below phallus, forming narrow bridge; ventromesal

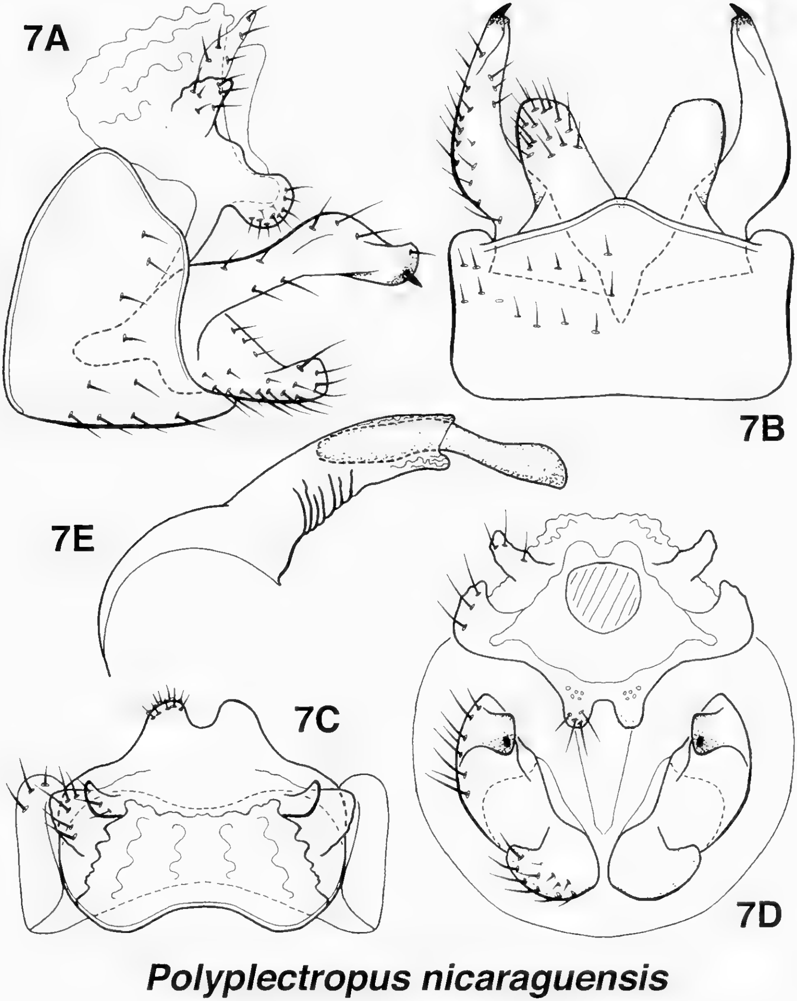

Fig. 7. *Polyplectropus nicaraguensis*, male genitalia. A, Lateral view. B, Ventral view. C, Dorsal view. D, Caudal view. E, Phallus.

processes round, setose, pigmented. Inferior appendages divided into two lobes; dorsolateral lobes, in lateral view, long, slender with median hump, posterior margin truncate, bearing ventrolateral spine; ventromesal lobes short, in lateral view, broad basally tapering to truncate apex, in ventral view, nearly rectangular, basally broad, di-

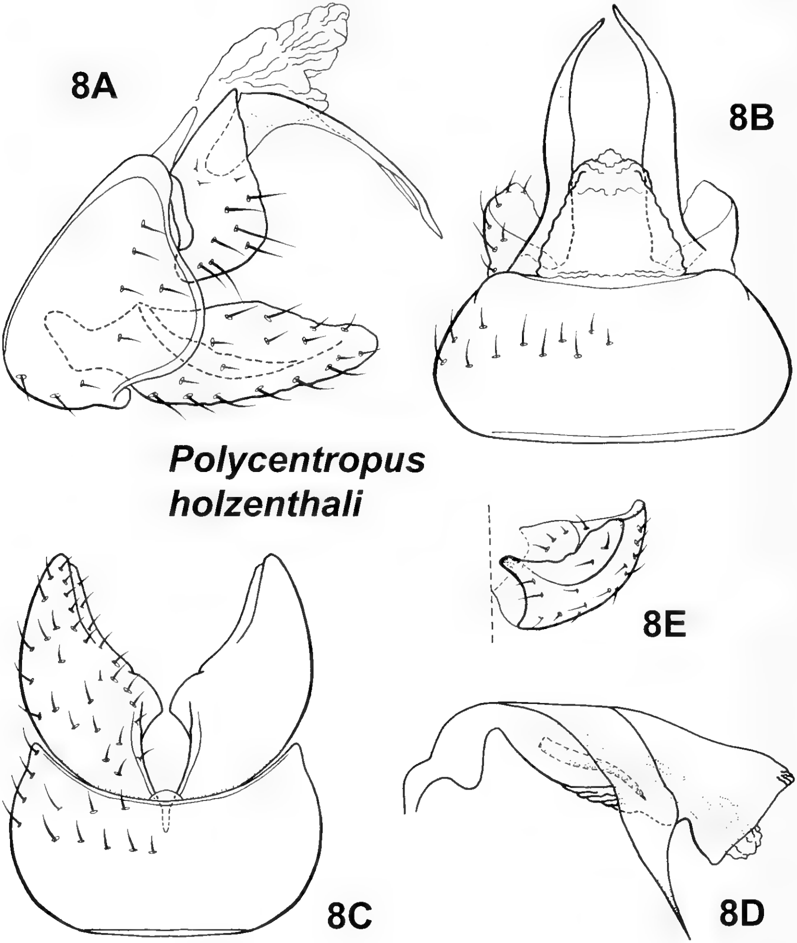

Fig. 8. *Polycentropus holzenthali,* Bueno and Hamilton 1986, male genitalia. A, Lateral view. B, Dorsal view. C, Ventral view. D, Phallus. E, Inferior appendage, caudal view.

rected laterally. Phallus narrow; phallic sclerite cylindrical; phallus surrounded by membrane, situated well dorsally in genital capsule.

Female.—Unknown.

Type material.—Holotype, ♂. NICARAGUA: Zelaya: Río Las Latas, el. 220 m, 14°04′N, 88°33′W, 2.vi.1998, J. M. Maes and B. Hernández (UMSP) (UMSP000066727). Paratype: Same data as holotype, 1 ♂ (NMNH).

Etymology.—This species is named for

the country where the types where collected.

Polycentropus holzenthali Bueno-Soria and Hamilton 1986 (Fig. 8)

Polycentropus holzenthali Bueno-Soria and Hamilton 1986: 300. [Type locality: MÉXICO: Chiapas: Tributario del Río Teapa situado en la carretera 195 a 3 km al N de Ixhuatán; NMNH, ♂.]

This species belongs to the *gertschi* group and is similar to *Polycentropus veracruzensis* Flint 1981, in the elongate shape of the inferior appendages, in the dorsal processes of the preanal appendages, and in the overall shape of the phallus. *Polycentropus. holzenthali* can be distinguished from *P. veracruzensis* by the nearly rectangular shape of the body of the preanal appendages, by the shape of the inferior appendages, and by differences in the phallus, including the presence of a single spine embedded in the endothecal membrane. *Polycentropus holzenthali* is here redescribed and reillustrated in order to provide additional views that will aid in the identification of these closely related species, *P. veracruzensis* and *P. holzenthali*. This specimen represents a new country record for this species in Nicaragua, and the first found outside of México.

Male.—Length of forewing 6.0 mm. Color in alcohol, brown. Genitalia as in Fig. 8. Sternum IX, in lateral view, with anterior margin almost straight, posterior margin sinuate. Tergum X membranous, in dorsal view, trapezoidal. Intermediate appendages not apparent. Preanal appendages bipartite; dorsal processes long, highly sclerotized, in lateral view curved posteroventrally, bearing subapical transparent ventral spine not exceeding margins of dorsal processes, in dorsal view, sinuate, tapering apically; body of preanal appendages setose, in lateral view, nearly rectangular, expanded posteroventrally. Inferior appendages, in lateral view, elongate, broad basally, narrowing gradually into rounded apex; in ventral view, semicircular, apex narrow, mesal margin expanded medially into triangular lobes. Phallus short, in lateral view apicoventral process broad basally, sharply narrowed apically and highly sclerotized; endothecal membrane with embedded spine.

Female.—Unknown.

Material examined.—NICARAGUA: Jinotega: Cerro Kilambé, 13°34′N, 85°43′W, el. 1,520 m, viii.1997, J. M. Maes and B. Hernández, 1 ♂ (UMSP) (UMSP000066735).

ACKNOWLEDGMENTS

I express my gratitude to the Graduate School, University of Minnesota (Educational Opportunity Fellowship); Bell Museum of Natural History, University of Minnesota (Dayton-Wilkie Natural History Funds), and Office of International Programs, University of Minnesota (International Graduate and Professional Fellowship) for their financial support during two field seasons in Nicaragua during the summers of 2000 and 2001. I thank my advisor Dr. Ralph W. Holzenthal, University of Minnesota, who has patiently and readily given guidance for the past two years, and without whom this project would not have been possible. I am also grateful to Dr. Oliver Flint, Jr., Smithsonian Institution, Dr. Ralph W. Holzenthal, and Dr. Jean-Michel Maes, Museo Entomológico, León, Nicaragua for providing material, as well as for their help and support. I also thank Roger Blahnik, Leandro and Ana Cecilia Chamorro, Jorge Armando Chávez, Córdoba Family, Coronel Family, Elizabeth Dobbins, Patricio Jerez, Julio A. Lacayo, Aracelly López, Denis Martinez, Fernando Muñoz-Quesada, Aysha Prather, and Maria Ruiz for their support and assistance in the field and in the laboratory.

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NOTE

Cecidomyiidae (Diptera) as Insect Parasitoids

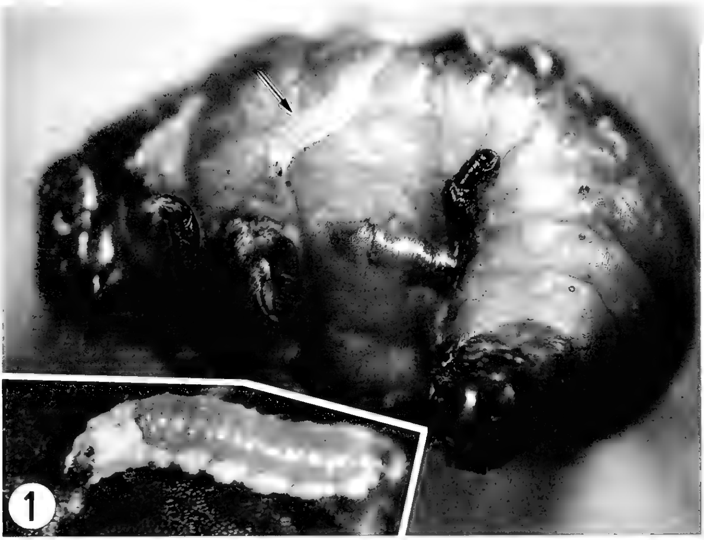
The family Cecidomyiidae (Diptera), commonly known as gall midges, includes, in addition to mycophages and phytophages, arthropod predators and endoparasites. The insect predators usually feed on mites and small homopterans such as aphids and scale insects but a few also attack holometabolous insects (Gagné 1994). Apparently no study has demonstrated larval development on a single arthropod host, resulting in the death of the host, a characteristic of insect parasitoids (Kuris and Lafferty 2000).

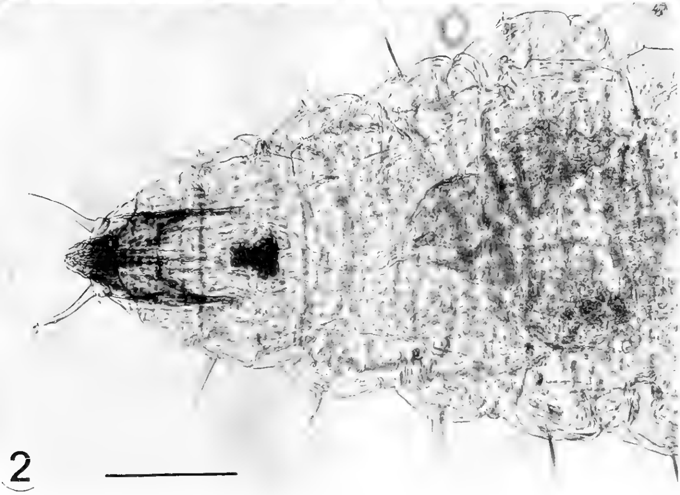
During an ecological study of insect-plant associations along the Oregon coast, the author encountered a population of the rare chrysomelid beetle, *Timarcha cerdo* Stål., feeding on the native salmonberry, *Rubus spectabilis* Pursh (Rosaceae). The genus *Timarcha* is primarily Old World with only two known species from North America, both restricted to areas west of the Rocky Mountains. The rarer of the two, *T. credo,* is known only from several populations in Oregon. It and its close relative, *T. intricata* Haldeman, are the only species of the genus able to develop on Rosaceae, although some populations of the latter species also develop on Ericaceae (Poinar et al. 2002).

Larvae of *T. cerdo* are fairly large and feed completely exposed on leaves of the host plant. During the spring of 2001 and 2002, cecidomyid larvae were noted on the bodies of these larvae in dune woods along the coast. Field-collected *Timarcha* larvae supporting very young cecidomyid larvae were brought to the laboratory and reared individually on leaves of *R. spectabilis.* Cecidomyiid eggs or eggshells were never found on the beetle larvae so either the females oviposit in the proximity of the host or the eggshells dropped off the beetle. The cecidomyiid larva remained on the surface of the beetle, usually between the thoracic and abdominal segments (Fig. 1), throughout its complete developmental period. Usually only one but occasionally two cecidomyiid larvae occurred on a single beetle larva, puncturing the host's cuticle and feeding on the released hemolymph. The parasites would often be semi-immersed in a pool of the host's hemolymph. There was no evidence of melanization of the hemolymph while the cecidomyids were present. As they matured, the larvae would sometimes migrate to other locations on the beetle, at which time, a zone of melanized subdermal tissue would surround the original feeding site. Upon completion of their development, the cecidomyid larvae would leave the host and enter the sand in the bottom of the container where pupation would occur. All of the beetle larvae died after the cecidomyid larvae had completed their development. Dissections showed that the body cavity was filled with bacteria at the time of death.

From larval specimens (Fig. 2), Dr. Raymond J. Gagné identified the cecidomyids as belonging to the *Lestodiplosis grassator* group of the tribe Lestodiplosini, supertribe Cecidomyiidi, subfamily Cecidomyiinae. Members of this group develop on various arthropods, mostly mites, scales and other cecidomyids (Gagné, 1994). Until adults are reared and the species completely identified, it is not possible to determine if the cecidomyid is an undescribed form specialized for developing ectoparasitically on leaf beetle larvae or if it is a generalist, acting both as a predator and ectoparasite depending on the potential hosts in the environment.

Parasitism of Coleoptera by cecidomyids is rare. Baylac (1987) described *Lestodi-*





Figs. 1–2. 1, Mature larva of *Lestodiplosis* sp. on the abdomen of the chrysomelid, *Timarcha cerdo*. Insert shows detail of mature *Lestodiplosis* sp. larva. Actual length of cecidomyiid larva 1 mm. 2, Detail of head and anterior body region of a mature larva of *Lestodiplosis* sp.removed from the body surface of *Timarcha cerdo*. Bar 50 μ.

plosis gagnei Baylac feeding on the larvae of the oil palm pollinating weevil, *Elaeidobius subvittatus* (Faust) in Colombia. However, in the above case, it is not known whether the cecidomyids are predators on several hosts or can complete their development on a single larva. The larvae of *E. subvittatus* are much smaller that those of *T. credo* and therefore the behavior of *L. gagnei* may be predaceous.

The present study, which is the first report of a cecidomyid attacking a member of the Chrysomelidae, represents a new type of association between gall midges and insects, namely where the gall midge serves as an ectoparasite. Ectoparasitism is a fairly common habit among parasitic Hymenoptera but is unusual for entomogenous Diptera (Clausen 1962). This association also falls under the definition of ecto-parasitoidism, where an individual consumer attacks only one host that dies after the parasitoid has completed its development (Kuris and Lafferty 2000).

Because of its rarity, *T. cerdo* could be considered an endangered species with the few remaining populations threatened by habitat destruction through land development. Any type of parasitism, including that by the cecidomyid described here, will add more stress to their dwindling populations.

Acknowledgments.—I thank Raymond J. Gagné, Systematic Entomology Laboratory, USDA, Washington, DC, for the identification of the larval cecidomyiids and Roberta Poinar for comments on earlier versions of the manuscript.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 502–505

NOTE

First Report of *Amblyomma humerale* Koch (Acari: Ixodida: Ixodidae) from Bolivia, with a Synopsis of Collections of this Tick from the South American Yellow-footed Tortoise, *Geochelone denticulata* (L.) (Reptilia: Testudines: Testudinidae)

Over most of the Neotropical Zoogeographic Region, turtles and tortoises are commonly parasitized by a complex of three morphologically similar tick species whose biosystematic relationships to one another are unclear: *Amblyomma sabanerae* Stoll, which ranges from southern Mexico through Central America and perhaps into Colombia (Fairchild et al. 1966, Robbins et al. 2001); *A. humerale* Koch, which occurs on Trinidad and across the whole of northern South America southward through Brazil and westward into Peru (Floch and Fauran 1958, Aitken et al. 1968, Walter 1990, Guerrero 1996, Verhaagh and Podloucky 1997); and the seldom-collected *A. crassum* Robinson, which appears to occupy a transition zone between *A. sabanerae* and *A. humerale,* having been recorded from Colombia, Peru and Venezuela (Robinson 1926, Fiasson 1949, Fairchild et al. 1966, Jones et al. 1972). However, published descriptions of these species are often vague, leading Fairchild (1943) to speculate that all three may merely be varieties of one widespread polytypic species. Whatever their systematic standing, these ticks are apparently capable of feeding on any terrestrial or semiaquatic testudine. Thus, it is not surprising that *A. humerale* has previously been collected from the South American yellow-footed tortoise, *Geochelone denticulata* (L.), the largest tortoise on the continental mainland, with a range extending from Trinidad and southeastern Venezuela through the Caribbean lowlands of the Guianas to Brazil, where it is known from the entire Amazon Basin, including those portions in adjacent eastern Colombia and Ecuador, northeastern Peru, and northern and eastern Bolivia (Aragão and Fonseca 1961, Aitken et al. 1968, Ernst and Barbour 1989). On 6 February 2000, one of us (SLD) removed 11 male specimens of *A. humerale* (Fig. 1) from the axillae of a single *G. denticulata* (sex unrecorded; actual host animal shown in Fig. 2) captured in Noel Kempff Mercado National Park (Parque Nacional Noel Kempff Mercado), in the northeastern corner of the Department of Santa Cruz, Bolivia. We believe that these are the first specimens of *A. humerale* ever reported from Bolivia.

Noel Kempff Mercado National Park is situated in lowlands between the Serranía de Huanchaca escarpment and the banks of the Río Itenez (Guaporé) and has been described elsewhere (Robbins and Deem 2002). Our specimen of *G. denticulata* was sighted alongside a trail running through seasonally inundated forest within the park (13.48.14S, 60.32.44W). The animal was approached on foot and manually restrained for physical examination. All tick specimens were preserved in 70% isopropanol and shipped to RGR for identification and analysis.

The Field Veterinary Program, Wildlife Conservation Society, has assigned accession number GCD1 and MEDARKS (Medical Archives) number 2002-0004 to the Noel Kempff Mercado collection of *A. humerale,* which is on long-term loan to RGR. Seven additional collections of *A. humerale* from *G. denticulata* are in the U.S. National Tick Collection, Georgia Southern University, Statesboro (Table 1). It seems likely that the range of *A. humerale* will eventually prove to be almost coextensive with that of *G. denticulata,* since both tick and

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Figs. 1–2. 1, One of 11 male specimens of *Amblyomma humerale* collected from *Geochelone denticulata* in Noel Kempff Mercado National Park, Department of Santa Cruz, Bolivia. 2, The Noel Kempff Mercado specimen of *Geochelone denticulata.*

Table 1. Collections of *Amblyomma humerale* from *Geochelone denticulata* in the U.S. National Tick Collection.

RML No	Ticks	Location	Date	Collector
36571	8 ♂	Trinidad: Mayaro	17 March 1960	T.H.G. Aitken
52486	6 ♂, 1 ♀	Colombia: Meta, La Macarena, Rio Cafre	29 June 1969	C.A. Velasquez
64672	1 ♂	Trinidad	August 1974	J.W. Bickham
116157	2 ♂	Brazil: Roraima, Estação Ecológica de Maracá	17 November 1981	D. Moskovits
117079	1 ♂	Ecuador: Napo, 1 km S, 6 km W of San José de Payamino	15 November 1983	R.M. Timm
117518	1 ♂, 1 ♀	Peru: Huánuco, Panguana	October 1983	R. Podloucky
119584	1 ♂	Peru: Madre de Dios, Pakitza, Parque Nacional del Manu, Rio Manu	1 February 1989	R.W. McDiarmid

tortoise have now been found in every South American country except Argentina, Chile (which has no tortoises), Paraguay and Uruguay.

We thank the Bolivian National Secretariat for permission to conduct research in Noel Kempff Mercado National Park, and the National Directorate for the Protection of Biodiversity for help in securing the necessary permits. Others who assisted in this investigation included John L. Behler, Wildlife Conservation Society; Carl H. Ernst, George Mason University; and Louise H. Emmons and George R. Zug, National Museum of Natural History, Smithsonian Institution. We are especially grateful to Lance A. Durden, Institute of Arthropodology and Parasitology, Georgia Southern University, for counsel concerning the distribution of *A. humerale* and for generously providing copies of the tick collection records in his care. Thanks also to Veronica Greco, Field Veterinary Program, for facilitating the shipment and accessioning of tick specimens. Funding for SLD was provided by the Field Veterinary Program, Wildlife Conservation Society.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 506–507

BOOK REVIEW

Katydids & Bush-Crickets. Reproductive Behavior and Evolution of the Tettigoniidae. By Darryl T. Gwynne. Comstock Publishing Associates, Cornell University Press. Ithaca and London. 2001. 217 pp. $45.

Darryl Gwynne's engaging book on a conspicuous but little known group of insects moves us from an introductory overview of this group and its basic biology to subsequent chapters recognizing the conspicuous contributions katydids have made to our knowledge of mechanisms surrounding Darwin's second evolutionary building block, sexual selection. It uses katydids and their unusual and distinctive behaviors to understand the mechanisms of sexual selection in the insect world. The book's important contribution is in its approach of adopting the scientific method to test hypotheses originating from observations of these insects in nature.

The author has made use of contributions and input of more than 40 of the world's contemporary researchers of this group, making this book a strong and enduring reference. On the surface, this book is about katydids, especially about aspects of the wide scope of their sexual behaviors. However, by virtue of their large size and various arrays of easily observed behaviors, katydids provide a generalized model for sexual selection studies, and the book becomes a guide for researchers of other insect groups interested in sexual selection theory. One captivating aspect of Gwynne's book is its personal approach to the science. Gwynne interjects his own preliminary lines of reasoning in his early research, a field trip he took that traced the steps taken by Colorado state entomologist C. P. Gillette nearly 100 years ago, and his fascination with Mormon crickets, which provided the biological avenue wherein he could test and better reveal Darwin's theory on sexual selection. It begins with his comparison of high density Mormon cricket populations in western Colorado, wherein males seldom sing (indicating males have more opportunity to select females as mates), with low density populations in eastern Colorado, wherein males sing constantly (indicating females have more opportunity to select males as mates).

The first chapter covers aspects of the biology of this second largest family of orthopterans (with more than 6,000 species known to date): chapter 2 discusses the taxonomy of the group; chapter 3 deals with general aspects of its biology; chapter 4 provides information on predators and parasites of katydids and the myriad defenses that katydids evolved to deal with their natural enemies; and chapter 5 reviews the most conspicuous aspect of katydid behavior—sound production, including the contexts in which katydids produce sound. The rest of the book develops sexual selection theory through the various behaviors of katydids, including mate choice, male competition, and the costs and benefits of sexual advertizing.

In searching out something to find fault with in this book, I was hard pressed, and I could uncover only a few items which deserve mention so the potential reader may be alerted to the fact that Tettigoniidae is an even more complex family than Gwynne so vividly covers. For example, Gwynne goes into great detail discussing the mechanisms of sound production and sound amplification, the mechanisms involving sound reception, and the functions of sounds produced. Although he mentions the use of tegminal disturbance sounds as uncommon among katydids (p. 84), this is based solely on the work of R. D. Alexander (1960) who correctly referred to it as being uncommon in U.S. species. Actually, it is relatively common among tropical katydids, especially among pseudophyllines, which are usually large and actively preyed upon by acoustically-sensitive predators such as birds and monkeys (Nickle and Castner 1995). Gwynne refers to sounds produced in the context of pair formation by females of only *some* phaneropterine katydids (p. 119), where, in fact, females of probably *most* phaneropterine species regularly produce sounds in response to calling sounds of conspecific males. And unlike most katydids and all sound-producing crickets wherein females move to the sounds produced by males, the males of most phaneropterines move to the response sounds produced by the females. Interestingly, he mentions *Poecilimon* (one of the phaneropterine exceptions to the rule) in Table 5.2 as a case demonstrating that male songs attract conspecific females. This is a genus in which females are micropterous and lack sound-producing organs.

Gwynne presents an interesting historical perspective on the subject of the katydid spermatophyllax and spermatophore, two post-mating proteinaceous packages made available to the female of many species. He discusses their potential roles and presents a sexual selectionist rationale for studying spermatophyllax use. In the end, unfortunately, the mystery of their function(s) is yet to be resolved.

Overall, Darryl Gwynne's book is a "must have" for persons interested in insect sound production and pair formation strategies, in katydids and their biology, and in sexual selection theory.

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PROC. ENTOMOL. SOC. WASH.
105(2), 2003, pp. 508–516

OBITUARY

Richard Herbert Foote
(1918–2002)

Richard H. Foote, a longtime member and former President of the Entomological Society of Washington, died on February 9, 2002. Known fondly as "Dick" to his many friends and colleagues, he passed away suddenly, at the age of 83, of complications following a broken hip. Among the highlights and accomplishments of his long career, Dick became a world recognized specialist on the taxonomy of fruit flies, served as leader of the Systematic Entomology Laboratory, ARS, USDA, and was an early advocate for the use of computers for information storage and retrieval in entomology.

Richard Herbert Foote was born on May 2, 1918 in Bozeman, Montana, by eight years the elder of the two children of Herbert and June Foote. He was raised in Helena, where (in the words of his sister Katie Osborne) "We got the full benefit of the unlimited love and care of our parents—an old-fashioned way to bring up children in a family. We were raised according to Christian tradition, and both of us were always confident of our parents' love as long as they lived."

Dick's interest in biology had its roots in his father's work as a sanitary and civil engineer. Herb Foote worked for the State of Montana from 1923, when he assumed the position of Director of the Water and Sewage Division of the Montana State Board of Health, until his retirement in the 1950's. He led the successful efforts to rid Montana of typhoid fever through his work on the drinking water systems of the state and received an honorary doctorate for his work in parasitology from the University of Montana. As a youth, Dick traveled with his Dad on some of his business trips about the state. Dick's mother June (Melton) Foote, was a Registered Nurse, with a degree from University Medical College, Kansas City,

Dick Foote as a young scientist.

Missouri in 1910, where she worked until 1916, when she and Herb were married and moved to Bozeman. She was a stay-at-home mom who, together with his father, provided a stable, warm, and loving environment for Dick and his sister.

Dick was a graduate of Montana State University, Bozeman (B.S. in Entomology, 1941). His formal education was interrupted by service in the U.S. Army in World War II (5/1943–6/1945), mostly in Europe where he was a clerk in the Office of the Chief Surgeon (12/1943–6/1945), attaining the rank of Tech. Sgt. He worked as a copy writer for Western Catalog Company (1945–46), and then as a self-employed pest control operator in Montana (1946–1947). He was then employed as a curator of the collection of medically important insects of the Public Health Service, Center for Disease Control, in Atlanta, Georgia (10/1947–9/1949), after which he earned a doctorate from Johns Hopkins University, School of Hygiene and Public Health (Sc.D. in Parasitology, 6/1952). His dissertation concerned the taxonomy of the immature stages of *Culex* mosquitoes.

In March 1952 Dick was employed by the U.S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, in the unit that later became the Systematic Entomology Laboratory, to help produce a manual of medically important mosquitoes. In 1954 he was assigned responsibility for flies affecting plants, after which he conducted extensive taxonomic research on fruit flies (Tephritidae).

In the USDA Dick served in numerous administrative positions, including Assistant to the Chief, Insect Identification and Parasite Introduction Research Branch, Entomology Research Division (1960–65), Assistant Branch Chief, IIPI (1965–72), and Laboratory Chief, Systematic Entomology Laboratory (1972–76), which then included 28 scientists and about 40 total staff. He returned to full time research on fruit flies in 1976, and although he retired from the USDA in May 1983, he continued this work until publication of the *Handbook of the Fruit Flies (Diptera: Tephritidae) of America North of Mexico* in 1993.

Dick was fond of editing and was good at it. He served as Editor for the *Journal of Economic Entomology,* the Thomas Say Foundation publications, the *Miscellaneous Publications of the Entomological Society of America,* the *Proceedings of the Entomological Society of Washington,* and the *Journal of the Washington Academy of Sciences,* and as an Assistant Editor for the *Annals of the Entomological Society of America.* After his retirement he worked part time as a copy editor for the Entomological Society of America publications until three months before his death. Dick was an active member of various professional societies, especially the Entomological Society of America, the Entomological Society of Washington, the American Institute of Biological Sciences, the Washington Academy of Sciences, and the Council of Biology Editors. He also belonged to the American Association for the Advancement of Science, American Mosquito Control Association, American Society for Information Science, Kansas Entomological Society, Society of Systematic Zoology, Sigma Xi, and the Council of Biological Information (London). He served as president of the Washington Academy of Sciences and the Entomological Society of Washington.

Dick's scientific publications (listed below) included 90 taxonomic works on flies, 10 publications on information retrieval, 32 book reviews, and 3 obituaries. Not listed are numerous reports and editorials he wrote. His research involved six families of flies, in which he described 12 genera and 68 species.

The majority of Dick's fly research concerned the taxonomy of Culicidae (mosquitoes) and Tephritidae (fruit flies). His work on work on mosquitoes included his dissertation on the larval and pupal stages of the *Culex* subgenera *Melanoconion* and *Mochlostyrax*, and a series of pictorial keys to various other mosquitoes, culminating in a manual for the identification of the medically important species (Foote and Cook 1959). His research on fruit flies, for which he is best known, included the description of 12 genera and 49 species. More importantly, however, Dick tackled several large projects that produced new data and synthesized previously published information, leaving a clear knowledge base that his colleagues could easily use and that his successors could build upon. These included his extensive revisions of the North American fruit fly fauna, culminating in publication of the *Handbook of the Fruit Flies (Diptera: Tephritidae) of America North of Mexico*, of which he was lead author, by Cornell University Press in 1993, a key to the Neotropical fruit fly genera (1980), and catalogs of the fruit flies of the Nearctic, Neotropical, Palearctic, and Australasian Regions.

Beyond his fly taxonomy, Dick will be remembered as a visionary in the field of information retrieval. In his Presidential address to the Entomological Society of Washington in 1969, he spoke of a "catalog for all seasons," a comprehensive automated index to all systematic knowledge about insects. In the late 1960s and early 1970s, Dick was a leader in bringing computer technology to address the problems of information retrieval in Biology, chairing or serving on all key groups, such as those of the National Academy of Science, American Institute of Biology and ESA. For Entomology and ESA, he delivered the first *Thesaurus* for any discipline (1977). In USDA he led automation projects to create the *Catalog of Coleoptera of America North of Mexico* and a fruit fly information system. These were prototypes for larger efforts to catalog all insects. Unfortunately, neither the appropriate amount of resources nor computer technology were then available to bring these project to full fruition, but the concepts and designs Dick developed inspired and greatly aided our later efforts to produce databases for fruit flies and other flies.

For more than a decade, Dick was a true leader of the Systematic Entomology Laboratory due to his vision of what Systematics should provide the larger scientific community. Under his direction and encouragement, projects to compile and verify the names of moths (Hodges, et alia 1983, Lepidoptera checklist), bugs (Henry and Froeschner 1988, Heteroptera catalog), flies, and beetles (see above) were begun. These were team efforts of extensive scope and vision. Indicative of his standing in the entomological community, in 1981 Dick received the Outstanding Entomologist Award in Systematics from the American Registry of Professional Entomologists.

We fondly remember Dick Foote not only for his accomplishments and innovative ideas, but also for his affable nature and eagerness to help others. He had a warm smile and a kind word for everyone. As an administrator at SEL, one of the largest laboratories in ARS, he tried to handle all aspects of "red tape," leaving his scientists free to concentrate on their work. Beyond his research, Dick also contributed to the advancement of knowledge about flies in lots of little ways, providing advice and encouragement to many colleagues and students. He and Martha loved to do things for others, such

Top: Dick and Martha Foote at party hosted by Ray and Sally Gagné to celebrate publication of "The Handbook" (1993); in background (l to r), Ron Hodges, Louie Blanc, and Al Stone. Bottom: Dick at work at "Adventures in Veneer" display.

as the wedding party they planned and hosted for Elmo and Ilse Hardy, the guitar Dick refinished for Steven Hodges, and the many decorative boxes and other handmade wooden objects he gave as gifts.

Dick's interests outside of entomology were varied. One was building and playing a classical guitar. Martha recalled that he would get up an hour early on workdays to have quiet time to play it just for his own pleasure. He developed a great skill in marquettry and wood inlay work, creating beautiful boxes, clocks, trays, pinning blocks, bolos and belt buckles, many of them with inlaid designs, such as a person's initials or images of butterflies and moths. He designed and built special tools that he used in this exacting work. He also spent many hours working on his home in Springfield, Virginia, building walkways and retaining walls, a deck, a screened porch, and the interior finishing of a paneled family room including built-in bookcases, and later the retirement home at Lake of the Woods, Locust Grove, that he and Martha helped to design. After his retirement, Dick was an active participant in the National Association of Retired Federal Employees and an active member of the Democratic Party in Orange County, Virginia.

The center of Dick's life, however, was his family, including his wife Martha B. Foote, four children (Judi Merriman of Camarillo, CA, Elin Stewart of Locust Grove, Suzanne Stewart of Fredericksburg, VA, and Christopher Foote of Redlands, CA), his sister, Katherine Osborne of Coeur d'Alene, Idaho, three grandchildren, a great-grandchild, three nieces, and a nephew. He met Martha while opening the door for her at a party in 1963, and they were married the following year. She was an art teacher and department head at West Springfield High School until 1983. An avid gardener, she (and occasional helper Dick) landscaped and beautifully planted the yard of their home at Lake of the Woods where they together enjoyed 19 years of retirement, family life and community involvement.

In both his professional career and community and family life, Dick brought the qualities of patience, good will, humor, helpfulness and fidelity to all his responsibilities.

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FLY TAXA DESCRIBED BY R. H. FOOTE

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Rhagoletoides Foote 1960 (Tephritidae)
Procecidocharoides Foote 1960 (Tephritidae)
Mylogymnocarena Foote 1960 (Tephritidae)
Metatephritis Foote 1960 (Tephritidae)
Paraterellia Foote 1960 (Tephritidae)
Cryptotreta Blanc & Foote 1961 (Tephritidae)
Lezca Foote 1978 (Tephritidae)
Laksyetsa Foote 1978 (Tephritidae)
Caenoriata Foote 1978 (Tephritidae)
Neotaracia Foote 1978 (Tephritidae)
Capitites Foote & Freidberg 1981 (Tephritidae)

Asphondylia ilicicola Foote 1953 (Cecidomyiidae)
Culicoides denningi Foote & Pratt 1954 (Ceratopogonidae)
Culicoides wirthi Foote & Pratt 1954 (Ceratopogonidae)
Rubsaamenia keeni Foote 1956 (Cecidomyiidae)
Holoneurus strobilophilus Foote 1956 (Cecidomyiidae)

Dasyneura abiesemia Foote 1956 (Cecidomyiidae)
Contarinia oregonensis Foote 1956 (Cecidomyiidae)
Mycodiplosis conicola Foote 1956 (Cecidomyiidae)
Mycodiplosis coryloides Foote 1956 (Cecidomyiidae)
Lestodiplosis taxiconis Foote 1956 (Cecidomyiidae)
Euarestoides arnaudi Foote 1958 (Tephritidae)
Euarestoides dreisbachi Foote 1958 (Tephritidae)
Tephritis labecula Foote 1959 (Tephritidae)
Valentibulla thurmanae Foote 1959 (Tephritidae)
Euxesta luteocesta Foote 1960 (Ulidiidae)
Paraterellia superba Foote 1960 (Tephritidae)
Paraterellia ypsilon Foote 1960 (Tephritidae)
Trypeta angustigena Foote 1960 (Tephritidae)
Tephritis opacipennis Foote 1960 (Tephritidae)
Tephritis signatipennis Foote 1960 (Tephritidae)
Tephritis ovatipennis Foote 1960 (Tephritidae)
Tephritis candidipennis Foote 1960 (Tephritidae)
Trupanea maculigera Foote 1960 (Tephritidae)
Trupanea signata Foote 1960 (Tephritidae)
Acrotaenia trisignata Foote 1960 (Tephritidae)
Urophora trivirgulata Foote 1960 (Tephritidae)
Neotephritis rava Foote 1960 (Tephritidae)
Procecidocharoides flavissima Foote 1960 (Tephritidae)
Procecidocharoides pullata Foote 1960 (Tephritidae)
Procecidocharoides caliginosa Foote 1960 (Tephritidae)
Metatephritis fenestrata Foote 1960 (Tephritidae)
Gymnocarena bicolor Foote 1960 (Tephritidae)
Myoleja unifasciata Blanc & Foote 1961 (Tephritidae)
Aciurina trilitura Blanc & Foote 1961 (Tephritidae)
Procecidochares stonei Blanc & Foote 1961 (Tephritidae)
Neaspilota wilsoni Blanc & Foote 1961 (Tephritidae)
Urophora timberlakei Blanc & Foote 1961 (Tephritidae)
Trypeta germana Foote 1964 (Tephritidae)
Tephritis arcualis Foote 1964 (Tephritidae)
Trypeta duplex Foote 1964 (Tephritidae)
Trypeta platypleria Foote 1964 (Tephritidae)
Medetera wheeleri Foote, Coulson & Robinson 1965 (Dolichopodidae)
Tachytrechus greenei Foote & Coulson 1965 (Dolichopodidae)
Rhopalomyia truncula Foote 1965 (Cecidomyiidae)
Cecidomyia candidipes Foote 1965 (Cecidomyiidae)
Rhagoletotrypeta rohweri Foote 1966 (Tephritidae)
Eurosta floridensis Foote 1977 (Tephritidae)
Valentibulla steyskali Foote 1977 (Tephritidae)
Lezca tau Foote 1978 (Tephritidae)
Laksyetsa trinotata Foote 1978 (Tephritidae)
Gonioxyna fuscata Foote 1979 (Tephritidae)
Gonioxyna hyalina Foote 1979 (Tephritidae)
Gonioxyna trinotata Foote 1979 (Tephritidae)
Valentibulla mundulata Foote 1979 (Tephritidae)
Neotaracia unimacula Foote 1979 (Tephritidae)
Trupanea caracasana Foote 1980 (Tephritidae)
Rhagoletis tomatis Foote 1981 (Tephritidae)
Rhagoletis penela Foote 1981 (Tephritidae)
Rhagoletis jamaicensis Foote 1981 (Tephritidae)
Rhagoletis adusta Foote 1981 (Tephritidae)
Trupanea bilineata Foote 1982 (Tephritidae)
Xanthaciura aczeli Foote 1982 (Tephritidae)
Gymnocarena flava Foote 1987 (Tephritidae)
Trupanea viciniformis Foote 1987 (Tephritidae)
Urophora setosa Foote 1987 (Tephritidae)
Urophora claripennis Foote 1987 (Tephritidae)
Valentibulla dodsoni Foote 1987 (Tephritidae)
Trupanea vitiosa Foote 1989 (Tephritidae)

Taxa Named in Honor of R. H. Foote

Alluaudomyia footei Wirth (Ceratopogonidae)
Campiglossa footei Thompson (Tephritidae)
Campiglossa footeorum Novak (Tephritidae)
Culicoides footei Wirth & Jones (Ceratopogonidae)
Dolichopus footei Harmston (Dolichopodidae)
Dracontomyia footei Aczél (Tephritidae)
Floracarus footei Keifer (Acari: Eriophyidae)
Footerellia Norrbom & B. Foote (Tephritidae)
Neaspilota footei Freidberg & Mathis (Tephritidae)
Polymorphomyia footei Korytkowski (Tephritidae)
Tephritis footei Goeden (Tephritidae)
Trupanea footei Frías (Tephritidae)

Allen L. Norrbom and F. Christian Thompson, *Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, ℅ National Musuem of Natural History, Smithsonian Institution, Washington, DC 20560-0168 (e-mail: anorrbom@sel.barc.usda.gov; cthompso@sel.barc.usda.gov)*

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REPORTS OF OFFICERS

EDITOR

Volume 104 of the *Proceedings* included four issues with a total of 1,096 pages. Eighty-nine regular papers, 15 notes, 5 book reviews, 2 obituaries, Society meetings, reports of officers, instructions for authors, and the contents for Volume 104 were published. About 108 manuscripts were submitted for consideration for publication from November 1, 2001 to October 31, 2002.

Two hardbound books were published in 2002: "A Revision of the Oriental Species of *Aphthona* Chevrolat (Coleoptera: Chrysomelidae)" by Alexander S. Konstantinov and Steven W. Lingafelter (349 pp.) and "Revision of the genus *Anoplophora* (Coleoptera: Cerambycidae)" by Steven W. Lingafelter and E. Richard Hoebeke (236 pp.). *Memoir* 24, "Holcocerini of Costa Rica (Lepidoptera: Gelechioidea: Coleophoridae: Blastobasinae)" by David Adamski is in press and due out before the end of 2002. Two other large manuscripts are under consideration by the Publications and Executive committees.

I extend thanks to Ray Gagné, Wayne Mathis, and Tom Henry of the Publications Committee for their continued advice and support, especially to Ray Gagné for excellent work in obtaining book reviews. Marie Blair and Cathy Apgar provided much needed assistance in handling correspondence, routing manuscripts, and preparation of manuscripts and plates for the printer.

I am also grateful to the many reviewers for their time-consuming effors 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

TREASURER

SUMMARY FINANCIAL STATEMENT FOR 2002

	General Fund	Special Publication Fund	Total Assets
Assets: November 1, 2001	$ 36,103.82	$172,904.85	$179,896.87
Total Receipts for 2002	$111,309.36	$ 23,812.59	$144,219.60
Total Disbursements for 2002	$103,433.86	$ —	$ 96,650.61
Assets: October 31, 2002	$ 43,979.32	$196,717.44	$240,696.76
Net Changes in Funds	$ 7,875.50	$ 23,812.59	$ 31,688.09

Audited by the Auditing Committee, November 22, 2002 consisting of Allen L. Norrbom, Chairman Steven W. Lingafelter, and Michael W. Gates. Presented to the membership at the meeting of December 4, 2002.

Respectfully submitted,
Michael G. Pogue,
Treasurer

MEMBERSHIP

In 2002, the Society received applications for new membership for 25 people as follows:

Gary D. Alpert
Daniel B. Blackford
Stephan M. Blank
Britt A. Bunyard
Fernand Daussin
Andrew R. Deans
Mustapha Debboun
Melissa Armstrong Doris
Duane Flynn
Robert G. Foottit
Scott Grubbs
Jason P. W. Hall
Michael W. Heyn
Cheslavo A. Korytkowski
Victor López-Martinez
Renato Contin Marinoni
David Novello
J. Audrey Painter
Kurt Milton Pickett
Robert Rabaglia
Leopoldo M. Rueda
Gregory Setliff
Rebecca Simmons
Hojun Song
James B. Whitfield

Each applicant was sent a letter acknowledging receipt of his/her application, and his/her name was read at a regular meeting of the Society and repeated in the minutes of the following meeting. The number of applications is up 28% from 2001.

Respectfully submitted,
Steven W. Lingafelter,
Membership Chair

PRESIDENT-ELECT

This year's banquet, co-sponsored with the Maryland Entomological Society, was held on Tuesday, June 11th, 2002 at the Uniformed Services University of the Health Sciences Dining Room in Bethesda, Maryland. Eighty-nine members and guests attended. Our banquet speaker was Dr. Daniel Janzen from the University of Pennsylvania and Guanacaste Conservation Area, Costa Rica, who spoke on "How to find all the species of caterpillars in a large, complex tropical habitat." I would like to thank Richard Andre of USUHS and David Furth for their help in planning the banquet.

Respectfully submitted,
Jonathan Mawdsley,
President-Elect

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SOCIETY MEETINGS

1,067th Regular Meeting—October 3, 2002

The 1,067th 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 Gabriela Chavarria at 7:08 p.m. The meeting was attended by 20 members and 6 guests. The minutes of the 1065th and 1066th meetings were approved as read.

Membership chair Steve Lingafelter read the names of seven new applicants for membership: Kurt Milton Pickett, Leopoldo M. Rueda, Fernand Daussin, Mr. Hojun Song, Britt A. Bunyard, Scott Grubbs, and Melissa Armstrong Doris. Four guests were introduced.

In miscellaneous business, President Chavarria thanked John Brown and Dave Furth for taking over the program chair duties for the remainder of the year and noted that the speaker list and schedule are complete.

For exhibits, Editor Dave Smith had on hand copies of two new ESW publications, the awaited *Anoplophora* (Cerambycidae) and *Apthona* (Chrysomelidae) revisions. Ed Cohen shared his new rhopalid Maryland record. Dave Furth was loaded to the gills: "*Biology of Leafbeetles*" by P. Jolivet & K. K. Verma, "*Agroecology of Carabid Beetles*" edited by J. M. Holland, "*Insectos de Nicaragua*" (3 volumes) by J. M. Maes, "*Encyclopedia of South American Aquatic Insects: Collembola*" by C. W. Heckman, "*American Beetles: Volume 2: Polyphaga*" by R. H. Arnett et al., and the Coleopterist Society announcement of grants available for secondary school students for beetle projects.

Dave Furth introduced the speaker, Tom Henry of the USDA Systematic Entomology Laboratory, who spoke of "Ecuadorian Bug-collecting Adventures: From the Amazon to the Andes." This consisted of an entertaining and informative travelogue of his recent trip to Ecuador with colleagues and friends. The first part of the trip was spent at the remote Tiputini Biodiversity Research Station, in association with Smithsonian Entomologist Terry Erwin. The 650-hectare station is luxuriously equipped, including paths with bridges, two 40-meter towers, an 80-bed dormitory, dining hall, periodic electricity, a laboratory with microscopes and a drying box, and a knowledgable local naturalist who serves as a guide. All this for $22/day (researchers) or $160/day (tourists). Dr. Henry & Co. then drove the PanAm highway from Quito to Loja and back. The areas accessible by car are mostly agricultural and therefore stripped of natural vegetation and there are few pull-offs along the road. The best collecting was in the far South around Loja. They ended the 30-day trip with a 1-day workshop on Hemiptera classification to the eager students at the Universidad Politécnica in Quito.

The meeting was adjourned at 8:10 p.m. Refreshments were provided by the Society.

Respectfully submitted,
Stuart H. McKamey,
Recording Secretary

1,068th Regular Meeting—November 7, 2002

The 1,068th 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 Gabriela Chavarria at 7:10 p.m. The meeting was attended by 19 members and 3 guests. The minutes of the 1067th meeting were approved as read.

Dave Furth read the nominations for next year's officers: for President-elect, Eric Grissel; Program co-Chairs, Dave Furth and

John Brown; Editor, Dave Smith; Treasurer, Mike Pogue; Recording Secretary, Stu McKamey; Corresponding Secretary, Holly Williams; Membership Chair, Mike Gates; and Custodian, Jon (Buck) Lewis.

There were no new applicants for membership. One guest was introduced.

In miscellaneous business, President Chavarria noted that longtime active ESW member Douglas Ferguson passed away on November 4th.

For exhibits, Edd Barrows and his student Dan Kajr presented their online, searchable "*Biodiversity Database of the Washington DC Area*" (http://biodiversity.georgetown.edu). Gabriela Chavarria displayed a pre-release version of a lightweight insect repellent suit that enables field personnel to live DEET-free and dress in real style.

Dave Furth introduced the speaker, Dr. Michael Gates of the USDA Systematic Entomology Lab, who spoke of "Eurytomidae (Hymenoptera: Chalcidoidea): Morphology, Biology, Phylogeny and the New Mexico Bootheel." This consisted of an overview of Eurytomidae, which has about 1,400 described species and a broad host range. Among its hosts are plants, insects, and even two documented cases of switching between the two: first consuming a gall-making insect larva then consuming the gall. Dr. Gates is investigating the relationships using morphological and molecular data in order to understand the status of the family and its relationship to other chalcidoids as well as to understand the evolutionary origin of phytophagy in the group. Dr. Gates went on to describe two recent collecting trips. The first was to the Grey Ranch, a large, biologically unusual area of New Mexico containing many habitats, from grasslands to conifers. Accomodations were provided free of charge at Culberson Camp, a cozy old ranch house. The second trip was to Puerto Rico for a mealybug biocontrol workshop. In his off-time, collecting on the streets of San Juan, he was able to determine that an introduced chalcidoid biocontrol agent was still present, suggesting that it had become established.

The meeting was adjourned at 8:15 p.m. Refreshments were provided by the Society.

Respectfully submitted,
Stuart H. McKamey,
Recording Secretary

1,069th Regular Meeting—December 4, 2002

The 1,069th 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 Jon Mawdsley, standing in for President Gabriela Chavarria, at 7:06 p.m. He promptly installed himself as the new President. The meeting was attended by 22 members and 29 guests. The minutes of the 1068th meeting were approved as read.

There were no new applicants for membership. Twelve guests were introduced.

Annual officers' reports were given and will appear in the April issue of PESW.

President Mawdsley called for the annual elections, reading the nominations for next year's officers (see minutes of 1068th meeting) and calling for nominations from the floor. There being none, he proposed a slate for all positions, which was approved by unanimous vote.

In miscellaneous business, President Mawdsley summarized the recent Executive Committee meeting: Manya Stoetzal and Paul Spangler were elected as honorary members of the ESW, and Don Anderson was elected as honorary ESW President. To reduce duty redundancy, it was proposed that the Corresponding Secretary and Membership Chair be rolled into a single position. Steve Lingafelter had the proposed changes to the bylaws on hand at the regular meeting for perusal.

For exhibits, Edd Barrows passed out a request for information on special arthropods in the D.C. area. Art Evans announced that the first annual Richmond Virginia Insect Fair will be held on June 14, 2003; reported that the 2002 Virginia bioblitz was a big success and indicated that they are looking for new sites for 2003; and then gave a rapid-fire slide presentation of California beetles (e.g., a live cupedid) and a variety of arthropods from Virginia and Costa Rica. Dave Furth displayed the book "*History of Insects,*" edited by A. P. Rasnitsyn and D. L. J. Quicke.

Dave Furth introduced the speaker, Dr. Dan Janzen of the University of Pennsylvania and the Guanacaste Conservation Area (ACG). He explained "How to Find All the Species of Caterpillars in a Large, Complex Tropical Habitat." The ACG comprises about 2% of the country's area and includes seasonal dry forest, rainforest, and montane forest in northwestern Costa Rica. Dr. Janzen's goal is to discover all external-feeding caterpillars of lepidopterans, to explore what he called the "last unknown large species-rich terrestrial beasts." From thorough light and day collecting, he knows there are approximately 7,000 such species in the ACG. With few exceptions, rearing from field-collected caterpillars is the only feasible method because of high host plant specificity: about 95% are oligophagous, and fewer than 1% are broadly polyphagous. For all caterpillars, they have on-going event-based data records with high-resolution photos, all life stages, host plant, parasitoids, even microbes. Identifications are obtained through collaboration with over 200 taxonomists. The 185,000 records are available online at http://janzen.sas.upenn.edu. Almost all the work is done by 14 full-time parataxonomists spread among the five ACG stations. From 1978 to the present date they have completed 37% of the fauna, at a cost of about $1,000 per species ($15/record) plus $1,000 per species for identification because of the time required to identify so many individuals. An inventory requires collaboration between parataxonomists and taxonomists, with the end users being the ecologists. The magnitude of the project requires, as Dr. Janzen put it, that he "cannot be distracted by ecology" if it is ever to be complete.

The meeting was adjourned at 8:35 p.m. Refreshments were provided by the Society.

Respectfully submitted,
Stuart H. McKamey,
Recording Secretary

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105(2), 2003, pp. 522–523

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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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1. Title page with title, author(s), and author(s) byline. In upper left, give name, address, phone, fax, and e-mail of the author to whom all correspondence and proofs are to be sent. Titles must include order and family placement, e.g., ". . . . . . . (Hymenoptera: Xyelidae). Taxa of the genus and species groups levels must have the authority name.
2. Abstract; key words
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4. Literature Cited (see below)
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Revision of the Oriental Species of *Aphthona* Chevrolat (Coleoptera: Chrysomelidae), by Alexander S. Konstantinov and Steven W. Lingafelter. 349 pp. 2002	40.00
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