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A NEW GENUS AND SPECIES OF MYRMECOMORPHIC MIRIDAE FROM MADAGASCAR (HETEROPTERA)

Dan A. Polhemus[1] and Vincent Razafimahatratra[2]

[1] Department of Entomology, NHB 127, National Museum of Natural History,
Smithsonian Institution, Washington, D.C. 20560, and
[2] Laboratorie de Zoologie et Biologie Général, Université de Madagascar,
Tananarive B. P. 906, Madagascar

Abstract.—A new genus and species of myrmecomorphic phyline Miridae, *Myrmecomiris madecassus,* is described from the spiny forest region of southwest Madagascar. The new genus is most closely related to the myrmecomorphic genera *Pangania* and *Systellonotopsis* which occur in southern Africa. The new Malagasy taxon was collected on several plant species, including an *Acacia* and a succulent *Euphorbia.*

The diverse mirid fauna of Madagascar is still poorly understood, especially in the botanically distinctive southwest portion of the island. During a recent expedition to Madagascar the senior author discovered an interesting new myrmecomorphic mirid, described below, in the coastal dry deciduous scrub near Tulear. Two other myrmecomorphic mirid genera, *Malagacheocoris* Carvalho and *Myrmecopsella* Poppius, are known from the island, and additional collecting will undoubtedly turn up others.

All measurements are given in millimeters. Specimen depository abbreviations are indicated in the acknowledgments. This research was supported in part by a grant from the National Geographic Society, Washington, D.C.

Myrmecomiris, new genus

Diagnosis. Myrmecomiris, n. gen. is a member of the subfamily Phylinae on the basis of its pretarsal structure and male genitalia. The structure of the male genitalia and the flattened pronotal collar assign it to the tribe Hallodapini, specifically to the *Systellonotus* group as defined by Schuh (1974). This genus appears to be most closely allied to *Pangania* Poppius, known from Tanzania, Mozambique and South Africa, and *Systellonotopsis* Poppius, known from Botswana and Tanzania. *Myrmecomiris* differs from *Pangania* in having long erect pubescence on the dorsum and a very long twisted vesica quite different from that figured by Schuh (1974) for *Pangania fasciatipennis* Poppius, although the right paramere is similar to that figured for *P. chnous* by Odhiambo (1963). In Schuh's (1974) key to South African phyline genera *Myrmecomiris* runs to *Systellonotopsis,* from which it differs in lacking erect pubescence on the pronotum and scutellum, in bearing long erect setae on the hemelytra, and in possessing a distinctively enlarged fourth antennal segment. All known females of *Pangania* and *Systellonotopsis* are macropterous, whereas only brachypterous females of *Myrmecomiris* have been collected so far. The geographical proximity of these related genera suggests that *Myrmecomiris* and *Systellonotopsis* may be sister groups isolated by the opening of the Mozambique Channel in Cretaceous time.

Two other genera of ant mimetic phyline Miridae, *Malagacheocoris* Carvalho and *Myrmicopsella* Poppius also occur in Madagascar. *Myrmecomiris* may be separated from *Malagacheocoris* by the structure of the male pronotum, which is strongly constricted and nearly cylindrical on the anterior half in the latter genus, but tapers relatively evenly on the anterior half in *Myrmecomiris*; the general body form of *Malagacheocoris* is also noticably more elongate (see Carvalho, 1952, p. 98, fig. 3). *Myrmicopsella* is known only on the basis of a single winged female (Poppius, 1914), but its generally blackish brown coloration, flat scutellum and macropterous females will easily separate it from *Myrmecomiris.* In addition the genera belong to different tribes, since Schuh (1974) assigned *Myrmicopsella* to his tribe Leucophoropterini, while *Myrmecomiris,* as noted above, falls into the Hallodapini, along with *Malagacheocoris.* The recorded distributions of these three Malagasy genera are plotted in Figure 6; all occur in the drier central and western portions of Madagascar, and no species is yet recorded from the wet eastern forests.

Description. MACROPTEROUS MALE. Head triangular when viewed from above; eyes large, protrusive, bearing a few very minute setae, removed from anterior margin of pronotum by distance equal to diameter of antennal segment I; vertex broadly convex, width subequal to twice the dorsal width of an eye, weakly concave along posterior margin, acarinate; frons and vertex bearing many long erect pale setae; gula short, acarinate, length near to one and a half times the diameter of antennal segment I; antennae long, segment I moderately enlarged, segments II and III slender, smaller in diameter than segment I, segment IV fusiform, enlarged, maximum diameter equal to that of segment I. Pronotum trapezoidal, anterior margin with broad flattened collar, lateral margins weakly concave, posterior margin sinuate, weakly concave medially, posterolateral angles acute; pronotal surface shining, lacking long erect setae. Scutellum tumescent, forming low conical protruberance posteriorly, bearing a few recumbent setae along anterior margin; mesoscutum barely exposed. Hemelytra complete, exceeding tip of abdomen, bearing numerous long erect pale setae, lateral margins weakly concave. Legs long, slender, fore coxae robust; claws slender; parempodia hair-like, parallel; pulvilli small, closely appressed to inner face of claw basally. Rostrum long, extending to metasternum between tips of middle coxae. Male genitalia of phyline-type, twisted to left in capsule when viewed from above, right paramere small, leaf-like; left paramere larger, cup-like; vesica long, twisted into several loops, gonopore subapical, well developed.

BRACHYPTEROUS FEMALE. Ant-like, head globose when viewed from above, eyes not protrusive, frons and vertex broadly convex; pronotum campanulate, swollen, anterior margin depressed to form flattened collar; scutellum conical; hemelytra brachypterous, extending to base of abdomen, truncate posteriorly; abdomen constricted basally, globose posteriorly with conspicuous pleural fold.

Type species. Myrmecomiris madecassus, n. sp.

Etymology. The name *Myrmecomiris* refers to the ant-like form of the females.

Myrmecomiris madecassus, new species

Diagnosis. Among the phyline Miridae of Madagascar, *M. madecassus* is the only known species with brachypterous ant-mimetic females. The distinct coloration of

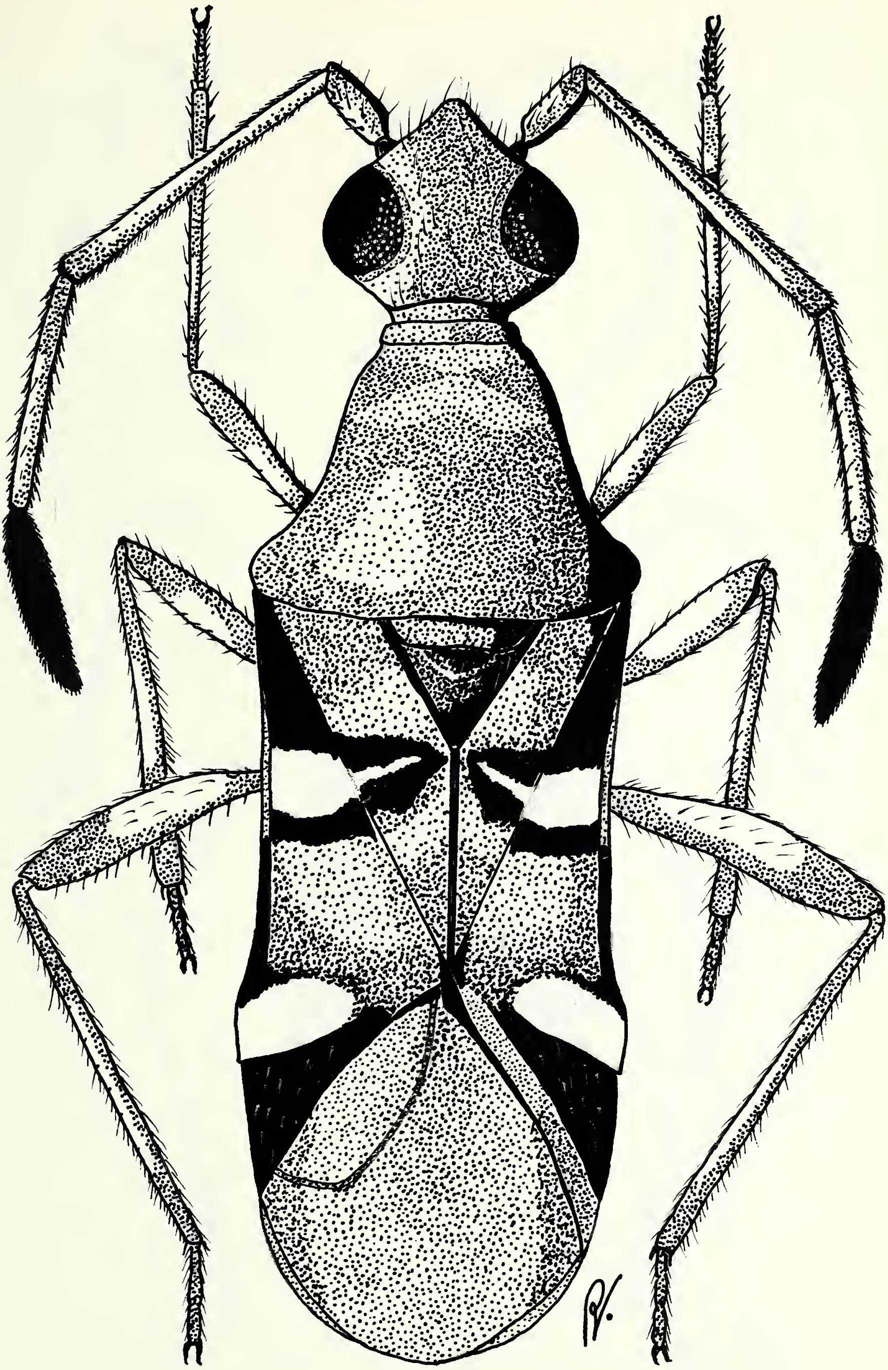


Fig. 1 *Myrmecomiris madecassus,* macropterous male, dorsal habitus.

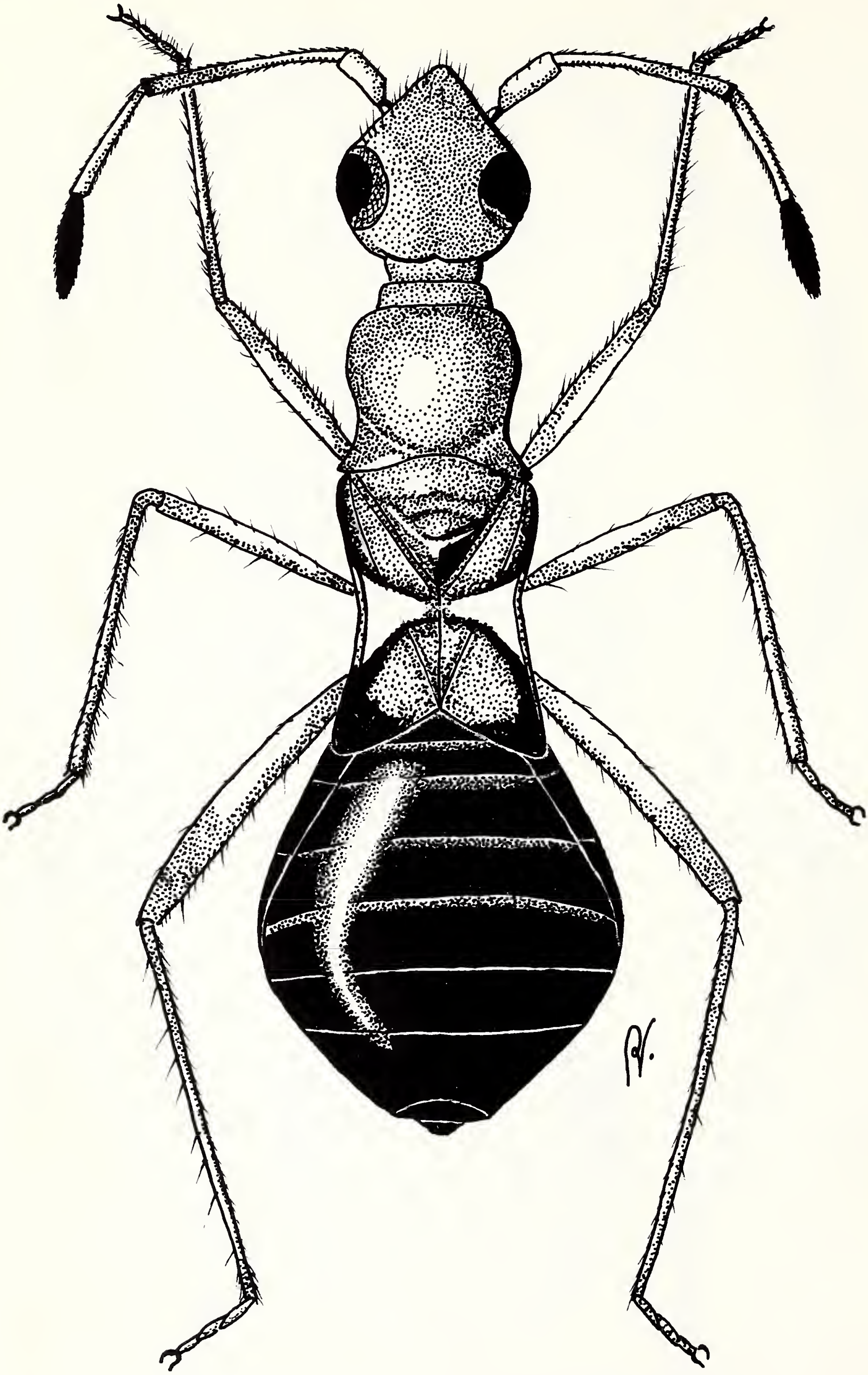
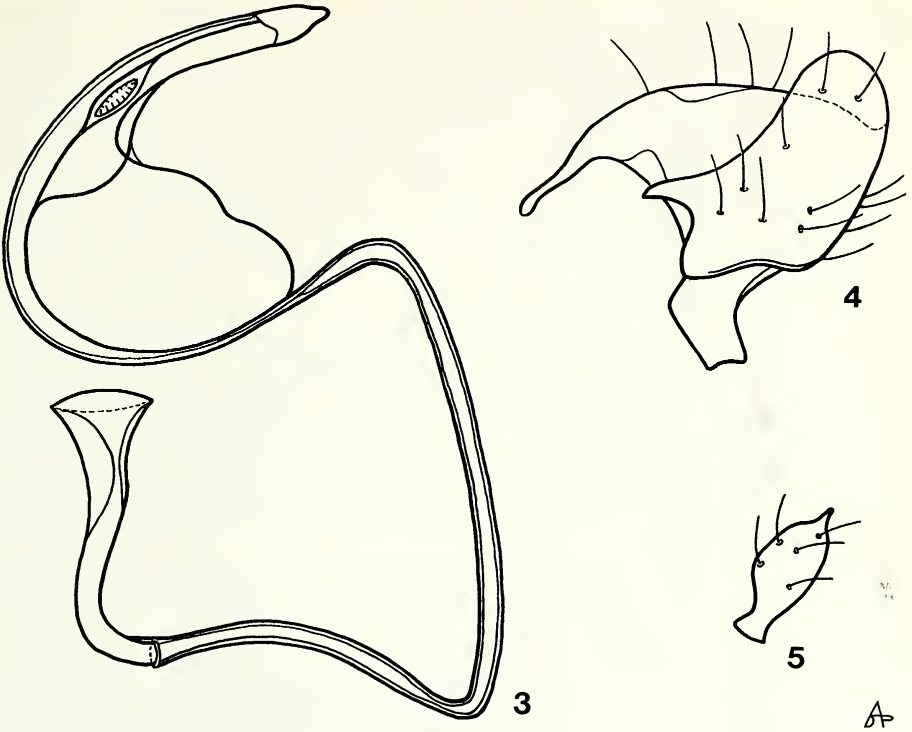


Fig. 2. *Myrmecomiris madecassus,* brachypterous female, dorsal habitus.



Figs. 3–5. *Myrmecomiris madecassus,* male genitalia. 3. Vesica. 4. Left paramere. 5. Right paramere.

the males, with light hemelytral fasciae bordered by black on an orange background, and the structure of the male genitalia are also diagnostic.

Description. MACROPTEROUS MALE. Small, elongate (Fig. 1), length 3.43 mm; maximum width (across base of pronotum) 1.08 mm. General coloration reddish brown, with translucent white maculae bordered with black on hemelytra.

Head declivant, reddish brown, shining, triangular when viewed from above; eyes large, produced vertically, reaching gula, moderately protruberant, dorsal width 0.18, removed from anterior margin of pronotum by distance equal to diameter of antennal segment I; frons broadly convex, bearing numerous long pale erect setae; antennal segment I moderately enlarged, segments II and III slender, segment IV enlarged, fusiform, maximum diameter equal to that of segment I, segments I–III pale brown, segment IV black, lengths of segments I–IV = 0.29, 0.92, 0.65, 0.50; clypeus moderately produced, not visible from above; vertex broad, width 0.34, subequal to two times the dorsal width of an eye, acarinate along posterior margin.

Pronotum reddish brown, tumescent, shining, bearing very short fine pale setae, width/length (midline) = 1.08/0.79, anterior collar width equal to diameter of antennal segment I, calli obsolete; lateral margins concave, posterior margin sinuate, weakly concave medially, posterolateral angles acute. Scutellum reddish brown, shining, bearing a few short recumbent pale setae, produced to low conical tumescence posteriorly, separated from mesoscutum by shallow sulcus; mesoscutum barely exposed, bearing a few short recumbent pale setae.

Hemelytra complete, exceeding tip of abdomen, lateral margins weakly concave, surface generally light brown with pruinose reflections, bearing scattered long erect pale setae intermixed with sparse short pale recumbent setae; translucent white triangular transverse fascia bordered with dark blackish brown present broadly on anterior portion of corium and narrowing onto central portion of clavus; posterior fifth of corium with transverse white band; cuneus dark reddish brown, shining, bearing only short recumbent pale setae; costal margin bearing short pale setae; membrane uniformly fumate.

Ventral surface generally reddish brown, glabrous, abdomen blackish, bearing fine recumbent pale setae; rostrum dark brown, glabrous, length 1.48, extending onto metasternum between tips of middle coxae; legs reddish brown, covered with fine recumbent pale setae, hind coxae pallid, tibiae set with short erect spines and bearing several longitudinal rows of numerous tiny black spinules; ostiolar peritreme pallid, protrusive; genital capsule conical, genitalia lying twisted to left when viewed from above, right paramere small, leaf-like, tip acuminate, left paramere larger, cup-like, with two slender projections, vesica long, twisted into several loops, gonopore subapical, well developed (see Figs. 3–5).

BRACHYPTEROUS FEMALE. Habitus ant-like (Fig. 2), length 3.26 mm; maximum width (across abdomen) 1.11 mm. General coloration reddish brown with pale fascia on hemelytra, abdomen blackish.

Head reddish brown, globose when viewed from above, eyes not protrusive, dorsal eye width 0.16; frons and vertex broadly convex, set with numerous pale erect setae, width of vertex 0.45, exceeding two times the dorsal width of an eye, posterior margin weakly concave; narrow posterior portion of head constricted to form a neck; rostrum length 1.62, reaching to middle trochanters.

Pronotum reddish brown, finely rugulose, bearing very short fine pale setae, campanulate, strongly swollen, anterior margin depressed to form flattened collar, lateral margins strongly sinuate, posterior margin concave, posterolateral angles acute. Scutellum reddish brown, shining, produced to vertical conical tumescence posteriorly, bearing a few short pale setae on anterior portion.

Hemelytra light brown, brachypterous, truncate posteriorly, barely covering base of abdomen, surface with pruinose reflections, bearing long erect pale setae; clavus, corium and cuneus poorly defined, triangular white fascia bordered with black present centrally on corium and narrowing onto clavus; posterolateral angle of hemelytron with raised pallid spot.

Abdomen dark blackish brown, shining, globose, constricted basally, set with short pale recumbent setae intermixed with long erect pale setae, sharp connexival folds present laterally bordering first 4 segments visible from above.

Discussion. The type series of *Myrmecomiris madecassus* was taken from vegetation near the rim of La Grotte, a coastal limestone sinkhole approximately 20 kilometers south of Tulear containing a tidally influenced freshwater pool (Fig. 6). The surrounding countryside was covered with a low dediduous spiny thorn scrub vegetation dominated by *Pachypodium, Acacia,* and succulent *Euphorbia* species intermixed with a diverse array of other deciduous broad leaved shrubs, with much of the vegetation in bloom due to recent rains. Adults and immatures of *M. madecassus* were collected on three different plants: an *Acacia* species, a succulent *Euphorbia*

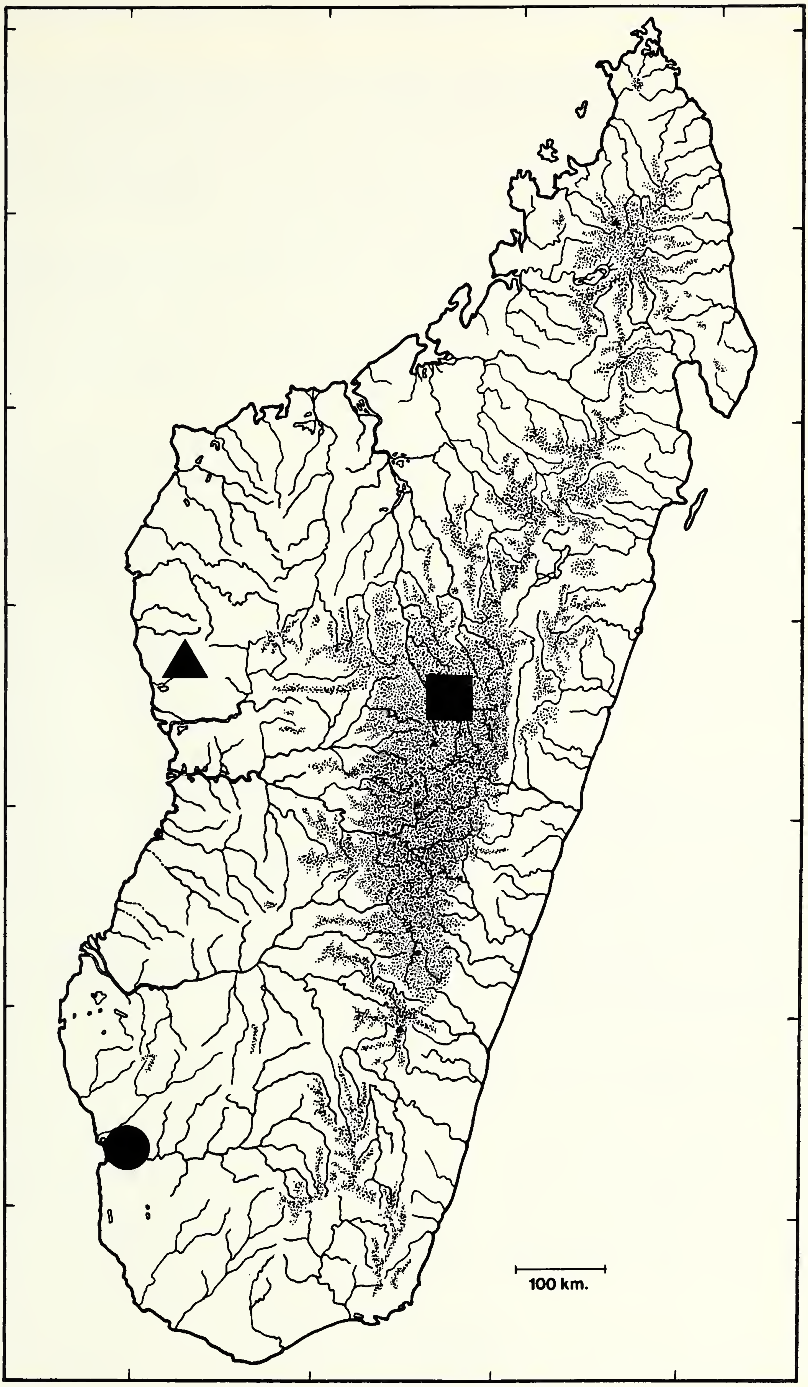


Fig. 6. Recorded distributions of ant mimetic phyline Miridae in Madagascar. ●: *Myrmecomiris madecassus*. ▲: *Malagacheocoris myrmecoides* Carvalho. ■: *Myrmicopsella nitidipennis* Poppius.

species, and a low unidentified broad leafed shrub. A single female was also taken on the ground amid litter below the *Acacia.* In every case the mirids were taken in association with small brownish ants belonging to the subfamily Myrmicinae, which appear to be the obvious model in this apparent mimicry system. Although a diligent search was made over a large area surrounding La Grotte, the mirids were found only on plants growing close to the edge of the sinkhole.

Material examined. Holotype, macropterous male: MADAGASCAR, Tulear Prov., La Grotte, approx. 20 km S of Tulear on St. Augustin rd., 0–10 m, XI-28-86, CL 2293, J. T. & D. A. Polhemus (AMNH). Paratypes: 2 macropterous males, 6 brachypterous females, same data as types (JTPC, TSIM).

Etymology. The name *madecassus* refers to the island of Madagascar.

ACKNOWLEDGMENTS

The holotype and allotype of *Myrmecomiris madecassus* are deposited in the American Museum of Natural History, New York (AMNH); paratypes are held in the J. T. Polhemus collection, Englewood, Colorado (JTPC) and the collection of the Parc de Tsimbazaza, Tananarive, Madagascar (TSIM). Special thanks go to Dr. Voara Randrianasolo of the Parc de Tsimbazaza for his assistance in arranging logistics within Madagascar, and to Jennifer Turnour of the CSIRO who provided transportation in the Tulear region. We also thank Thomas J. Henry of the Systematic Entomology Laboratory, USDA, c/o National Museum of Natural History, Washington, D.C. and Dr. John T. Polhemus of Englewood, Colorado for critical review and comments on early drafts of this manuscript.

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THE WORLD'S LARGEST ISOMETOPINE, *GIGANTOMETOPUS ROSSI*, NEW GENUS AND NEW SPECIES (HETEROPTERA: MIRIDAE)

Michael D. Schwartz and Randall T. Schuh

Department of Entomology, The American Museum of Natural History,
Central Park West at 79th Street, New York, New York 10024-5192

Abstract.—Gigantometopus rossi, a new genus and species of Isometopinae from Sumatra, which is almost three times the length of any previously known isometopine, is described and illustrated.

While sorting and identifying Miridae on loan from the California Academy of Sciences, San Francisco (CAS) we discovered an undescribed genus and species of what we believe is the largest known member of Isometopinae.

Gigantometopus, new genus

Type species. Gigantometopus rossi, n. sp.

Diagnosis. Distinguished from all known isometopines by the large body size, the long, suberect setae, and the strongly tumid scutellum.

Description of Macropterous Female. **General Aspect.** Exceptionally large, ovoid, total length 6.98 (Fig. 1); surface strongly punctate, smooth, shining between punctures, with long, suberect, pale, simple setae. **Head.** Vertical, height greater than width, flattened (Fig. 2), juga slightly carinate; shallowly punctate ventrad of eye, posteriolateral margin strongly punctate, with longer, erect setae; eyes not contiguous, emarginate near ocelli, forming posterior margin of head laterally, extending slightly dorsad of pronotum; vertex ecarinate; antennal segments I and II thicker than III and IV, II slightly thickened distally; labium reaching apex of metacoxa. **Pronotum.** Trapezoidal in dorsal view (Fig. 1); collar suture punctate; lateral margin carinate; anterior lobe and calli slightly swollen, calli impunctate, reaching lateral margins, with a single deep median fossa. **Scutellum.** Heartshaped, tumid, attaining height of pronotum in lateral view, sunken basomedially, apex flat and pointed; impunctate basolaterally. Hemelytra. Lateral margin weakly convex; embolium flattened and slightly tilted dorsad; clavus laterad of claval vein, and costal vein, deeply punctate; cuneal fracture prominent; membrane with two cells and minutely setose. **Legs.** Procoxa and metafemur swollen; five mesofemoral and six metafemoral trichobothria with well-developed bothria (Figs. 3, 4); claws without subapical tooth; parempodia setiform; pulvilli absent. **Ostiolar peritreme.** Large evaporative surface and produced peritremal disk. Genitalia. Not examined.

Etymology. From the Latin *gigas* meaning giant, and *metopus* from the generic name *Isometopus,* the type genus of the subfamily.

Discussion. In worldwide keys to isometopine genera (McAtee and Malloch, 1932; Ghauri and Ghauri, 1983) *Gigantometopus* keys to *Isometopidea* Poppius, but differs from the two included species of that genus, *lieweni* Poppius (from Sri Lanka) and

Fig. 1. Habitus of *Gigantometopus rossi.*

miriformis Slater and Schuh (from South Africa), and all other isometopines by its great size.

McAtee and Malloch (1932) proposed tribes and infratribal groupings for the Isometopinae. The vertical head, the cuneus not reaching the apex of the hemelytra, and the parallel-sided clavus, which extends beyond the apex of the scutellum, place

Fig. 2. *Gigantometopus rossi,* lateral view of head and thorax.

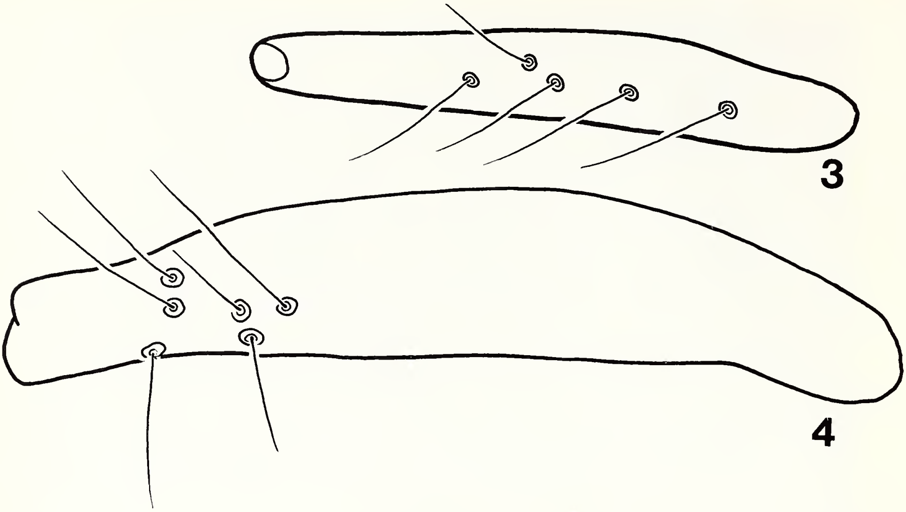
Gigantometopus in the tribe Isometopini and division Myiommaria. Henry and Wheeler (1988) and Akingbohungbe and Henry (1984) suggest raising Myiommaria to the tribal level. There has not been a comprehensive cladistic analysis of the subfamily, we insert our new genus within their scheme of higher categories only for comparative purposes.

Gigantometopus is important to the classification of the Miridae because of the presence of a more full compliment of femoral trichobothria (five mesofemoral, six metafemoral) and tarsal claws without a subapical tooth, indicating greater variability in these attributes than was previously known. Schuh (1976) proposed that the reduced trichobothrial number, two mesofemoral and three metafemoral, is an autapomorphy of Isometopinae. Schuh and Schwartz (1984) hypothesized that the presence of a subapical tooth is synapomorphic of a group containing the Isometopinae, Cylapinae and *Psallops.* It now seems clear that a more thorough survey of the distribution of states of these character systems, as well as the study of other characters in the Isometopinae, Cylapinae and *Psallops,* is necessary to determine the validity of the theory proposed by Schuh (1976) and Schuh and Schwartz (1984) that these taxa form a monophyletic group. Clearly, each characteristic shows greater variation than was previously thought to be the case.

Gigantometopus rossi, new species
Figs. 1–4

Diagnosis. See above.

Description. Coloration. Pale testaceous with antennal segment II, space between eye and antennal fossa, 'V' shaped marking on front of head ventrad of eye, propleura, 'W' shaped marking on posterior lobe of pronotum, mesoscutum laterally and mesially, scutellum and clavus mesially, corium except near claval suture and interiad



Figs. 3, 4. *Gigantometopus rossi.* 3. Mesofemoral trichobothria. 4. Metafemoral trichobothria.

of basal portion of radius, veins of membrane, basal half and apex of metatibia, metatarsal segment III (other legs less so), ventral portion of thorax, and abdomen laterally, ranging from pale to dark fuscous to piceous; vertex, lora, proepsternum, coxa, femur distally (especially metafemora), and extreme ventral portion of abdomen rufus. Measurements (in millimeters). Total length 6.98; length from apex of tylus to cuneal fracture 4.94; maximum width of pronotum 2.69; length of pronotum 1.55; width of head across eyes 1.03; interocular width (directly posteriad of ocelli) 0.32; interocellar width 0.15; height of eye 0.75; height of head 1.71; distance between eye and antennal fossa 0.41; antennal segment I 0.23; II 1.64; III 1.10; IV 0.39; labial segment I 0.88; total length of labium 3.10; length of cuneus at lateral margin 0.78; length from apex of cuneus to apex of membrane 1.50.

Holotype. Female. SUMATRA. Sumatera Barat. Mangani, mine near Kota Tinggi, 700 m, 20 July 1983, Edward S. Ross. Deposited in CAS. Type No. 16508.

Etymology. A patronym for Dr. E. S. Ross who collected the holotype.

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KEY AND DIAGNOSES FOR THE GENERA OF 'BROADHEADED' DISCOCEPHALINES (HEMIPTERA: PENTATOMIDAE)

L. H. ROLSTON

Department of Entomology, Louisiana Agricultural Experiment Station,
Louisiana State University Agricultural Center, Baton Rouge, Louisiana 70803

Abstract.—A key and diagnoses are given for the 14 genera of the tribe Discocephalini that have the interocular width equal to or greater than the length of the head, the basal segment of the rostrum reaching onto the prosternum, and the base of the abdominal venter unarmed. The genus *Beroaldus* Distant, 1890, is recognized as a junior synonym of *Phoeacia* Stål, 1862. The male of *Placidocoris bivittatus* Ruckes, previously known only from the female holotype, is described.

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There are 14 genera in the tribe Discocephalini that have the interocular width equal to or greater than the length of the head, the basal segment of the rostrum projecting onto the prosternum and the base of the abdominal venter unarmed. These 'broadheaded' discocephalines have no formal name, and not all of the genera are closely related. Most of them have a similar, easily recognized facies. Among them are some of the most common and several of the rarest of the discocephalines. Two other discocephaline genera, *Parvamima* Ruckes and *Dryptocephala* Laporte, also have the interocular width equal to or greater than the length of the head, but they differ vastly from each other and from the 'broadheaded' genera. *Parvamima* has the metasternum strongly produced and excavated posteriorly in apposition to a stout, medial tubercle at the base of the abdominal venter. *Dryptocephala* has a relatively short rostrum, the basal segment reaching only to the anterior margin of the prosternum, and a strongly explanate pronotum. The interocular width of *Phineus* Stål is usually somewhat less than the length of the head, but the two dimensions are equal in an occasional specimen. However, the base of the abdominal venter is clearly armed in *Phineus.*

Becker (1977) enumerated all the genera of 'broadheaded' discocephalines save *Placidocoris* Ruckes in a review of the genus *Colpocarena* Stål. Earlier, a key to half of these genera was given by Ruckes (1966) in a paper dealing mostly with those species that Kirkaldy (1909) had cataloged under *Platycarenus* Fieber or as "species of doubtful position." However, there has been no key to all the genera of 'broadheaded' discocephalines or, for that matter, to the other, more numerous genera of discocephalines. Consequently, placing discocephaline specimens to genus often has been frustrating, and the relatively few modern reviews and revisions of discocephaline genera are not as useful as they would be were the genera keyed.

The ratios given in the key and diagnoses should not be interpreted rigidly. Although a range is given for each ratio when possible, not all species were seen, and some species were represented by only one or a few specimens. Spiracles are present and usually apparent on the 8th paratergites. Mention is made of these spiracles only when they are concealed.

KEY TO GENERA OF 'BROADHEADED' DISCOCEPHALINES

1. Longitudinal median of mesosternum sulcate and densely punctate, most adjacent punctures in sulcus separated by distance less than diameter of one puncture ... 2

– Longitudinal median of mesosternum impunctate or sparingly punctate, asulcate or sulcate 3

2(1). Tumid portion of mesosternum on each side of medial sulcus densely punctate; ostiolar ruga on each side reaching 0.3 distance from mesial limit of ostiole to lateral margin of metapleuron .... *Platycarenus* Fieber

– Tumid portion of mesosternum on each side of medial sulcus largely smooth and impunctate; ostiolar ruga on each side reaching 0.5 distance or slightly more from mesial limit of ostiole to lateral margin of metapleuron .. *Discocephalessa* Kirkaldy

3(1). Apex of scutellum reaching to or beyond imaginary line connecting anterolateral connexival angles of last abdominal segment (Fig. 12) 4

– Apex of scutellum not reaching such a line 6

4(3). Length of head 0.6 or less of interocular width; anterior margin of last abdominal sternite in male right-angular medially (Fig. 33) ... (part) ... *Discocephala* Laporte

– Length of head more than 0.6 of interocular width; if nearly 0.6 of interocular width then length of head 0.9–1.1 of medial pronotal length; anterior margin of last abdominal sternite in male arcuate (Figs. 13, 15) 5

5(4). Distance between eye and ocellus on each side less than 0.75 distance between ocelli; length of head 0.7 or less of medial length of pronotum; antennae 4-segmented .... *Phoeacia* Stål

– Distance between eye and ocellus on each side subequal to distance between ocelli; length of head and medial length of pronotum subequal; antennae 5-segmented .... *Ischnopelta* Stål

6(4). Width of head across eyes about 1.33 times basal width of scutellum 7

– Width of head across eyes not more than about 1.25 times basal width of scutellum 8

7(6). Lateral margins of juga deeply concave before eyes (Fig. 17) ...... *Colpocarena* Stål

– Lateral margins of juga not at all concave before eyes (Fig. 21) ....*Tetragonotum* Ruckes
8(6). Distance from ocellus to nearest eye 0.70 or more of distance between ocelli ... 9
– Distance from ocellus to nearest eye less than 0.70 of distance between ocelli ... 13
9(8). Large, acute, anteocular process present on lateral margin of each jugum (Fig. 23) ....*Harpogaster* Kormilev
– Anteocular process absent or small and obtuse 10
10(9). Length of head more than 0.85 of interocular width .... *Placidocoris* Ruckes
– Length of head less than 0.75 of interocular width 11
11(10). Metasternum flat or shallowly concave; anterior margin of sternite 6 in male obtusely produced (Fig. 33) (part) .... *Discocephala* Laporte
– At least posterior part of metasternum sulcate medially; anterior margin of sternite 6 in male acutely produced (Fig. 37) 12
12(11). Metasternum sulcate medially for entire length .... *Alveostethus* Ruckes
– Metasternum medially carinate anteriorly, sulcate posteriorly ... *Acclivilamna* Ruckes
13(8). Stout, bent, anteapical process present on inferior surface of each hind femur of males, sometimes reduced in females (Fig. 48); apex of scutellum in form of Gothic arch (Fig. 50) .... *Uncicrus* Ruckes
– Hind femora unarmed; apex of scutellum rounded 14
14(13). Ostiolar ruga on each side extending about 0.5 of distance from mesial limit of ostiole to lateral margin of metapleuron .... *Allinocoris* Ruckes
– Ostiolar ruga on each side extending about 0.75 or more of this distance .... *Lineostethus* Ruckes

Platycarenus Fieber, 1860
Figs. 1–5

Platycarenus Fieber, 1860:77; Ruckes, 1966:10, 11–12 (type species *Cydnus umbraculatus* Fabricius, 1803, by monotypy).

Head. Length of head 0.65–0.78 interocular width, 1.00–1.14 times medial length of pronotum. Distance between ocelli 0.31–0.34 interocular width, from each ocellus to nearest eye 0.93–1.07 distance between ocelli. Width of head across eyes 1.22–1.33 times basal width of scutellum. Lateral margin of each jugum with deep concavity creating anteocular lobe (Fig. 1). Antennae 5-segmented. Bucculae weakly produced, widely divergent posteriorly, not reaching base of head.

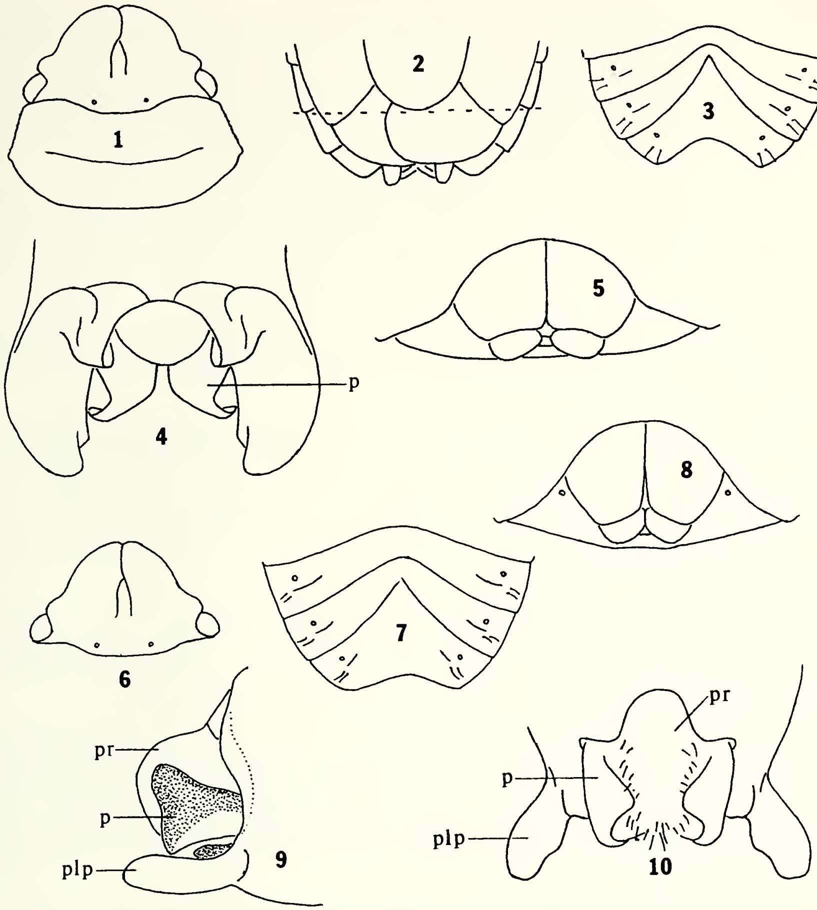
Thorax. Apex of scutellum reaching imaginary line connecting anterolateral connexival angles of penultimate abdominal segment (Fig. 2). Costal angles of coria reaching middle of penultimate connexiva. Mesosternum medially sulcate, moderately tumescent one each side. Metasternum somewhat produced ventrad, medially sulcate. All thoracic sterna including tumescent areas of mesosternum densely punctate. Ostiolar ruga on each side straight, spatulate, extending 0.3 distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Anterior margin of sternite 7 in male acutely produced medially, that of sternite 6 arcuately produced (Fig. 3); length of sternite 5 medially 0.40–0.50 lateral length; medial length of sternites 6+7 comprising 0.54–0.58 medial length of abdominal venter. Parameres depressed, curving ventrad apically (Fig. 4). Spiracles on paratergites 8 covered by basal plates (Fig. 5).

Species. Monotypic.

Remarks. Ruckes (1966:12–13) redescribed the type species.

The only other genus of 'broadheaded,' discocephalines with a densely punctate



Figs. 1–5. *Platycarenus umbraculatus.* 1. Head and pronotum. 2. Relationship of scutellar apex and abdominal segments. 3. Sternites 5–7 of male. 4. Genital cup. 5. Genital plates. 6–10. *Discocephalessa humilis* complex. 6. Head. 7. Sternites 5–7 of male. 8. Genital plates. 9. Distal part of pygophore, lateral view. 10. Same, dorsal view. Symbols: p, paramere; plp, posterolateral projection of ventral margin; pr, proctiger.

mesosternum is *Discocephalessa.* Differences between these genera include the ratio of head width to scutellar width, length of ostiolar rugae, type of parameres and structure of the pygophore.

Discocephalessa Kirkaldy, 1909
Figs. 6–10

Platycarenus subgenus *Discocephalessa* Kirkaldy, 1909:215 (type species *Discocephala notulata* Stål, 1862, by original designation).

Discocephalessa: Ruckes, 1966:10, 13–14.

Head. Length of head 0.75–0.85 interocular width, 0.94–1.06 medial length of pronotum. Distance between ocelli 0.34–0.40 interocular width. Distance from each ocellus to nearest eye 0.72–0.93 distance between ocelli. Width of head across eyes 1.00–1.11 times basal width of scutellum. Lateral margins of juga moderately concave before eyes (Fig. 6). Antennae 5-segmented. Bucculae weakly developed anteriorly, moderately so posteriorly, diverging at labium, reaching base of head.

Thorax. Scutellum approaching imaginary line connecting anterolateral connexival angles of penultimate abdominal segment. Costal angles of coria surpassing scutellum, resting above connexiva near suture between last and penultimate abdominal segments. Mesosternum and metasternum longitudinally sulcate. Prosternum and mesosternal sulcus densely punctate; tumescent portion of mesosternum on each side of sulcus sparsely punctate or impunctate. Each ostiolar ruga curving slightly cephalad, reaching about one-half to two-thirds of distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Anterior margin of sternite 7 acutely produced medially in male, that of sternite 6 arcuately produced (Fig. 7); length of sternite 5 medially 0.40–0.55 lateral length; length of sternites 6+7 medially 0.56–0.62 medial length of abdominal venter. Posterolateral projections of pygophore separated from margin by sutures and membranes (Figs. 9, 10). Parameres somewhat compressed with compact, complex head.

Species. andina (Breddin, 1904), *humilis* (Herrich-Schäffer, 1843), *notulata* (Stål, 1962), *sordida* (Walker, 1867) and *terminalis* (Walker, 1867).

Remarks. Ruckes (1866:14–22) redescribed the above species with the exception of *humilis* of whose identity he was uncertain. He observed that *humilis* is applied to a complex containing 12 distinctly different patterns of parameres.

Some differences between *Discocephalessa* and *Platycarenus,* the only genera of ‘broadheaded’ discocephalines with densely punctate mesosternum, were mentioned previously. A remarkable feature of *Discocephalessa,* a feature found elsewhere among the ‘broadheaded’ discocephalines in the genera *Placidocoris* and *Uncicrus,* is the partial separation of the posterolateral pygophoral projections by sutures and membranes.

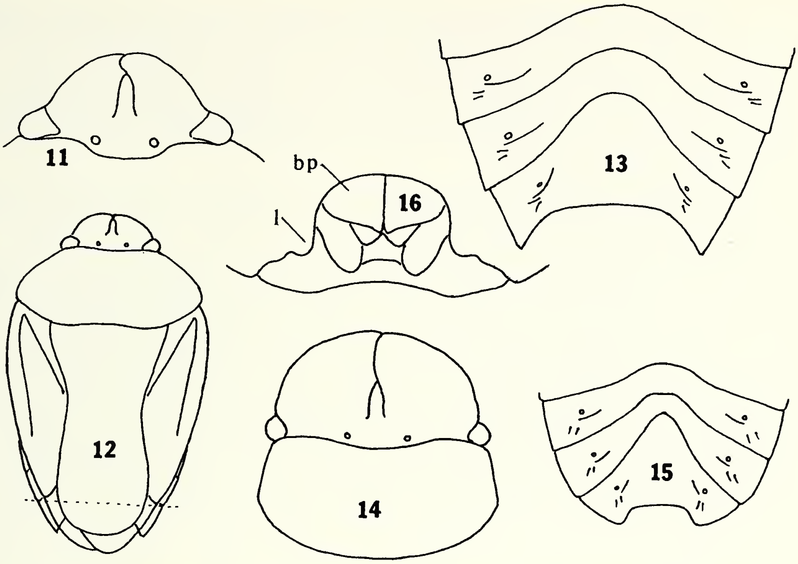
Phoeacia Stål, 1862
Figs. 11–13

Phoeacia Stål, 1862:97 (type species *Discocephala lineaticeps* Stål, 1860, by original designation).

Beroaldus Distant, 1890:322 (type species *Beroaldus erubescens* Distant, 1890, by monotypy). NEW SYNONYMY.

Head. Length of head 0.72–0.88 interocular width, 0.56–0.70 medial length of pronotum. Distance between ocelli 0.35–0.42 interocular width, from each ocellus to nearest eye 0.50–0.69 distance between ocelli. Width of head across eyes 0.86–0.97 basal width of scutellum. Head before eyes smoothly arcuate (Fig. 11). Antennae 4-segmented. Bucculae weakly produced anteriorly, moderately so where diverging around base of labium, reaching base of head.

Thorax. Scutellum extending to apex of abdomen or nearly so, approaching to surpassing imaginary line connecting posterolateral connexival angles of last abdominal segment (Fig. 12). Costal angles of coria projecting over anterolateral connexival angles of last abdominal segment but not attaining apex of scutellum. Scutellum



Figs. 11–13. *Phoeacia gibba*. 11. Head. 12. Habitus. 13. Sternites 5–7 of male. 14–16. *Ischnopelta* sp. 14. Head and pronotum. 15. Sternites 5–7 of male. 16. Genital plates. Symbols: bp, basal plate; l, lobe.

slightly constricted in width at distal ends of frena. Mesosternum moderately tumescent; very shallow, impunctate sulcus bordered on each side by thin line of short hairs. Metasternum nearly flat to shallowly sulcate medially. Ostiolar ruga on each side extending 0.75 distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Medial length of sternite 5 in male 0.50–0.75 lateral length; anterior margins of sternites 6 and 7 arcuately produced medially, medial length of both combined 0.44–0.60 medial length of abdominal venter (Fig. 13). Parameres usually substyliform and largely concealed between ventral pygophoral margin and proctiger, but sometimes expanded, depressed and curved ventrad apically, and more or less fully visible from dorsal view when pygophore is extracted.

Species. Nominal species are *erubescens* (Distant, 1890), *gibba* (Fieber, 1851) and *lineaticeps* Stål, 1860.

Remarks. Phoeacia, Ischnopelta and *Discocephala* (in part) are the only genera of 'broadheaded' discocephalines in which the scutellum reaches nearly to the apex of the abdomen, and only *Phoeacia* has 4-segmented antennae.

The types of the three nominal species enumerated above were examined.

Ischnopelta Stål, 1868
Figs. 14–16

Discocephala subgenus *Ischnopelta* Stål, 1868:18 (type species *Discocephala scutellata* Signoret, 1851, fixed by Kirkaldy, 1909).
Ischnopelta: Kirkaldy, 1909:XXXIII.

Head. Length of head 0.58–0.75 interocular width, 0.93–1.11 medial length of pronotum. Distance between ocelli 0.30–0.33 interocular width, from each ocellus to nearest eye 0.88–1.00 distance between ocelli. Width of head across eyes 1.24–1.39 times basal width of scutellum. Lateral jugal margins slightly sinuous before eyes (Fig. 14). Antennae 5-segmented. Bucculae weakly produced, widely separated at labium, reaching base of head.

Thorax. Scutellum extending nearly to apex of abdomen, surpassing imaginary line connecting anterolateral connexival angles of last abdominal segment. Costal angles of coria touching this line. Mesosternum tumescent, without carina, with medial depression anteriorly, impunctate. Metasternum slightly concave, margins adjacent to coxae thickened. Ostiolar ruga on each side curving cephalad, extending about 0.6 distant from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Medial length of sternite 5 in males 0.45–0.60 length at lateral margins; medial length of sternites 6+7 about 0.56 medial length of abdominal venter; anterior margin of each of these sternites arcuately produced medially (Fig. 15). Parameres palmate, forming a sort of cup covered by proctiger. Posterior margin of last sternite of female with small lobe on each side covering spiracles on paratergites 8 (Fig. 16).

Species. oblonga (Fieber, 1851) and *scutellata* (Signoret, 1851).

Colpocarena Stål, 1868
Figs. 17–20

Discocephala subgenus *Colpocarena* Stål, 1868:17 (type species *Sciocoris complanatus* Burmeister, 1835, by monotypy).

Colpocarena: Kirkaldy, 1909:215; Becker, 1977:368–369.

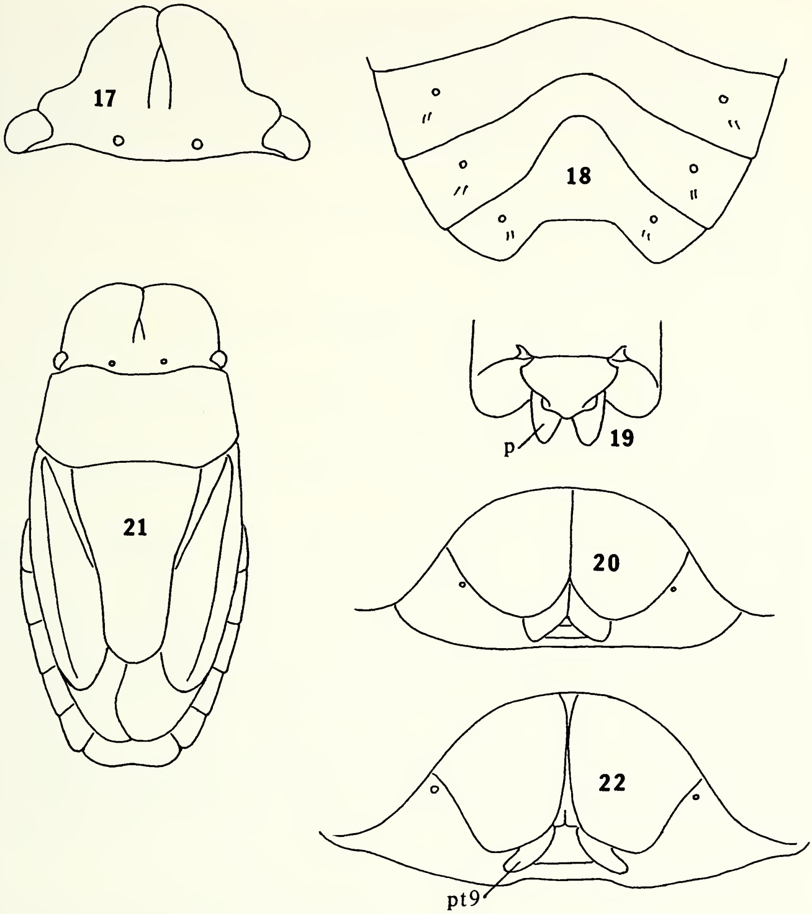
Head. Length of head 0.73 interocular width, subequal to length of pronotum. Distance between ocelli 0.32–0.35 interocular width, from each ocellus to nearest eye 0.81–0.89 distance between ocelli. Width of head across eyes 1.34–1.36 times basal width of scutellum. Lateral margins of juga strongly concave before anteocular convexity at each eye (Fig. 17). Antennae 5-segmented. Bucculae scarcely produced, widely separated posteriorly, nearly reaching base of head.

Thorax. Pronotum transversely depressed behind cicatrices. Scutellum approaching imaginary line connecting anterolateral connexival angles of penultimate abdominal segment. Costal angles of coria exceeding this line, lying over connexiva of last abdominal segment. Mesosternum moderately tumescent, neither sulcate nor carinate, impunctate; xyphus slightly concave. Metasternum weakly concave, margins adjacent to coxae thickened. Ostiolar ruga on each side extending 0.8 distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Medial length of sternite 5 in male 0.62 length of lateral margins; medial length of sternites 6+7 about 0.45 medial length of abdominal venter; anterior margins of sternites 6 and 7 arcuately produced (Fig. 18). Parameres projecting posterodorsad, curving slightly ventrad toward apex, depressed, concave ventrally, convex dorsally (Fig. 19).

Species. Monotypic.

Remarks. Becker (1977) provided a detailed redescription of the genus and type species.



Figs. 17–20. *Colpocarena complanata.* 17. Head. 18. Sternites 5–7 of male. 19. Genital cup. 20. Genital plates. 21, 22. *Tetragonotum megacephalum.* 21. Habitus. 22. Genital plates. Symbols: p, paramere; pt 9, paratergite 9.

Tetragonotum Ruckes, 1965
Figs. 21, 22

Tetragonotum Ruckes, 1965:117 (type species *Tetragonotum megacephalum* Ruckes, 1965, by original designation).

Head. Length of head 0.71 interocular width, 1.11 medial length of pronotum. Distance between ocelli 0.33 interocular width, from each ocellus to nearest eye 0.93 of distance between ocelli. Width of head across eyes about 1.29 times basal width of scutellum. Head subrectangular with broadly rounded anterolateral margins (Fig. 21). Bucculae weakly produced, diverging posteriorly, not reaching base of head.

Thorax. Scutellum not reaching imaginary line connecting anterolateral angles of penultimate connexival segments, exceeding such a line connecting preceding connexival segments. Costal angles of coria surpassing scutellar apex, lying above penultimate tergite near posterior margin. Mesosternum bilaterally tumescent, impunctate, shallowly sulcate medially. Metasternum apparently hexagonal, nearly flat. Each ostiolar ruga nearly straight, reaching about two-thirds of distance from mesial margin of ostiole to lateral margin of metapleuron; ostiole nearly at right angle to surface of metapleuron.

Abdomen. Male unknown. Paratergites 9 small, divergent (Fig. 22).

Species. Monotypic.

Remarks. Known only from holotype.

Harpogaster Kormilev, 1957
Figs. 23–25

Harpogaster Kormilev, 1957:48–50; Pirán, 1962:8–9 (type species *Harpogaster willineri* Kormilev, 1957, by original designation).

Dentocephala Ruckes, 1960:1–3 (type species *Dentocephala parva* Ruckes, 1960, by original designation) (synonymized by Pirán, 1962).

Head. Length of head 0.85 interocular width, equal to medial length of pronotum. Distance between ocelli 0.38 interocular width, from each ocellus to nearest eye subequal to distance between ocelli. Width of head across eyes subequal to basal width of scutellum. Anteocular process stout, acute (Fig. 23). Antennae 5-segmented. Bucculae weakly, uniformly produced, diverging at labium, reaching base of head.

Thorax. Scutellum approaching imaginary line connecting anterolateral connexival angles of abdominal segment 5. Costal angles of coria lying above connexiva of penultimate abdominal segment. Both mesosternum and metasternum medially sulcate; sulci impunctate; mesosternum slightly tumescent on each side of sulcus, sparingly punctate. Each ostiolar ruga curving cephalad, extending slightly more than one-half distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Anterior margin of sternite 7 in male acutely produced medially, that of sternite 6 right angular medially (Fig. 24). Medial length of sternite 5 in male 0.40 length of lateral margins; medial length of sternites 6+7 about 0.50 medial length of abdominal venter. Parameres expanded, depressed, curved ventrad apically (Fig. 25).

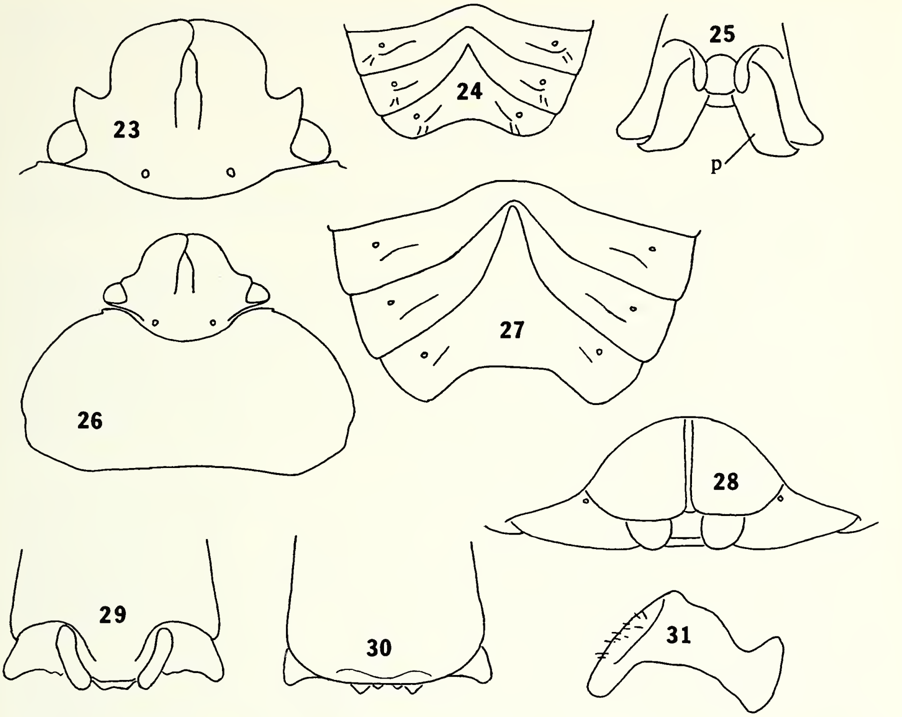
Species. Monotypic.

Remarks. The large, anteocular processes are diagnostic among the genera of 'broadheaded' discocephalines. The pygophore of the type species is peculiar in having the dorsal margin above each paramere projecting as a thin, foliate process (Fig. 25). Only the holotype of *Dentocephala parva* was examined.

Placidocoris Ruckes, 1965
Figs. 26–31

Placidocoris Ruckes, 1965:114–116 (type species *Placidocoris bivittatus* Ruckes, 1965, by original designation).

Head. Length of head 0.88–0.94 interocular width, 0.80–0.89 medial length of pronotum. Distance between ocelli 0.36–0.42 interocular width, from each ocellus to nearest eye 0.70–0.80 distance between ocelli. Width of head across eyes 0.77–



Figs. 23–25. *Harpogaster willineri.* 23. Head. 24. Sternites 5–7 of male. 25. Genital cup. 26–31. *Placidocoris bivittatus.* 26. Head and pronotum. 27. Sternites 5–7 of male. 28. Genital plates. 29. Genital cup. 30. Distal part of pygophore, ventral view. 31. Paramere. Symbols: p, paramere.

0.90 basal width of scutellum. Lateral margins of juga sinuous, strongly concave before eyes (Fig. 26). Antennae 5-segmented. Bucculae not attaining base of head, produced more strongly posteriorly than anteriorly, diverging around base of labium.

Thorax. Anterolateral margins of pronotum strongly convex from dosal view. Scutellum reaching well past imaginary line connecting anterolateral connexival angle of 5th abdominal segment. Costal angles of coria reaching beyond similar line drawn across anterolateral connexival angles of penultimate abdominal segment. Mesosternum tumescent on each side of medial sulcus which contains a few punctures. Metasternal sulcus an elongated pentagon. Ostiolar ruga on each side stoutly produced, reaching 0.6 distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Anterior margins of sternites 6 and 7 acutely produced medially in male, sternite 7 nearly dividing sternite 6 (Fig. 27); medial length of sternites 6+7 about 0.60–0.66 medial length of abdominal venter; length of sternite 5 reduced medially to 0.25–0.28 lateral length. Posterolateral pygophoral projections stubby, separated by sutures and membranes from remainder of pygophore (Figs. 29, 30). Visible part of parameres subcylindrical, inclined ventrad. Excised paramere L-shaped (Fig. 31).

Species. Monotypic.

Remarks. Placidocoris bivittatus was described from a single female, which was examined. The distal portion of the pygophore and a paramere of the previously unknown male are figured here (Figs. 29–31).

Discocephala Laporte, 1832
Figs. 32–35

Discocephala Laporte, 1832:55, 57 (type species *Discocephala marmorea* Laporte, 1832, by monotypy).

Head. Length of head 0.52–0.60 interocular width, 0.76–0.89 medial length of pronotum. Distance between ocelli 0.31–0.35 interocular width, from each ocellus to nearest eye 0.84–1.00 distance between ocelli. Width of head across eyes 1.12–1.24 time basal width of scutellum. Lateral margins of juga almost evenly arcuate, very shallowly emarginated before eyes (Fig. 32). Antennae 5-segmented. Bucculae weakly produced but well defined, slightly constricted before labium, then separating widely at labium, not reaching base of head.

Thorax. Apex of scutellum surpassing imaginary line connecting anterolateral connexival angles of penultimate abdominal segment but not reaching such a line connecting posterolateral connexival angles of same segment. Costal angles of coria reaching connexiva of last abdominal segment. Mesosternum tumescent, neither clearly sulcate nor carinate; xyphus flat. Metasternum flat or weakly concave. Ostiolar ruga on each side curving cephalad, distally truncate, reaching little more than 0.6 distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Medial length of sternite 5 in male 0.57 lateral length; medial length of sternites 6+7 about 0.56 medial length of abdominal venter; anterior margin of sternite 7 nearly right angular medially, that of sternite 6 arcuate (Fig. 33). Portion of parameres within genital cup roughly cylindrical, directed posteriorly (Fig. 34).

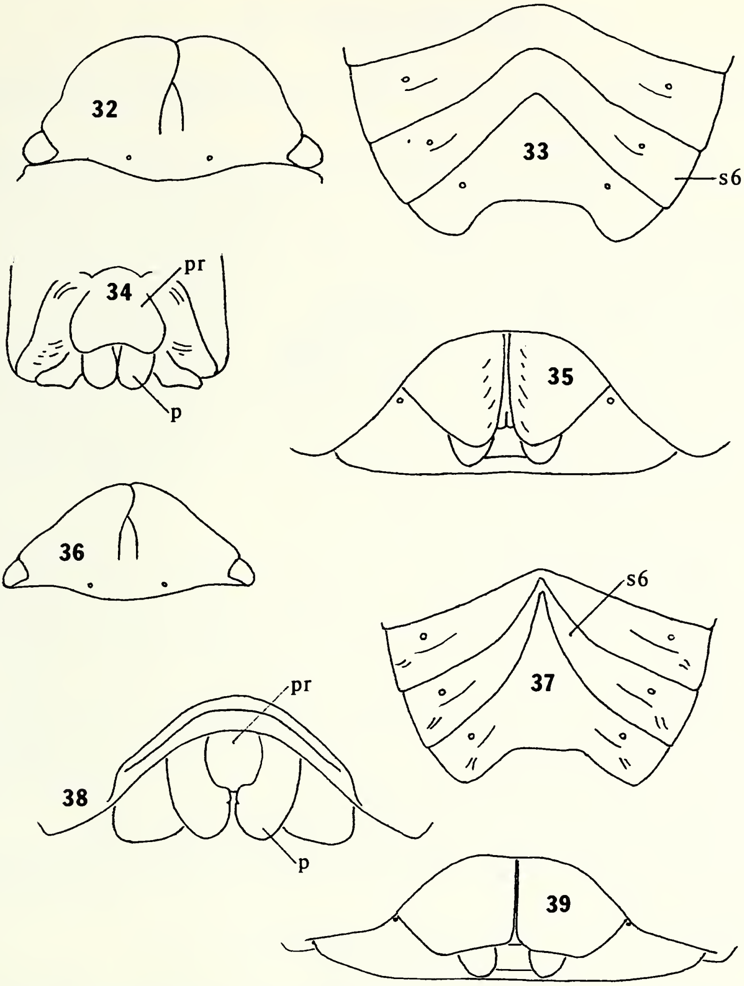
Species. deplanata Walker, 1867, *luteicornis* Walker, 1867, and *marmorea* Laporte, 1832.

Alveostethus Ruckes, 1966
Figs. 36–39

Alveostethus Ruckes, 1966:10, 31–33 (type species *Discocephala latifrons* Dallas, 1851, by original designation).

Head. Length of head 0.51–0.82 interocular width, 0.66–0.86 medial length of pronotum. Distance between ocelli 0.31–0.39 interocular width, from each ocellus to nearest eye 0.69–1.00 distance between ocelli. Width of head across eyes 0.89–1.10 basal width of scutellum. Lateral margins of head slightly sinuous (Fig. 36). Antennae 5-segmented. Bucculae scarcely developed except at base of head.

Thorax. Scutellum approaching imaginary line connecting anterolateral connexival angles of penultimate abdominal segment. Costal angles of coria reaching such a line connecting anteromedial connexival angles of last abdominal segment. Mesosternum tumescent, weakly carinate at anterior and posterior extremities, impunctate. Metasternum moderately produced, acute anteriorly, narrowly truncate posteriorly, deep medial sulcus open posteriorly, with ramus on each side between mesocoxa and metacoxa. Ostiolar ruga on each side reaching 0.6–0.7 distance from mesial limit of ostiole to lateral margin of metapleuron.



Figs. 32–35. *Discocephala* sp. 32. Head. 33. Sternites 5–7 of male. 34. Genital cup. 35. Genital plates. 36–39. *Alveostethus politus*. 36. Head. 37. Sternites 5–7 of male. 38. Genital cup and posterior margin of tergite 7. 39. Genital plates. Symbols: p, paramere; pr, proctiger; s6, sternite 6.

Abdomen. Sternite 3 (2nd visible) subtuberculate mesially. Anterior margin of both sternites 6 and 7 acute medially in male; sternite 7 nearly dividing 6, and 6 reducing medial length of 5 to 0.20–0.30 length of lateral margins (Fig. 37); length of sternites 6+7 comprise 0.60–0.68 length of abdominal venter along median. Parameres stout, somewhat depressed (Fig. 38).

Species. latifrons (Dallas, 1851), *politus* (Signoret, 1851), *pseudopolitus* (Ruckes, 1957) and *rugulosus* (Fieber, 1851)

Remarks. Ruckes (1966:32–38) keyed and redescribed the species.

Acclivilamna Ruckes, 1966
Figs. 40–46

Acclivilamna Ruckes, 1966:11, 39–49 (type species *Discocephala vicina* Signoret, 1851, by original designation).

Head. Length of head 0.67–0.70 interocular width, 0.92–1.00 median length of pronotum. Distance between ocelli 0.31–0.34 interocular width. Distance from each ocellus to nearest eye 0.94–1.00 distance between ocelli. Width of head across eyes 1.08–1.18 times basal width of scutellum. Lateral margins of juga sinuous, with at most a weak obtuse process before each eye (Fig. 40). Antennae 5-segmented. Bucculae weakly developed, diverging around labium, reaching base of head.

Thorax. Apex of scutellum on or near imaginary line connecting anterolateral connexival angles of penultimate abdominal segment. Costal angles of coria resting above connexiva of last abdominal segment. Mesosternum slightly tumid bilaterally, weakly sulcate medially; xyphus nearly flat. Metasternum with thin, strong, medial carina anteriorly and deep, fusiform sulcus posteriorly. Each ostiolar ruga curving slightly cephalad, lanceolate, apically acute, covering about 0.67 distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Medial length of sternite 5 in male about 0.18 length of lateral margins (Fig. 41); medial length of sternites 6+7 about 0.71 medial length of abdominal venter; anterior margin of each of last two sternites acutely produced. Parameres robust, cylindrical, projecting posteriorly, heavily sclerotized laterally and dorsally (Fig. 44). Spiracles on paratergites 8 concealed by basal plates (Figs. 45, 46).

Species. Monotypic.

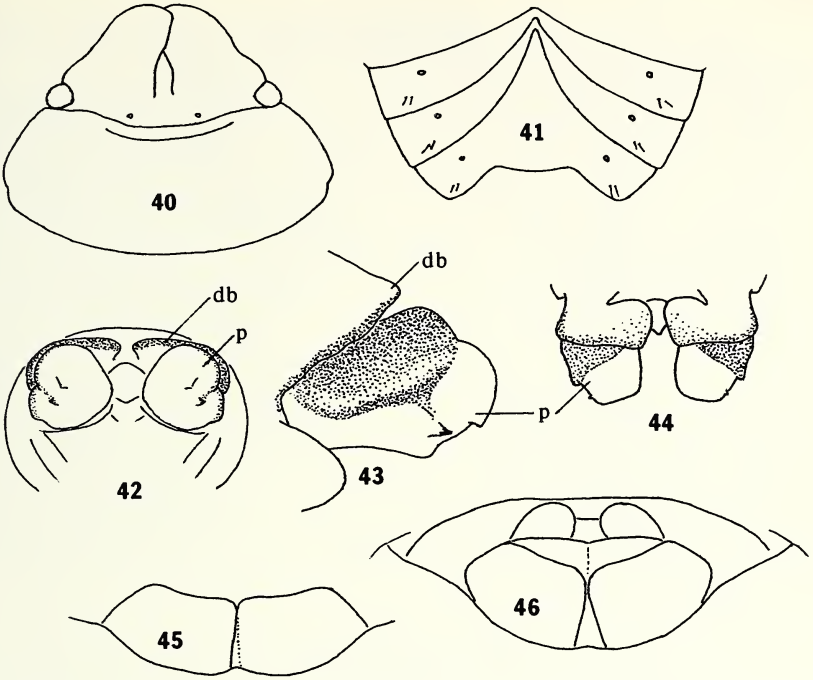
Remarks. The synonymy of the type species is as follows:

Acclivilamna vicina (Signoret, 1851).
Discocephala vicina Signoret 1851:332–333.
Discocephala caenosa Stål, 1860:15 (synonymized by Stål, 1868).
Discocephala (*Platycarenus*) *vicina*: Stål, 1868:18.
Platycarenus (*Discocephalessa*) *kormilevi* Ruckes, 1958:4–7 (synonymized by Ruckes, 1966).
Accilivilamna vicina: Rucke, 1966:40–41, figs. 5, 21, 22, 27.

I examined the type (female) of *Discocephala vicina* Signoret, which is in the Naturhistorisches Museum Wien under the synonym *Platycarenus vicina,* the type (male) of *Discocephala caenosa* Stål, which is in the Naturhistoriska Riksmuseet, the holotype (male) and allotype of *Platycarenus kormilevi* Ruckes, which are in the American Museum of Natural History. All of these specimens apparently are examples of a single species.

The outline of the lateral margin of the head, pronotum and base of the hemelytron of *A. vicina* published by Ruckes (1966, fig. 27) was probably drawn from the holotype of *P. kormilevi.* It is misleading in that the anteocular convexity is exaggerated as a small process. It does appear, however, that the species is sexually dimorphic with a more pronounced sinuosity of the jugal margins in the male than in the female.

The genital plates distad of the basal plates in the type of *D. vicina* are displaced and partially obscured by the protrusion of a curved, cylindrical structure presumed to be the anal tube. The basal plates are outlined in Figure 45. In the allotype of *P.*



Figs. 40–44. *Acclivilamna* (*Discocephala caenosa,* type). 40. Head and pronotum. 41. Sternites 5–7 of male. 42. Pygophore, caudal view. 43. Distal part of pygophore, lateral view. 44. Same, ventral view. 45. Basal plates (*Discocephala vicina,* type). 46. Genital plates (*Platycarenus kormilevi,* allotype). Symbols: db, dorsal border; p, paramere; pr, proctiger.

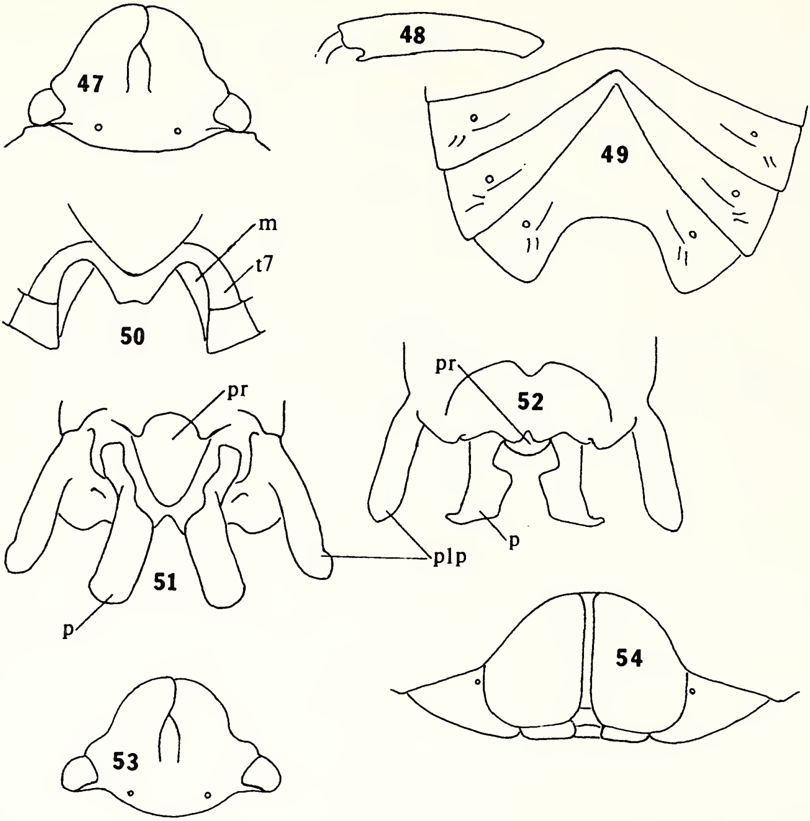
kormilevi the genital plates appear to be positioned normally except that both basal plates are rotated (Fig. 46).

Uncicrus Ruckes, 1966
Figs. 47–52

Uncicrus Ruckes, 1966:10, 26–27 (type species *Discocephala kollarii* Fieber, 1851, by original designation).

Head. Length of head 0.95 interocular width, 0.84 medial length of pronotum. Distance between ocelli 0.48 interocular width, from each ocellus to nearest eye 0.48 distance between ocelli. Width of head across eyes 0.87 basal width of scutellum. Jugal margins moderately concave before eyes (Fig. 45). Antennae 5-segmented. Bucculae moderately and uniformly produced, diverging posteriorly, not attaining base of head.

Thorax. Scutellum approaching imaginary line connecting anterolateral connexival angles of last abdominal segment. Costal angles of coria extending little past apex of scutellum. Mesosternum sulcate medially, with a few punctures in sulcus; xyphus carinate medially. Metasternum weakly sulcate medially. Ostiolar ruga on each side



Figs. 47–52. *Uncicrus kollarii.* 47. Head. 48. Hind femur. 49. Sternites 5–7 of male. 50. Tergite 7. 51. Genital cup. 52. Distal part of pygophore, ventral view. 53, 54. *Allinocoris nubila.* 53. Head. 54. Genital plates. Symbols: m, membrane; p, paramere; plp, posterolateral pygophoral projection; pr, proctiger; s, scutellum; t7, tergite 7.

extending 0.6 distance from mesial limit of ostiole to lateral margin of metapleuron. Hind femora of male each armed subapically with large hook on inferior surface (Fig. 48); this projection reduced in female (sec Ruckes, 1966).

Abdomen. Anterior margins of sternites 6 and 7 acutely produced medially in male (Fig. 49); medial length of both combined about 0.60 medial length of abdominal venter; medial length of sternite 5 about 0.25 lateral length. Posterior margin of tergite 7 in male deeply emarginate with large, medial projection (Fig. 50). Posterolateral pygophoral projections separated from remainder of pygophore by sutures and membranes (Figs. 51, 52). Parameres expanded, depressed and curved ventrally toward apices.

Species. Monotypic.

Remarks. The form of the posterior margin of tergite 7 in the male and the femoral armament are unique among the 'broadheaded' discocephalines. Tergite 7 is like that of *Antiteuchus,* one of the most common 'longheaded' discocephalines.

A single male of this genus was examined.

Table 1. Comparison of *U. kollarii* and *A. nubilus.*

Criterion	*kollarii*	*nubilus*
Length of head : interocular width	0.95	0.93
Length of head : medial length of pronotum	0.84	0.87
Length of head : width of head	0.64	0.62
Width of head : basal width of scutellum	0.87	0.94
Distance between ocelli : interocular width	0.48	0.49
Distance from ocellus to eye : distance between ocelli	0.48	0.48
Medial length of pronotum : pronotal width	0.42	0.42
Basal width scutellum : scutellar length	0.73	0.77
Length (mm) antennal segment 1	0.55	0.50
Length (mm) antennal segment 2	0.90	0.80
Length (mm) antennal segment 3	1.20	1.15
Length (mm) antennal segment 4	1.30	1.25
Length (mm) antennal segment 5	1.30	1.30
Length (mm) rostral segment 1	0.9	0.8
Length (mm) rostral segment 2	2.1	1.7
Length (mm) rostral segment 3	0.9	1.0
Length (mm) rostral segment 4	0.8	—

Allinocoris Ruckes, 1966
Figs. 53, 54

Allinocoris Ruckes, 1966:10, 29 (type species *Discocephala nubila* Dallas, 1851, by original designation).

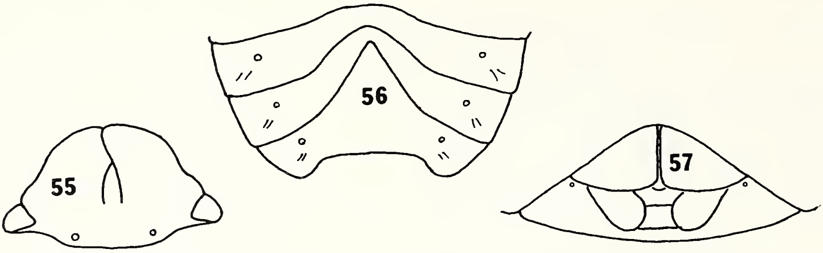
Head. Length of head 0.93 interocular width, 0.87 medial length of pronotum. Distance between ocelli 0.49 interocular width, from each ocellus to nearest eye 0.48 distance between ocelli. Width of head across eyes 0.94 basal width of scutellum. Lateral margins of head rather strongly concave before eyes (Fig. 53). Antennae 5-segmented. Bucculae weakly produced, strongly divergent at labium, reaching base of head.

Thorax. Scutellum apparently reaching slightly beyond imaginary line connecting anterolateral connexival angles of penultimate abdominal segment (see remarks below). Costal angles of coria surpassing scutellum. Mesosternum moderately tumescent with broad, shallow, sparsely punctate sulcus medially; xyphus flat, weakly carinate. Metasternum flat, weakly carinate medially. Ostiolar ruga on each side reaching one-half distance from mesial limit of ostiole to lateral margin of metapleuron.

Species. Monotypic.

Remarks. The genus and species are known only from the female holotype. The thorax and abdomen of this specimen were forced apart in pinning, so the relationship between the scutellum and abdomen can only be estimated. The specimen is in such poor condition that remounting to reunite the thorax and abdomen would be very risky.

Ruckes (1966:31) placed *Allinocoris* near *Uncicrus* because the pronotum, mesosternum, metasternum and rostrum of the type species of the two monotypic genera are similar. The similarity extends further (Table 1). From available specimens, the characters separating *Allinocoris* from *Uncicrus* are the absence of an anteapical



Figs. 55–57. *Lineostethus marginellus.* 55. Head. 56. Sternites 5–7 of male. 57. Genital plates.

process on each hind femur and the broadly rounded scutellar apex of *Allinocoris,* which in *Uncicrus* has the shape of a Gothic arch.

Lineostethus Ruckes, 1966
Figs. 55–57

Lineostethus Ruckes, 1966:10, 10–27; Hildebrand and Becker, 1982:774–775 (type species *Discocephala clypeatus* Stål, 1962, by original designation).

Head. Length of head 0.67–0.84 interocular width, 0.80–1.05 length of pronotum. Distance between ocelli 0.40–0.46 interocular width, from each ocellus to nearest eye 0.42–0.65 distance between ocelli. Width of head across eyes 1.03–1.20 times basal width of scutellum. Margins of head before eyes almost evenly arcuate (Fig. 55). Antennae 5-segmented. Bucculae scarcely produced anteriorly, more so posteriorly, diverging at labium, reaching base of head.

Thorax. Apex of scutellum reaching imaginary line connecting anterolateral connexival angle of penultimate abdominal segment. Costal angles of coria reaching such a line connecting anterolateral connexival angles of last abdominal segment. Mesosternum sulcate medially, moderately tumescent on each side; sulcus impunctate; xyphus weakly carinate. Metasternum flat with weak medial carina. Ostiolar ruga on each side reaching 0.7–0.8 distance from mesial limit of ostiole to lateral margin of metapleuron.

Abdomen. Anterior margin of sternite 7 in male produced and narrowly rounded medially, that of sternite 6 broadly rounded (Fig. 56). Medial length of sternite 5 in male 0.28–0.40 lateral length; medial length of sternites 6+7 combined 0.56–0.60 medial length of abdominal venter. Spiracles on paratergites 8 exposed or covered according to species (Fig. 57).

Species. clypeatus (Stål, 1862), *graziae* Hildebrand and Becker, 1982, *marginellus* (Stål, 1872) and *tenebricornis* (Ruckes, 1957).

Remarks. Hildebrand and Becker (1982) revised the genus, paying particular attention to the genitalia in describing or redescribing the species.

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THE IDENTITY OF A "LOST SPECIES": *CERMA GALVA* STRECKER, 1898 (LEPIDOPTERA, NOCTUIDAE)

Morton S. Adams[1] and Timothy L. McCabe[2]

[1] HCO Box 74, West Shokan, New York 12494, and
[2] New York State Museum, Albany, New York 12230

Abstract.—*Cryphia galva* (Strecker) 1898, described from Clyde, New York, is identified as a Colorado species, *Cryphia olivacea* Smith, 1891, NEW SYNONYM. The adult moths and dissections of the male and female genitalia are illustrated.

Cerma galva Strecker was described from a unique male specimen, the holotype (Fig. 1), deposited in the Field Museum, Chicago, Illinois. The specimen bears a label attributing it to W. L. Devereaux, Clyde, New York. Little further is known of this moth. Forbes (1926) was of the opinion that it was "a lost species, most likely not from N.Y." In recent years extensive collecting in Wayne and surrounding counties (Adams, Franclemont, Chapman, pers. comm.) has also failed to discover the species.

It has been possible to trace and visit the type locality. Devereaux's granddaughter resides on the farm and shared a series of letters between Herman Strecker, Berks County, Pennsylvania and Devereaux. The Strecker-Devereaux correspondence for the most part consists of lists, including rough sketches of moths sent by Devereaux to Strecker for determination. The letters from Strecker date from 1876. No mention is made of *Cerma galva,* nor for that matter of the other two species Strecker described from Clyde, New York in 1898 (*Agrotis azif,* synonym of *Euxoa detersa* form *personata* Grote and *Hadena lona,* a synonym of *Apamea indocilis* Walker). Likewise, Devereaux made no acknowledgement of Strecker's determinations in his published list (Devereaux 1879).

Cerma galva was recognized by Forbes (1954) as ". . . a *Bryophila,* and almost certainly the European *B. muralis. . . .*" In the most recent American check list (Franclemont and Todd, 1983) *Bryophila* is a synonym of *Cryphia* Hübner. This genus is represented by several species in the western United States and across Eurasia. However, no species are known from east of the Great Plains in the United States. All the known host records of the genus have been on lichens (Franclemont, pers. comm.).

The synonymy was recognized when examining specimens of *Cryphia olivacea* Smith (Fig. 2) collected by one of the authors (TLM) from Estes Park, Colorado, elevation 9,000 ft. The synonymy was confirmed by comparison with a dissection of the lectotype of *C. olivacea* in the United States National Museum of Natural History through the courtesy of Robert Poole. The dissection of the holotype of *C. galva* (Fig. 3) was damaged in preparation, however dissection of a series of males from the Estes Park population demonstrated that both types were within the normal range of variation for the species. Dissections of both sexes from Estes Park are illustrated (Figs. 4–6).

Figs. 1–6. *Cryphia* species: 1) *Cerma galva* Strecker, 1898. Holotype. Photograph Eric Metzler; 2) *Cryphia olivacea* Smith, Estes Park, Colorado. Collection and photograph TLM; 3) *Cerma galva* Strecker, 1898. Holotype. Genitalia dissection A. E. Brower, photograph J. G. Franclemont; 4) *Cryphia olivacea* Smith, male genitalia, aedoeagus removed, Estes Park, Colorado. Dissection and photograph TLM; 5) *Cryphia olivacea* Smith, 1891. Female genitalia dissection and photograph TLM; 6) *Cryphia olivacea* Smith, aedoeagus, same data.

It is probable that the confusion surrounding the identity of *C. galva* arose when Strecker mislabelled material received from Colorado. In 1898 he also described material received from Glenwood Springs, Colorado, elevation 6,000 ft. Barnes and McDunnough (1916) illustrate *C. olivacea* from the latter locality. The species is also illustrated in Hampson (1908).

Catalogue listing should appear as follows:

Cryphia olivacea (Smith)
(Figs. 1–6)

Cerma olivacea Smith, 1891:103. Dyar, 1902:106. Smith, 1893; Hampson, 1908: 653. Barnes and McDunnough, 1916:165. McDunnough, 1938:93. Todd, 1982: 159.

Type locality: USA: Colorado, male Type No. 71 [USNM, Washington].
Genitalia preparation, USNM 43,238.

Cryphia olivacea; Franclemont and Todd, 1983:136.

Cerma galva Strecker, 1898:5. NEW SYNONYMY. Smith, 1893. Dyar, 1902:106. Forbes, 1926:644. McDunnough, 1938:93. Forbes, 1954:250.

Type locality: USA: Clyde, New York, male. [Field Museum, Chicago].
Genitalia preparation, A. E. Brower No. 3; 24-I-68.

Cryphia galva; Franclemont and Todd, 1983:136.

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REVISION OF THE *NYSTALEA AEQUIPARS* WALKER SPECIES COMPLEX WITH NOTES ON NYSTALEINE GENITALIA (LEPIDOPTERA: NOTODONTIDAE)

S. J. Weller

Department of Zoology, University of Texas at Austin,
Austin, Texas 78712

Abstract.—The genus *Proelymiotis* Schaus is placed in synonymy with *Nystalea* Guenée. The *N. aequipars* species complex is defined, and contains four species. Two new species, *N. corniculans* and *N. montana* are described. Diagnoses and illustrations are provided for all species in the *aequipars* complex. A brief description of nystaleine genitalic and prothoracic leg structures is also provided.

The genus *Nystalea* Guenée (1852) (Lepidoptera: Noctuoidea: Notodontidae) is comprised of medium to large-sized moths, and contains forty-two species (Weller, unpubl.). Representatives of this genus are found as far north as Florida (*N. indiana* Grote) and southern Texas (*N. collaris* [Schaus]) and as far south as Argentina (*N. nyseus* [Cramer]). Larvae have been reared on from the following plant families: Myrtaceae, Anacardiaceae, Sapindaceae and Guttiferae (Todd, 1973; specimen label data), but preserved larval material and descriptions are lacking. Almost nothing is known about the adult biology.

My systematic work on the higher classification of the tribe Nystaleini reveals that the type species of the genus *Proelymiotis* Schaus, *P. aequipars* Walker, shares derived genitalic characters with the genus *Nystalea,* and lacks derived features that would support recognition as a separate genus. Therefore, I place *Proelymiotis* as a synonym of *Nystalea.* I describe the general, genitalic characteristics of the Nystaleini (Forbes, 1935, 1948; Weller, 1989), and the derived genitalic characters of *Nystalea* to justify this synonymy. The *N. aequipars* species complex is diagnosed, two new species belonging to this complex are described, and male and female genitalia of *N. aequipars* and related species are illustrated.

METHODS

I removed abdomens from museum specimens and placed them in hot 10% KOH (potash). These were then cleaned in several rinses of 40% ethanol. I stained preparations with either chlorozol black (Kodak or ICN) dissolved in 20% ethanol, or with chlorozol black followed by saffranin dissolved in 95% ethanol. Stained preparations were positioned, dehydrated, and mounted in either euparol (BMNH specimens) or balsam (all other specimens). Antennae, palps and legs were treated similarly except they were not stained before mounting. Wings were bleached and then stained overnight with eosin Y before mounting. Terminology follows Forbes (1948), Sibatani et al. (1954), and Klots (1970). I define new terminology below.

Label data is given exactly as it appears on specimens. Comments, dissection numbers and collections are included in brackets. Abbreviations for type repositories and collections consulted are: AMNH, American Museum of Natural History; BMNH, British Museum (Natural History); CAS, California Academy of Sciences; CMNH, Carnegie Museum of Natural History; CNC, Canadian National Collections of insects, arachnids and nematodes; CRNM, Costa Rican Museum of Natural History; LACM, Los Angeles County Museum, California; DJ, D. Janzen, private collection, Pennsylvania; NMNH, National Museum of Natural History; SJW, S. J. Weller, private collection, Texas; VOB, V. O. Becker, private collection, Brasilia, Brazil; ZMHB, Zoologisches Museum an der Humboldt–Universitat zu Berlin.

GENITALIC AND PROTHORACIC LEG MORPHOLOGY OF *NYSTALEA* AND RELATED GENERA

Male prothoracic leg

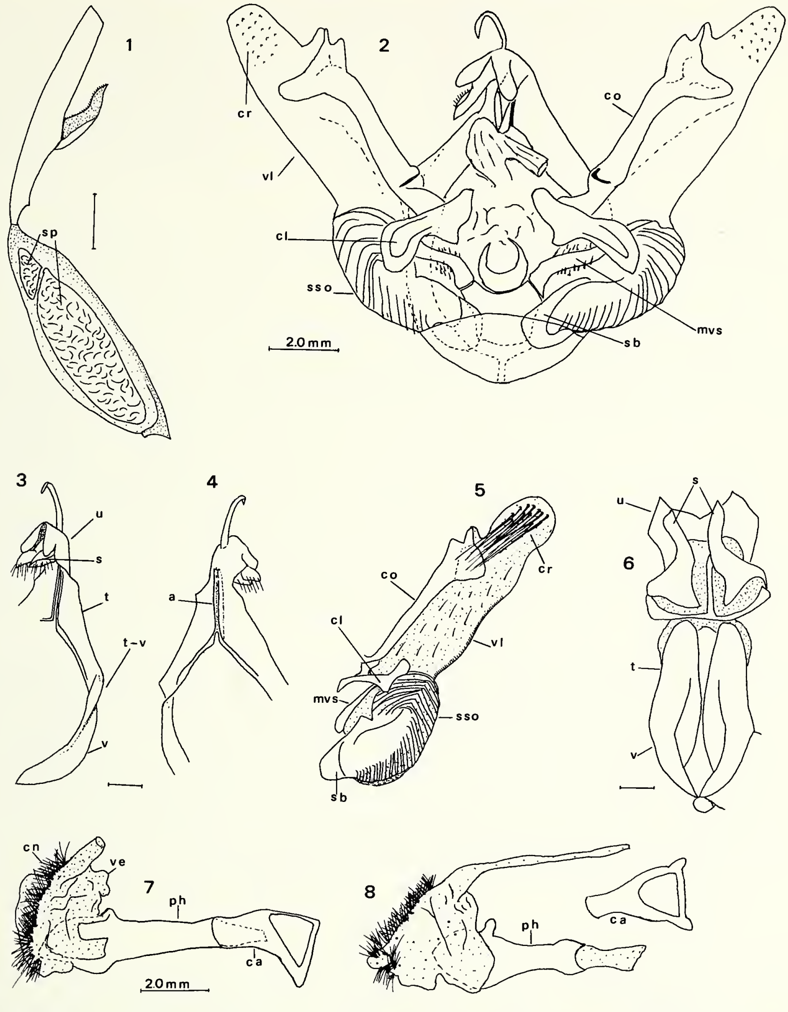
In many nystaleines, the males possess a prothoracic femur and tibia that are modified for pheromone production and dissemination. The lateral, anterior surface of the femur has one (*Calledema* Butler, *Bardaxima* Walker) or two (*Nystalea*) elliptical areas of thin, slightly invaginated membrane covered with wooly hairs and surrounded by flat, square-tipped scales with widely spaced lamellae (Fig. 1). Longer hairs overlay this area, and a cluster of long, stiff hairs occurs on the prothoracic tibia. This structure is analogous to the male mesothoracic leg pheromone emitting organ in the Noctuidae. Presumably, the femoral membranous areas produce short-range pheromones that are distributed by the tibial scent pencil during male courtship. I refer to these prothoracic leg structures as *scent pockets.*

Genitalia

Little descriptive morphology of notodontid genitalia is available in the literature (Forbes, 1948; Barth, 1955; Holloway, 1983). New terminology is defined here for structures in *Nystalea* and related genera. This information is extracted from a larger study of neotropical notodontids (Weller, unpubl.).

Male genitalia. Tegumen, vinculum and sociuncus (Sibatani, 1972) (Figs. 2–4, 6). The region of the vinculum homologous to the noctuid saccus, is nearly fused and a sclerotized, caudal extension covers the base of the sacculus. The tegumen-vinculum connection in many neotropical notodontids is fused in an S-shaped configuration (Figs. 3, 4) that differs from the C-shaped fusion found in the European genus *Pheosia* Huebner (Fig. 6). The uncus base is fused to the tegumen in *Nystalea,* and a pair of apodemes or sclerotized thickenings extend from the tegumen into the uncal base (Figs. 3, 4). These apodemes are present in several nystaleine genera (i.e., *Tachuda* Schaus, *Strophocerus* Moeschler), but unfused connections between the tegumen and uncus occur in other nystaleine genera (i.e., *Bardaxima*). The tegumen-uncal fusion also may be variable within a genus (i.e., *Calledema*). In *Nystalea,* the shape of the uncus is unique: the base projects ventrally in two, sclerotized lobes and a slender, curved, often membranous uncal process extends dorsally (Figs. 2–4). Socii are present in most notodontids. In *Nystalea,* the socii are sclerotized and articulating.

Valve (Figs. 2, 5). The sacculus of nystaleines is composed of a sclerotized, inner area with membranous pleats. The sclerotized area provides sites for muscle attachment and either fuses or articulates with the juxta (sacculus base; sb). Long scales similar to androconia of other moths arise from the base of the sacculus. Barth (1955)



Figs. 1–8. Scale equals 1.0 cm unless otherwise indicated. 1. Scent pocket (sp) located on male prothoracic femur of *Nystalea* sp. 2. Male genitalia of *N. aequipars* (1732 BMNH); cl = costula, co = costa, cr = corona-like structure, mvs = midvalve sclerotization, sb = sacculus sclerotized base, sso = saccular scent organ, vl = valvula. 3. Caudal view of tegumen, vinculum and sociuncus of *Nystalea virgula* (1383 BMNH), valve removed; s = socii, t = tegumen, t–v = area of tegumen–vinculum fusion, u = uncus, v = vinculum. 4. Cephalic view of same showing apodemes present at tegumen–uncus fusion. 5. Left valve of same. 6. Caudal view of tegumen, vinculum and sociuncus of *Pheosia tremula* (1287 BMNH). 7. Aedeagus of *N. aequipars* with callosum; ca = callosum, cn = cornuti, ph = phallus, ve = vesica. 8. Aedeagus of *N. similis* (SJW507 CNC) with callosum removed.

demonstrated that a gland is located within the sacculus of *Hemiceras proximata* Dognin. The hemiceratine sacculus is homologous to the nystaleine. Presumably, pheromones are produced and distributed by this modified sacculus. I will refer to this structure as the *saccular scent organ.* The size of the nystaleine saccular scent organ varies within and between genera. The dorsal edge of the sacculus is defined by a strip of sclerotization extending to the anellus and fuses with the juxta in many species. This *midvalve sclerotization* (mvs) effectively separates the saccular and costal compartments.

In *Nystalea,* the dorsal edge of the costa (co) consists of a sclerotized rod that extends two-thirds the length of the valve and widens into a characteristic shape. Beyond this widening, the distal portion is membranous with short setae and stiff hairs arranged like a noctuid corona (Forbes, 1954). The notodontid and noctuid structures are not necessarily homologous, and I will refer to the notodontid structure as *corona-like* (cr). From the base of the dorsal edge of the costa, a sclerotized process extends into the anellus where muscle attachments occur. Presumably, these structures, in conjunction with the sociuncus and costa, provide traction *in copula.* Forbes (1948) suggests that these notodontid processes may be homologous with structures in the genera *Himera* Duponchel and *Nacophora* Hulst (Geometridae) and with the hairy pads of the family Thyatiridae. From limited observations, the processes in these three families do not appear to be homologous. I will refer to the notodontid structure as the *costula* (cl) (Latin: little rib) rather than "costal process" to distinguish it from the costal process of the sacculus (Forbes, 1954). Costular shape is usually species-specific.

Between the sclerotized, costal rod and the midvalve sclerotization, a membranous area exists with scattered setae or with defined patches of setae and hairs. This consistently well-defined area in nystaleine genitalia appears to be homologous with the "valvula" of Pierce (1914). Pierce (1914) originally applied the term to the central, lightly sclerotized area between the sclerotized costa and sacculus of a geometrid valve. Sibatani et al. (1954) restrict the term to the "ventro-apical region" of the valve, however, consistent and homologous application of an apical-basal division of the male valve seems unlikely. I follow Pierce (1914) in applying the term valvula (vl) to the midarea between the sclerotized costa and sacculus as defined by the midvalve sclerotization.

Anellar region. The anal tube is usually weakly sclerotized ventrally. Ventral to the costula, scattered setae occur in the region of the manica, and the juxta is sclerotized and slightly to extremely concave in most nystaleines.

Aedeagus (Figs. 7, 8). The vesica (=endophallus, Klots, 1970) tends to be bulbous terminating in a narrow tube that is directed cephalad rather than caudad. Deciduous cornuti are present in many notodontid genera (Forbes, 1948; Holloway, 1983), and these may vary in size or shape. The base of the aedeagus in *Nystalea* and related genera is surrounded by a separate, tube-like sclerotization that has large muscles attached to it dorsally and ventrally. The tube-like sclerotization is fused to the manica and detaches from the phallus proper at this point of fusion. I will use the term *callosum* (Latin: hard skin) to refer to this extra sclerotization encircling the base of the aedeagus. The presence of a callosum (ca) is a derived condition and defines a large group of genera corresponding in part to the Nystaleini of Forbes (1948) (Weller, 1989).

Male eighth sclerites (Fig. 9). The shape of the male eighth sternite is often species-specific in the Notodontidae (Forbes, 1948; Holloway, 1983). In *Nystalea,* the eighth tergite has a characteristic pattern of sclerotization with a midplate defined by a less melanized area that extends to the cephalic edge. Muscles attach to the edge of the sclerotized midplate which can be seen in partially digested preparations.

Female genitalia. Ovipositer and eighth sclerites (Figs. 9–11). The papillae anales of *Nystalea* and related genera are usually covered with short, scattered setae with longer, inwardly curved setae arising from the base. The papillae anales may be membranous, lightly sclerotized or extremely sclerotized depending on the species. The posterior apophyses are usually long and slender. The shape of the eighth tergite and sternite may vary within as well as between genera. Some species in *Nystalea* possess lateral processes on their sternal margins (i.e., *N. ebalea,* and *N. aequipars* species complex), others possess lateral processes on the lamellae antevaginalis (i.e., *N. marmorea* Schaus), and others possess both (i.e., *N. corrusca* Schaus). In *Nystalea* and some other nystaleines, the ostium bursae is very wide, extending nearly the entire width of the eighth sternite.

Other structures (Fig. 10). In the Nystaleini, the ductus bursae may be membranous, partially or completely sclerotized. In *Nystalea,* females have a sclerotized ductus bursae which, in some, is also dorso-ventrally flattened (e.g., *N. aequipars* and *N. virgula* Felder). In these species, the flattened edges of the ductus bursae are membranous which allows the ductus bursa to expand into a rounded tube when a hypodermic needle is inserted. The ductus seminalis arises from the left, caudal area of the corpus bursae near the ductus bursae. The corpus bursae may or may not be partially sclerotized. Single or multiple signa are present and their shape may be species-specific. The dorso-ventrally flattened ductus bursae occurs in several nystaleine genera.

Notodontid female genitalia tend to have greater morphological variety within genera than is usually found in the Noctuoidea (Franclemont, pers. comm.). It is not uncommon for female genitalia to exhibit species-specific characters in neotropical notodontids. Closely related species (i.e., *N. aequipars* species complex), however, have nearly identical female genitalia.

Nystalea Guenée

Nystalea Guenée, 1852:122 (Type species: *Nystalea conchyfera* Guenée, 1852:122, plate 9, fig. 2 [a junior subjective synonym of *Phalaena Noctua ebalea* Cramer, 1780:310, fig. C], by subsequent designation Kirby, 1892:618, see *Taxonomic note*).

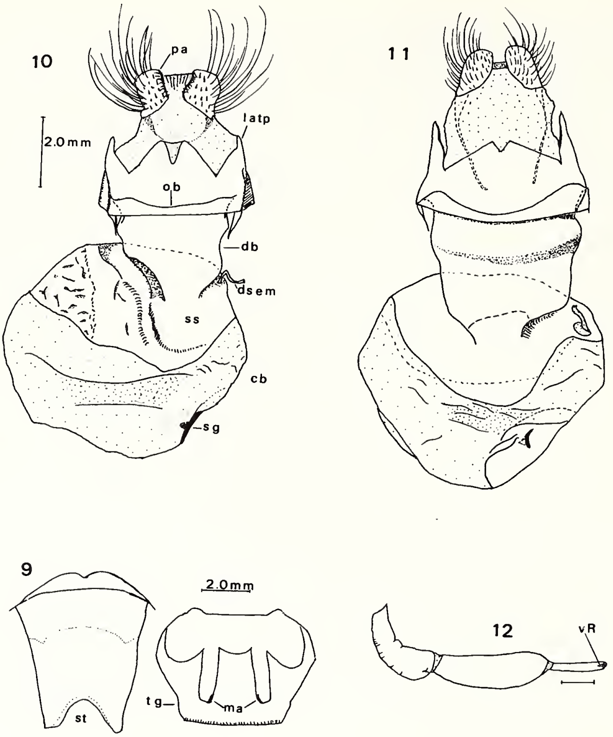
Cyrrhesta Walker, 1857:633 (Type species: *Phalaena Noctua nyseus* Cramer, 1775: 119, pl. 75, fig. E, by monotypy, see *Taxonomic note*).

Eunystalea Grote, 1895:7 (Type species: *Nystalea indiana* Grote, 1884:7, by original designation).

Congruia Dyar, 1908:45 (Type species: *Congruia congrua* Dyar, 1908:45, by original designation).

Proelymiotis Schaus, 1901:273 (Type species: *Nystalea aequipars* Walker, 1858:1742, by original designation). **New Synonym** (see *Synonymical Note*).

Diagnosis. The well-developed corona-like structure of the costa and paddle-like uncus of male genitalia are derived character states of this genus.



Figs. 9–12. Scale equals 1.0 cm unless otherwise indicated. 9. Male eighth sternite and tergite of *N. aequipars,* ma = muscle attachment points, st = sternite, tg = tergite. 10. Female genitalia of *N. aequipars*; cb = corpus bursae, db = ductus bursae, dsem = ductus seminalis, latp = lateral prominences on eighth sternite, ob = ostium bursae, pa = papillae anales, sg = signum, ss = sclerotized shield. 11. Female genitalia of *N. corniculans* (SJW632 CMNH). 12. Male labial palp of *N. aequipars*; vR = vom Raths organ.

Description. Head: antennae short bipectinate or ciliate in males, short ciliate or with scattered short setae in females; antennal scape with long tuft of scales; labial palp as in Figure 12; maxillary palp two-segmented and proboscis well-developed in both sexes. Thorax: male prothoracic femur with scent pocket; prothoracic tibia with compact brush of scales; fifth tarsomere with 4 or more long setae emanating from distal edge; metathoracic leg with long hairs in males. Abdomen: males lacking abdominal scent organs. Forewings: male from 4.1 cm (*Nystalea* undescribed sp., Cuba) to 7.0 cm (*N. lineiplena* Walker, *N. corrusca*). Male genitalia-slender, paddle-like uncus with base divided and sclerotized; socii sclerotized and projecting from underneath base; costa sclerotized for three-quarters of its length, distal fourth membranous and forming a corona-like structure; costula present; saccular scent organ present; juxta shape characteristic (Fig. 2), abutting aedeagus but not fused to it; aedeagus with callosum; vesica with deciduous cornuti, except *N. ebalea* with spines. Female genitalia: eighth sternite usually with a pair of lateral projections; ductus bursae sclerotized and sometimes dorso-ventrally flattened; corpus bursae sometimes sclerotized where ductus bursae joins and surrounding area, one or two signa present; ductus seminalis from dorsal, caudal area of corpus bursae.

Taxonomic note. In the *Uitlandsche Kapellen* (or *Papillons exot.*) by Cramer and Stoll, some species are not described with a genus, rather "Phal. Noct." is given after the specific name. Subsequent workers assumed that "Phal." was an abbreviation for "Phalaena" and "Noct." for "Noctua," and to be consistent with the Code, omitted one of the two generic names from the original combination. I report the original combination here because the omission is not standardized in the older literature. For example, references to both *Noctua ebalea* and *Phalaena ebalea* are found.

Synonymical note. Schaus (1901) defined the genus *Proelymiotis* based on forewing venation. Forbes (1939) questioned the validity of *Proelymiotis* as a distinct genus from *Nystalea.* Forewing venation varies within the genus *Nystalea* as defined by the male genitalic characters (Weller, 1989). *Proelymiotis aequipars* shares the derived genitalic characters of *Nystalea,* and lacks any derived features that would support its recognition as a separate genus. Thus, I place *Proelymiotis* as a junior subjective synonym of *Nystalea.*

N. aequipars species complex

Diagnosis. All species of complex neotropical with contrasting forewing coloration of basal two-thirds of forewing dark and outer third light (Figs. 20, 21).

Description. Head: male and female antennae ciliate. Thorax: dorsum various shades of cinnamon brown; ventrum grey or cream-colored. Abdomen: small tuft of scales on second abdominal tergite; dorsal surface light to dark cinnamon brown; ventral surface pale cream, sometimes with dark brown, longitudinal stripe on the midline. Forewing coloration: basal two-thirds light or dark brown; outer half either: greyish white with grey and brown mottling, pale ochre with brown or black mottling, or pale ochre with greenish hue; between the subterminal and adterminal lines, a series of dark, triangular spots. Hindwing: basal one-fourth to three-fourths white or yellow, outer part dark brown or fuscous; fringe white with brown, brown with white or pale ochre with brown markings; dorsum of veins dark brown or white. Venation as in Figure 13.

Remarks. Contrasting forewing coloration also occurs in the old world species of *Chadisra* Walker, but the male and female genitalia are completely different from *Nystalea.* The figure in Draudt (1932) labelled "*aequipars*" (pl. 144, g3) is the ochre forewing morph and the one labelled "*similis*" (pl. 144, g4) is the white forewing morph. Both are present in *N. aequipars* and *N. montana,* n. sp., and only the white forewing morph occurs in *N. corniculans,* n. sp. and *N. similis.* Hindwing color variation is discussed for each species below.

Nystalea aequipars Walker

Nystalea aequipars Walker, 1858:1742. Holotype male. Brazil.
Nystalea divisa Moeschler, 1882:44, plate 18, fig. 32. Holotype female. Surinam.
Heterocampa seminivea Walker, 1869:17. Holotype female. [Colombia] Limas.

Diagnosis. Males possess a paddle-like costula (Fig. 14).

Description. Forewing: male 4.7 to 6.0 cm (N = 15; $\bar{x} = 5.3$), female 5.0 to 6.7 cm (N = 8; $\bar{x} = 5.9$); both white and ochre forewing morph occur in this species. Hindwing: males with basal third to half white, outer part fuscous; females with basal fourth to third white, outer part fuscous; all three types of fringe coloration occurs. Male genitalia: Figure 22, gen. prep. 1736 (BMNH); the paddle-like uncus may be long and curved to extremely shortened as in a Mexican specimen (NMNH 43,167). The paddle-like costula is occasionally rounder distally with a definite "neck" (Fig. 15). Female genitalia: Figures 10, 28, gen. prep. 43,507 (NMNH).

Remarks. Schaus (1901) placed *N. divisa* and *H. seminivea* as synonyms of *P. aequipars.* The holotypes of *P. aequipars, H. seminivea* and *N. divisa* are the white forewing morph. Both *H. seminivea* and *N. divisa* are females. I have not dissected *P. aequipars* or *H. seminivea,* but I have examined the genitalic preparation *N. divisa.* Female genitalia are not obviously species-specific in this complex with the exception of *N. corniculans,* n. sp. Both type specimens occur within the range of *N. aequipars,* and the Schaus (1901) synonymy is not changed.

The costula variation may be an occasional developmental aberration. It appears in two specimens from Corcovado, Costa Rica and two specimens from Muzo, Columbia. These moths have darker hindwings with yellow scales compared to other specimens from the same locality with the paddle-like process. There is one specimen from Santa Rosa, Costa Rica that has one normal and one rounded costula, but it is has a normal, white hindwing. Without reared material, it is not possible to know whether the dark hind wing, rounded costula specimens represent population variation within *N. aequipars* or represent a distinct species.

Biology. A crude drawing of a caterpillar showing a modified anal segment was found under a specimen at the BMNH with the host given as *Clusia* sp. (Guttiferae).

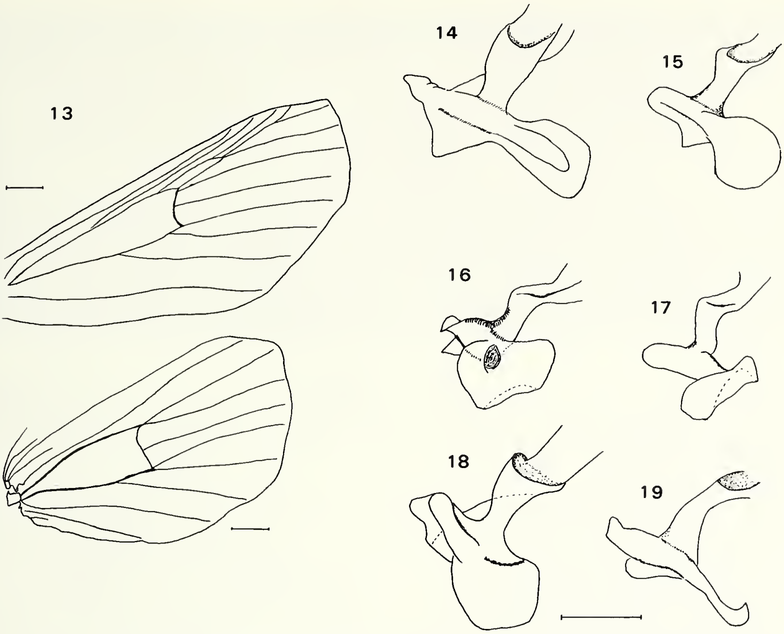
Distribution and geographic association. Geographic distribution: Mexico to Brazil, and the Antilles. Altitudinal distribution: 0–1,100 meters.

Type material examined. Nystalea aequipars Walker. Holotype male. Verbatim label data: "Amaz[on]," "554," "7°7," "TYPE: Lep No 1832, Nystalea aequipars Walker, HOPE DEPT. OXFORD." Condition: good.

Nystalea divisa Moeschler. Holotype female. Slide label data: "Surinam, Genitalia Prep. no. BE26 P. Thiaucourt 13IV 1981, ZMHB." Condition: genitalic preparation in good condition, did not view specimen.

Heterocampa seminivea Walker, 1869. Holotype female. Verbatim label data: "73-78, Limas," "Limas," "Heterocampa seminivea." Condition: good, with left hind wing torn.

Other specimens examined. 72 males, 33 females (dissections: 12 males, 4 females). *White hindwing.* MEXICO: 1♂—Jalapa [43,167 NMNH]; 1♀—Jalapa [NMNH]; 1♂—Orizaba, NMNH; 2♀—Cordoba, May 14'06 [43,507 NMNH]; Guatemala: 1♂—Clujel, Aug. [Dognin coll NMNH]; COSTA RICA: 1♂—Limon Prov., N edge Tort. Nat. Pk., Cerro Tortuguero, 0–100 m, 30 May 1984 [SJW496 DJ]; 2♂—Limon Prov., 9.4 km W Bribri Suretka, 9–11 June 1983 [DJ]; 1♀—Puntarenas Prov., 6 km S San Vito 08°42'N, 83°00'W, 13–18 March 1967 [NMNH]; 2♂—Puntarenas Prov., 35 km S Palmar Norte, Fila Esquinas, 150 m, 8°45'[N] × 83°20'[W], 7–8 Jan 1983 [DJ]; 1♂—same locality, 7–8 Jan 1986 [SJW494 DJ]; 1♂—Guanacaste Prov., Santa Rosa Nat. Pk., 18–24 July 1981 [DJ], 2♂—same locality, 1–31 July 1983, 300 m [SJW485 DJ];



Figs. 13–19. Scale equals 1.0 cm unless otherwise indicated. 13. *N. aequipars*; forewing venation of male (1604 BMNH), hindwing venation of female (1603 BMNH). 14. Left costula of *N. aequipars.* 15. Aberrant left costula of *N. aequipars.* 16. Left costula of *N. montana.* 17. Alternate view, left costula of *N. montana.* 18. Left costula of *N. similis.* 19. Left costula of *N. corniculans.*

1♀—Guanacaste Prov., 4 km E Casetilla Ricon Nat. Pk., 700 m, 16 June 1983 [DJ]; 2♂, 1♀—same locality, 22 May 1982 [DJ]; 1♂—same locality, 11 April 1983 [DJ]; GUADELOUPE: 1♂—Domaine Ducios, 24–28 June 1960 [SJW568 AMNH]; 1♂—Grand étang, 9 March 1975 [NMNH]; 2♀—Sofaia, 31 May 1975 [NMNH]; MARTINIQUE: 1♀—Colson, 15 July 1974 [43,510 NMNH]; 2♀—same locality, 2 May 1975 [NMNH]; DOMINICAN REPUBLIC: 1♀—La Plaine, 17 Feb 1964 [43,511 NMNH]; 1♀—2.2 mi E of Pont Case, 27 Jan 1965 [NMNH]; 1♀—same locality, 19 Feb 1965 [NMNH]; 1♀—same locality, 5 Feb 1964, [43,165 NMNH]; 1♂—same locality, 18 April 1965 [NMNH]; 1♀—same locality, April 26 1965 [NMNH]; 1♀—1.3 mi E Pont Casse, 10 May 1964 [NMNH]; 1♂—La Vega Prov., Hotel Montana, ca. 520 m, 10 km NE Jarabacoa, 28 May 1973 [43,166 NMNH]; TOBAGO: 1♂—St. George Prov., Hillsborough Dam, 21 March 1979 [NMNH]; ST. VINCENT: 1♂—Montreal, 11–13 Nov 1975 [NMNH]; PUERTO RICO: 1♂—Pico del Este, El Yunque Radar Station, 1,000 m, 5–6 Jan 1971 [NMNH]; 1♀—State Forest Maricao, 22 June 1955 [NMNH]; COLOMBIA: 1♂—Muzo, 400–800 m [1734 BMNH]; 1♂—Villavicencio: Ost, 400 m [no date, SJW606 BMNH]; VENEZUELA: 2♀—Merida [coll Dognin, NMNH]; 2♂—Aragua, Rancho Grande, 1,100 m 15–16 March 1978 [NMNH]; 5♂—same locality, 30–31 March 1978 [NMNH]; BRITISH GUIANA: 1♂—Omai [NMNH]; FRENCH GUIANA: 1♀—St. Laurent du Maroni [NMNH]; SURINAM:

1♂—Paramaribo [NMNH]; BRAZIL: 1♂—St. Catherina, Rio Laeiss, Blumenau, Dec 1933 [1736 BMNH]; 1♀—same locality, Jan 1934 [1281, 1737 BMNH]; 1♂—St. Catherina, Hansa Humboldt, 60 m, July 1936 [1282 BMNH]; 4♂, 20—same locality [NMNH]; 1♂—St. Catherines [43, 169 NMNH]; 1♂—Para [1732 BMNH;] 1♀—Blumenau, 732 [NMNH]; 2♀—Bresil Joinville Arp. [Dognin coll, NMNH]. *Dark hindwing.* COSTA RICA: 4♂—Sirena, Corcovado Nat. Pk., Osa Penin. 23 March 1984 [SJW608 NMNH]; same locality, 1 May 1984 [SJW617 CMNH]; same locality, 1 May 1984 [SJW618 NMNH]; 1♂—same locality, 10–19 Aug 1980 [DJ]; 4♂--same locality, 5–11 Jan 1981 [DJ]; 1♂—same locality, 1 May 1984 [DJ]; 2♂—same locality, 23 March 1984 [DJ]; 1♂—COLOMBIA: Muzo, 4–800 m [no date, SJW607 BMNH].

Nystalea corniculans, new species
Figs. 11, 16, 23

Diagnosis. Male costula thin and curved (Fig. 19). Midventral processes of female's eighth sternite more triangular than in other species and lateral processes slightly longer (Fig. 11).

Description. Body coloration: as described in species-complex section above. Forewing: male 7.0–6.2 cm (N = 2), female 6.8 cm (N = 1); only white forewing morph known for this species. Hindwing: white with dark brown edge; fringe brown with white streaks. Male genitalia: similar to *N. aequipars* but costula differs, Figure 23, gen. prep. 1733A (BMNH); the length of the paddle-like uncus varies from extremely short (Bolivian specimen) to moderately long (Peruvian specimens), and the length of the costula varies similarly. Female genitalia: as described in diagnosis, Figure 11, genitalia preparation SJW632 (CMNH).

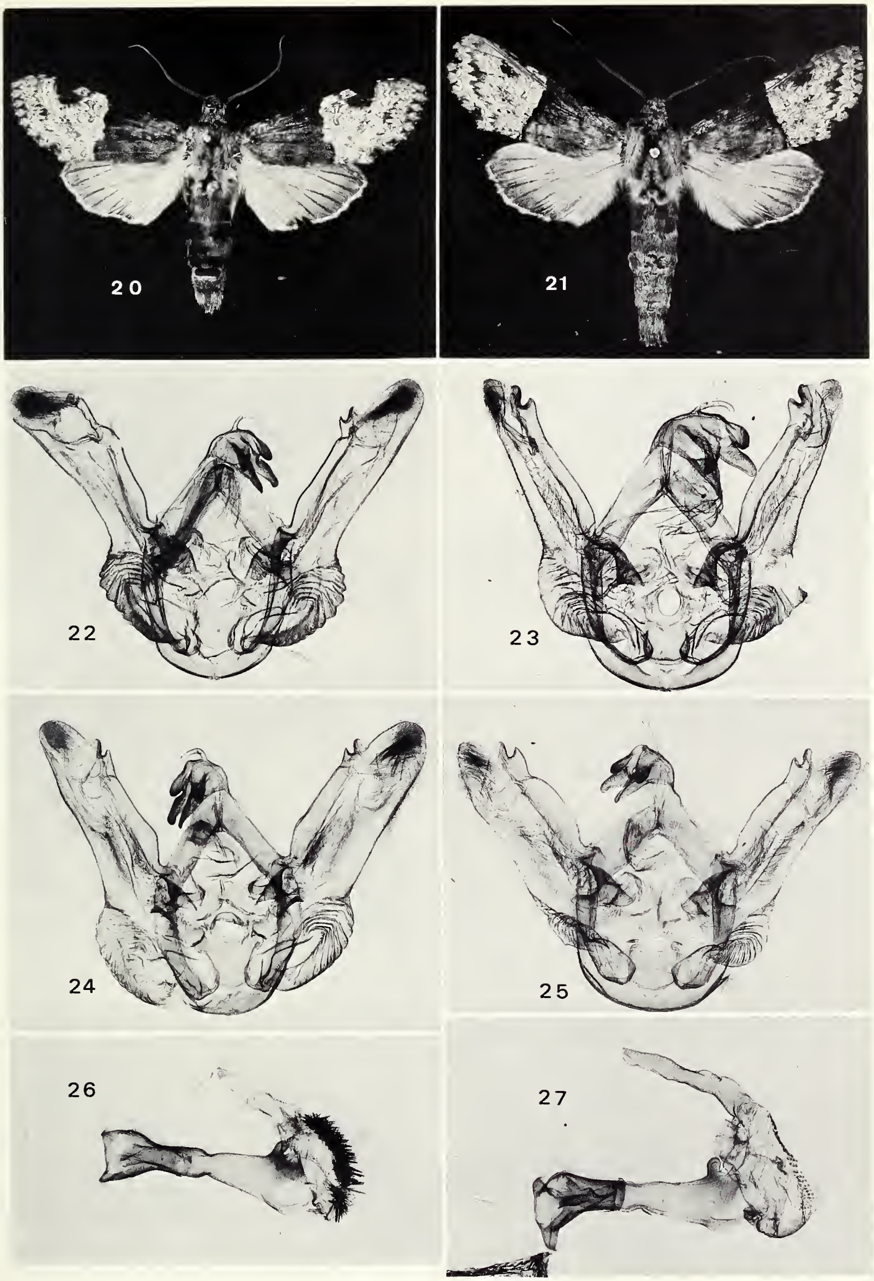
Remarks. These moths occur at unusually high altitudes for nystaleines. Unlike many high-elevation moths, the proboscis is well-developed in *N. corniculans.* Two specimens from Ecuador were collected in wet forest habitat. This species may be ecologically separated from *N. montana,* n. sp. which was collected in a semiarid habitat at 2,800 m (see below).

Distributions and associations. Geographic distribution: Ecuador, Peru, and Bolivia. Altitudinal distribution. 2,000–2,500 meters.

Etymology. The name "*corniculans*" is Latin for "*horned*" and refers to the shape of the male costal process.

Type material examined. 6 males, 1 female (dissections: 6 males, 1 female). Holotype male. Verbatim label data: "Santo Domingo, S.E. Peru, 6,000 ft., G. Ockenden," "Joicey Coll., Brit. Mus. 1922-306," "Notodontidae genitalia slide NO. 1689, a," "TYPE: Nystalea corniculans Weller." Condition: good.

Paratypes (5 males, 1 female). Verbatim label data: 1♀—"Ecuador: Morona-Santiago, Rio Culebrillas, 34 km SE Gualaceo, 2200m 22–23 Oct. 1987, J. Rawlins, C. Young, R. Davidson, Wet Forest [SJW632 CMNH];" 1♂—"ECUADOR: Morana-Santiago, Rio Culibrillas, 34 km SE Gueleceo, 2200m 22–23 Oct. 1987, J. Rawlins, C. Young, R. Davidson, Wet Forest [SJW630 CMNH];" 1♂--"PERU: Oconeque, Carabaya, 7,000 ft [3,500 m], July 1904, dry s. [1733a,b BMNH];" 1♂—"PERU: Dept. Amazonas, 20 km above Puente Ingenio on road to Poma cocha, Alt 1750 [m], 8 X [Oct.] 1964. F.C. Hutchison & I.K. Wright at coleman lantern [CAS];" 1♂—"BOLIVIA: Cochabamba [SJW566 CMNH]"; 1♂—"BOLIVIA: vic. Santa Cruz, purchased 1966 M. Grunbaum [LACM]."



Figs. 20–27. 20. Fascies of male *N. montana.* 21. Fascies of male *N. similis.* 22. Male genitalia, *N. aequipars* (1736 BMNH). 23. Male genitalia, *N. corniculans,* paratype (1733A BMNH). 24. Male genitalia, *N. montana,* paratype (43,508 NMNH). 25. Male genitalia, *N. similis* (43,502 NMNH). 26. Aedeagus of *N. montana.* 27. Aedeagus of *N. similis.*

Nystalea montana, new species
Figs. 17, 18, 20, 24, 26, 29

Diagnosis. Male costula ends in a saucer-like disk (Figs. 16, 17).

Description (Fig. 20). Body coloration: as described in species-complex section above, but overall appearance darker than other species. Forewing: males 4.7 to 6.3 cm (N = 6, $\bar{x}$ = 5.6), females 5.6 to 6.6 cm (N = 6, $\bar{x}$ = 6.0); ochre forewing morph common, white morph with more grey than *N. similis.* Hindwing: with yellow (rarely white) on basal fourth, outer scales dark brown; fringe color variable. Male genitalia: differs from *N. aequipars* in shape of costula, Figure 24; gen. prep. 43,508 (NMNH), very little variation in length of uncus or other aspects of the male genitalia. Female genitalia: as in Figure 29; gen. prep. 1673 (BMNH).

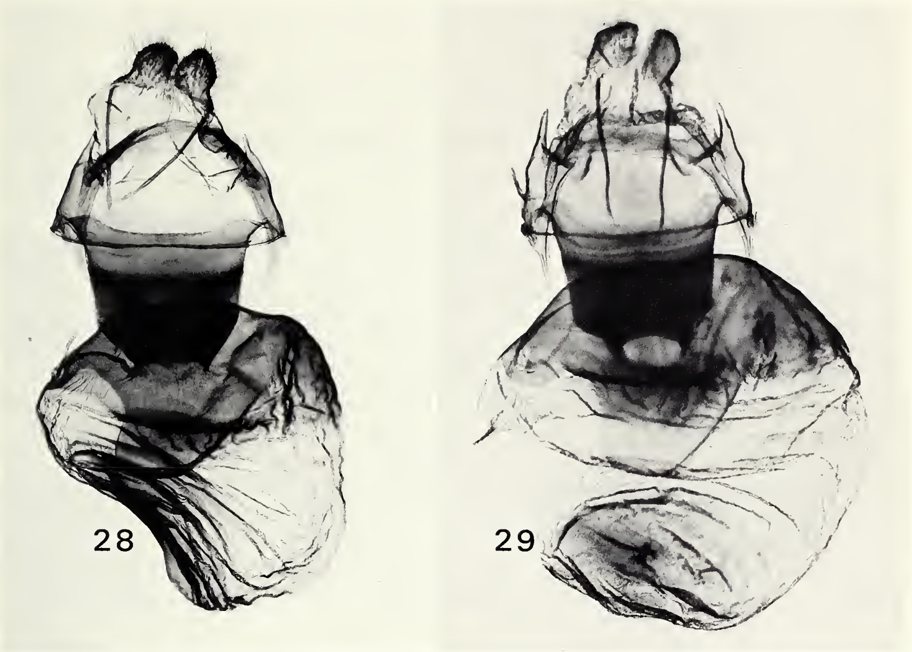
Remarks. Males collected at 730 m in Ecuador occurred in seasonal wet forest, in predominantly secondary growth with remnants of primary forest, and flew between midnight and 0330. There was one specimen collected on Chimborazo, Ecuador at 2,800 m in semiarid habitat. There are no genitalic or other obvious morphological features that separate it from the lower elevation specimens. The apparently disjunct distribution of this species probably reflects paucity of collection in crucial areas rather than a biogeographic phenomenon.

Distributions and associations. Geographical range: Costa Rica, Ecuador. Altitudinal range: 650–1,500 meters, 2,800 meters (disjunct, no specimens known between 1,500–2,800).

Etymology. The name "*montana*" was chosen because most specimens of this species were from the lower montane elevations in Costa Rica and Ecuador.

Type material examined. 51 males, 7 females (dissections: 10 males, 1 female. Holotype male. Verbatim label data: "Juan Vinas, CR," "Jan," "Rothschild Bequest B.M. 1939-I," "Notodontidae genitalia slide 1672, ♂," "TYPE: Nystalea montana Weller."

Paratypes (50 males, 6 females). COSTA RICA: 1♀—Juan Vinas [1673 BMNH]; 1♀—Juan Vinas, May [NMNH]; 1♂—Prov. San Jose, Estacion Carillo Pk., 700 m, July 1984 [DJ]; 1♂—same locality, Aug 1984 [DJ]; 2♂—same locality, Sept. 1984 [DJ; SJW489 NMNH]; 2♂—same locality, Oct. 1984; 1♂—same locality, Nov 1984 [43,508 NMNH]; 3♂—same locality, Feb 1985 [DJ]; 2♂—same locality, May 1985 [DJ]; 7♂—Prov. San Jose, Carillo Nat. Pk., La Montura Braulio, 1,100 m, 17 Dec 1981 [SJW486 CRNH]; 1♀—Prov. San Jose, Par. Nac. Braulio Carillo, Estacion Zurque (El Tunel), 1,500 m, Oct. 1985 [43,509 NMNH]; 2♂—Prov. San Jose, Par. Nac. Braulio Carillo, Estacion Zurqui (El Tunel), 1,500 m, 10°04′N × 84°01′W, Oct. 1985 [DJ]; 3♂, 2♀—Cartago Prov, Tapanti, Rio Grande de Orosi, 9°46′[N] × 83°50′[W], 1,300–1,400 m, 17 Nov 1982 [DJ]; 1♂—same locality, 23 Jan 1985 [DJ]; 5♂—Cartago Prov., Moravia de Chirripo, 1,000 m, 1♀—same locality, May 1983 [SJW495 CRNH]; 1♂—Alajuela, Finca San Gabriel, 650 m, 11 Nov 1983 [SJW488 AMNH]; 5♂—Alajuela, Finca San Gabriel, 16 km ENE Queb Grande, 650 m [DJ]; 1♂—Alajuela Prov., F[in]ca la Campana, El Ensayo, 7 km NW Dos Rios, 700 m [DJ]; 1♂—same locality, 21 March 1985; 1♂—Puntarenas Prov., Monteverde, 1,400 m, 10–11 Dec 1979 [DJ]; 3♂, 1♀—Heredia Prov. El Angel Waterfall, 8.2 km downhill Vara Blanca, 1,350 m, 3 Jan 1981 [SJW487 CMNH]; 3♂—same locality, 5 Aug 1981 [DJ]; 1♂—same locality, 22 April 1984 [DJ]; 1♂—Turrialba, La Fuente, Jan 1940 [NMNH]; ECUADOR: 1♂—Dos Puentes, 700 ft, kil. 99, N.S. lot 133, Jan 1929 [NMNH]; 1♂—



Figs. 28, 29. 28. Female genitalia, *N. aequipars* (43,507 NMNH). 29. Female genitalia, *N. montana,* paratype (1673 BMNH).

Cañar, 20 km SE La Troncal, 2,200 ft [230 m], 22–28 July 1984; [SJW504 NMNH]; 1♂—same locality, 25–30 June 1984 [NMNH]; 1♂—same locality, 24 June 1984; 1♂–same locality, 16–21 July 1984 [SJW]; 1♂—same locality, 4 Aug 1984, 12–3:30 am [SJW]; 1♂—Chimborazo, 11 km NE Pallatanga, 2,800 m, 11 Nov 1987, C. Young, R. Davidson, J. Rawlins, semiarid [SJW631].

Nystalea similis Draudt

Nystalea similis Draudt, 1932:918, plate 144, fig. G. Holotype male. Brazil, Petropolis.

Diagnosis. Forewing with nearly straight border between brown and white areas and often marked by heavy black line. Male costula short and rounded (Fig. 18). Sacculus scent organ reduced one-half to one-third size of those occurring in other species. Sclerotized, ventral extension of costa is square. Distad corona-like area shorter than width of sclerotized square.

Description (Fig. 21). Forewing: male 5.1 to 5.7 cm (N = 9, $\bar{x}$ = 5.4), female 6.1 cm (N = 1); only white forewing morph known for this species. Hindwing: male translucent white with little brown and white fringe; female light brown with white fringe. Male genitalia: as in diagnosis, Figures 25, 27, genitalic preparation 43,502 (NMNH); little genitalic variation observed. Female genitalia: similar to *N. montana.*

Remarks. This species is apparently restricted to southern Brazil. The range of *N.*

aequipars overlaps with *N. similis,* but the two can be separated using the presence (*N. similis,* Fig. 21) or absence (*N. aequipars*) of the straight, heavy black line, as well as the male genitalic characters.

Distributions and associations. Geographic distribution: southern Brazil. Altitudinal distribution: 450–1,300 meters.

Type material examined. Holotype male. Verbatim label data: "Petropolis, 600m, Rocha Mi[r]anda, ex. coll. W.Hopp." "gen. prep. P.Thiaucourt prep.no. BE28. 21-VI-1981 (ZMHB)."

Other material examined. 7 males, 1 female (dissections: 6 males, 1 female. Label data: BRAZIL: 1♂—Sao Paulo, Est Biol. Boraceia, nr. Salesopolis, 850 m, 14 March 1972 [SJW507 CNC]; 1♂—St. Catherina, Nova Bremen, 250 m, 7 Oct. 1926 [SJW506 CMNH]; 2♂—St. Catharina [43,502 NMNH; 1735 BMNH]; 1♂—St. Catherines, Hansa Humboldt [43,170 NMNH]; 2♂—MG, Caraca, 1,300 m, 2–4 i. [Jan] 1985 [SJW611 V.O.B.]; 1♀—Itatiaya Rio [SJW626, LACM].

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Note added in proof: One paratype of *N. montana* will be deposited in the National Museum of Ecuador (label data: Cañar, 16–21 July 1984).

J. New York Entomol. Soc. 98(1):50–87, 1990

THE NEW HAIRSTEAK BUTTERFLY GENUS *ORCYA*, A REVISION OF THE NEOTROPICAL "*THECLA*" *ORCYNIA* ASSEMBLAGE (LEPIDOPTERA: LYCAENIDAE)

Kurt Johnson

Department of Entomology, American Museum of Natural History,
Central Park West at 79th Street, New York, New York 10024

Abstract.—The new genus *Orcya* is described to include a monophyletic group of twelve species distributed from Mexico south to central Argentina. Nine species are transferred from *Thecla, ahola* Hewitson, *anthracia* Hewitson, *aunia* Hewitson, *bassania* Hewitson, *catharina* Draudt, *cordelia* Hewitson, *larseni* Lathy, *marmoris* Druce and *orcynia* Hewitson, and three new species described, *O. hewitsoni* (northwest Andes), *O. obliqua* and *O. supra* (Argentina). Lectotypes are designated for *T. ahola* and *T. anthracia.* Numerical cladistic analysis (PAUP) indicates *Orcya* is the sister group of *Noreena* Johnson, MacPherson and Ingraham and *Contrafacia* Johnson (Theclinae, Eumaeini).

In conjunction with a numerical cladistic analysis of eleven groups of Neotropical Theclinae ("hairstreak butterflies," tribe Eumaeini, sensu Eliot, 1973), I recently revised the formerly monotypic genus *Noreena,* erected the sister genus *Contrafacia* and designated the sister groups of these, respectively, as the "orcynia" and "orios" species groups of "*Thecla*" (Johnson, 1989a). "*Thecla*" is a polyphyletic grade genus used historically to include some 750 Neotropical hairstreak taxa (Bridges, 1988). Numerous other species of these butterflies remain undescribed. Since the early work of Clench (1944, 1946), until recent revisionary studies, a major task for Neotropical lycaenid systematics has been retrieval of monophyletic groups from "*Thecla*" and description of their additional members.

Among the large "*Thecla*" grade, and contrasting the seldom collected members of *Noreena* and *Contrafacia* (Johnson, 1989a), the "orcynia-Group" (originally termed such by Draudt, 1919) includes several familiar and widely distributed butterflies well-represented in museums and private collections. There are also some undescribed members from less-collected areas of the Neotropics. The purpose of this paper is to revise the "*Thecla* orcynia-Group," erecting the new genus *Orcya* to include nine species formerly placed in *Thecla* and three new species.

SYSTEMATICS

Johnson (1989a: tables II, III, fig. 9) enumerated characters for eleven groups of Eumaeini and presented a cladogram of five terminal groups including *Noreena, Contrafacia,* the "orcynia" and "orios" assemblages and one undescribed group (Johnson, 1989a: fig. 8). For diagnostic purposes, autapomorphies were delimited only for the two terminal genera revised (*Noreena* and *Contrafacia*).

In addition to the synapomorphies uniting *Orcya* with *Noreena* and *Contrafacia* (Johnson, 1989a: fig. 8; herein Table 1 and Fig. 1A) *Orcya* is distinguished by a

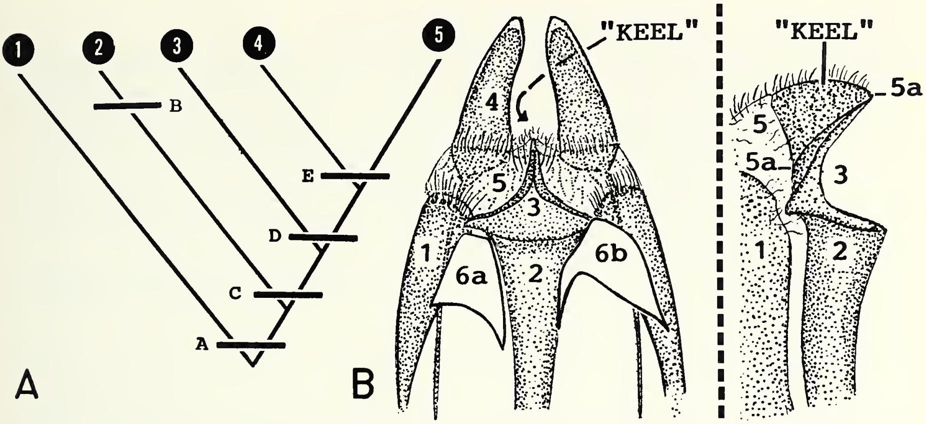

Fig. 1. A. Cladogram of *Orcya* (2) and relatives (1, "orios" Group; 3, undescribed sister group; 4, *Contrafacia*; 5, *Noreena*). Cladogram (from Johnson, 1989a) derived from parsimonious distribution of unweighted characters rooted by concensus between the Lundberg rooting method (Swofford, 1985) and outgroup rooting using as outgroups the "spurina," "thyesta" and "brescia" groups of *Thecla* (as defined in Johnson, 1989a) (Consistency Index = 0.850). For full character and outgroup descriptions see Johnson, 1989a, tables 1–3, figs. 8, 9. Crossbar "B" denotes autapomorphy of *Orcya* illustrated at right in B; crossbars "A" and "C"–"E" represent synapomorphies summarized in Table 1. B. Ventral view (left) and lateral view (right) of autapomorphic dorsal "keel" on ductus bursae terminus in *Orcya* (keel is salient in lateral view; in ventral view, curvate arrow indicates keel is behind lamellae, perpendicular to plane of the illustration). Features: 1, eighth tergite; 2, ductus bursae terminus; 3, lamellae; 4, papillae anales; 5, membranes joining dorsal "keel" with line connecting "5a" notations denoting flat dorsal surface typifying noncongeners; 6a, b, usual location of additional sclerotized components unique to some *Orcya* species.

salient autapomorphy of the female genitalia. The dorsal surface of the lamella postvaginalis and adjacent ductus bursae exhibits a pronounced sclerotized keel. This keel (Fig. 1B) extends from the terminus of the lamella postvaginalis to the dorsal antrumal margin and joins the genital apparatus to the membranes connecting the base of the papillae anales and the caudal edge of the eighth tergite (Fig. 1B). Also aiding ready identification of *Orcya* taxa are two prominent wing characters: (1) an under surface medial hindwing stripe offset basally with one to three parallel cell-end streaks (sensu Nicolay, 1976; herein Figs. 2[A]–5), an apomorphy considered precursor of the more complex "split-stripe" pattern occurring in *Contrafacia* and *Noreena* (Johnson, 1989a: figs. 1, 5, 10) and (2) no upper surface androconial "brands" on the forewings of males (Figs. 2–5), a condition considered primitive to outstanding, bipartite, brands apparent in *Noreena* and *Contrafacia* (Johnson, 1989a: figs. 1, 5). Considering these characters, recognition of *Orcya* is extremely straightforward with most of its species also readily identifiable.

Draudt (1919, p. 788) included several species in his "orcynia-Group" which do not belong in *Orcya*. The disparate morphologies of these species are documented here in Figure 12 (see Remarks under *Orcya*).

Table 1. Synapomorphies of lineages in Figure 1.[1]

A. *Female genitalia,* condition of sclerotized juncture between cephalic element of ductus bursae and antrum [Fig. 4A]: [Johnson, 1989a, 13]—juncture between cephalic element of ductus bursae and antrum characterized by a constricted neck of closely abutting, fully sclerotized, surfaces appearing laterally folded and ventrally transparent [Fig. 7A].

Male internal secondary sexual organs, condition of the brush organs [Fig. 2B]: [Johnson, 1989a, 14]—vincular brush organ present [Figs. 3, 6].

C. *Male genitalia,* condition of saccus: [Johnson, 1989a, 4]—saccus radically elongate, cephalic expanse exceeding that of entire vincular arc (measured from base of saccus to basal juncture of uncus lobes) [Figs. 6, 7AB].

Male genitalia, condition of vinculum [Fig. 3A]: [Johnson, 1989a, 6]—ventro-caudal area of vincular arc with spurs abutting or overlapping the juncture of valve's bilobed area and caudal extension [Figs. 3, 6, 7AB].

Wing pattern, condition of under surface hindwing pattern: [Johnson, 1989a, 17]—both sexes with medial stripe and two to three parallel cell-end streaks (*sensu* Nicolay, 1976) [Fig. 10].

D. *Male genitalia,* condition of valval caudal extension [Fig. 3A]: [Johnson, 1989a, 3]—caudal extension greatly thickened caudad bilobed area, tapering caudally with convex ridge defined along ventral inner margin of the lobes [Figs. 3, 6, 7B].

Male genitalia, condition of vinculum [Fig. 3A]: [Johnson, 1989a, 7]—ventrum of vinculum extremely compact, measure of entire edge not exceeding measure of entire edge of bilobed area of valvae [Figs. 3, 6, 7B].

Male external secondary sexual organs, condition of wing androconial structures [Fig. 1G]: [Johnson, 1989a, 16]—each forewing dorsum with androconial patch bipartite, occurring in two sectors (each on the respective distal and basal sides of the crossvein of the discal cell) [Fig. 1F–I].

E. *Male tergal morphology,* condition of eighth tergite: [Johnson, 1989a, 1]—eighth tergite with "subcordate incised posterior cavity" (*sensu* Johnson, 1989a, Tb. 2(A) (1), Johnson 1989b) [Figs. 2, 6].

Male genitalia, condition of bilobed area of valvae [Fig. 3A]: [Johnson, 1989a, 2]—bilobed area robust and strongly angled ventrad the caudal extension [Fig. 3].

Male genitalia, condition of saccus: [Johnson, 1989a, 5]—saccus with emphatic terminal knob [Figs. 3, 6].

Female genitalia, condition of ductus bursae: [Johnson, 1989a, 8]—cephalic element of ductus bursae strongly arched laterally [Figs. 4, 6].

Female genitalia, point of attachment of ductus bursae to corpus bursae: [Johnson, 1989a, 9]—point of entry of ductus bursae on centro-lateral surface of corpus bursae [Figs. 4, 6].

Female genitalia, condition of juncture of ductus bursae and corpus bursae: [Johnson, 1989a, 10]—ductus bursae joins corpus bursae with variously expansive sclerotized arms [Figs. 4, 6].

Female genitalia, point of attachment of ductus seminalis to corpus bursae: [Johnson, 1989a, 11]—ductus seminalis emanates from a sclerotized shield located on the lateral to disto-lateral surface of the corpus bursae [Figs. 4, 6].

Female genitalia, condition of juncture between cephalic element of ductus bursae and antrum [Fig. 4A]: [Johnson, 1989a, 12]—juncture, viewed from any angle, transparent and constricted to a marked "hour-glass"-like shape [Figs. 4, 6].

Male internal secondary sexual organs, condition of brush organs [Fig. 3A]: [Johnson, 1989a, 15]—saccal brush organ present [Fig. 3, 6].

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[1] Condensed from analysis of eleven eumaeine groups by Johnson (1989a, tables 1–3, figs. 8–9); bracketed figure citations refer thereto. Bracketed numbers indicate original character numbers of Johnson (1989a, table 2A) where respective plesiomorphic states are characterized and additional remarks provided. For clarity, some descriptions are slightly modified from that text. For autapomorphies of groups 4 (*Contrafacia*) and 5 (*Noreena*) see Johnson (1989a, table 2B, figs. 8–9).

MATERIALS AND METHODS

Specimens were studied from the Allyn Museum of Entomology (AME), American Museum of Natural History (AMNH), British Museum (Natural History) (BMNH), Carnegie Museum of Natural History (CMNH), Field Museum of Natural History (FMNH), Hope Entomological Collections, Oxford University (HEC), Instituto Miguel Lillo, Tucumán, Argentina (IML), Milwaukee Public Museum (MPM), Museum National d'Histoire Naturelle, Paris, France (MNNH) and the Robert C. Eisele Collection (Tucumán, Argentina). Methods and terminology follow Johnson (1989). In the Material Examined an asterisk indicates at least one specimen of the gender(s) noted was dissected.

Orcya, new genus

DIAGNOSIS. Compared to other Eumaeini, relatively large (forewing base/apex to 17 mm [many eumaeines generally 10–14 mm]) with wings distinctive in combining (1) upper surface blue iridescence void of androconia in males and (2) under surface brown to gray grounds marked by single, thin, whitish medial lines on both wings (on hindwing complemented by distinctive streaks or crescents in discal cell, postbasal or submarginal areas). Morphology typified by (1) males with eighth tergite unmodified, genitalia with elongate saccus (equalling or greatly exceeding length of valvae), valvae variously "spindle"-shaped and overlapped ventro-terminally by broad vincular spurs and (2) females with eighth tergite unmodified, genitalia with ductus bursae divided into sclerotized caudal and cephalic elements joined by a transparent, flexible, neck and terminal lamellae with a pronounced dorsal keel midway between the apophyses papillae anales.

Among eumaeines *Orcya* resembles *Noreena* and *Contrafacia* most (see Remarks and Johnson, 1989a), but these latter genera have the more complex under surface "split-stripe," modified eighth tergites in males, and caudal elements of the female genitalia laterally arched proxad a detached sclerotized shield on the corpus bursae.

DESCRIPTION. Adults. Figures 2–5. *Male.* Upper surface of wings: ground variously iridescent blue from basal to postmedial areas, depending on the species. Forewings lacking androconial brands. Except for one tailless species [*O. larseni,* see below] hindwing with short tail at vein CuA1 terminus, longer tail vein CuA2 terminus. Under surface of wings: ground brown to grayish; forewing with thin, whitish medial to postmedial band, variously jagged or complemented by discal and submarginal maculation depending on the species. Hindwing with wide gray to whitish medial line, complemented in the discal cell by a distal slash and, depending on the species, additional basal, postbasal and submarginal lines, suffusions or crescents. Limbal area with variously pronounced "Thecla-spot" (CuA1 submargin) and various darkening of the anal lobe base. Length of forewing: 14.5–16.5 mm (one species conspicuously smaller, see *O. obliqua*). *Female.* Upper surface of wings: ground variously iridescent blue to blue-green, usually with iridescence more distally expansive than on males; lacking androconia. Except for one tailless species [*O. larseni,* see below] tailed as in male. Under surface of wings: marked similar to males. Length of forewing: 14.5–17.0 mm. *Male Tergal Morphology and Genitalia.* Figures 6, 8. Eighth tergite unmodified. Genitalia with vinculum and saccus distinctly elongate (saccus length equal to or greatly exceeding length of vincular arc) and with prominent

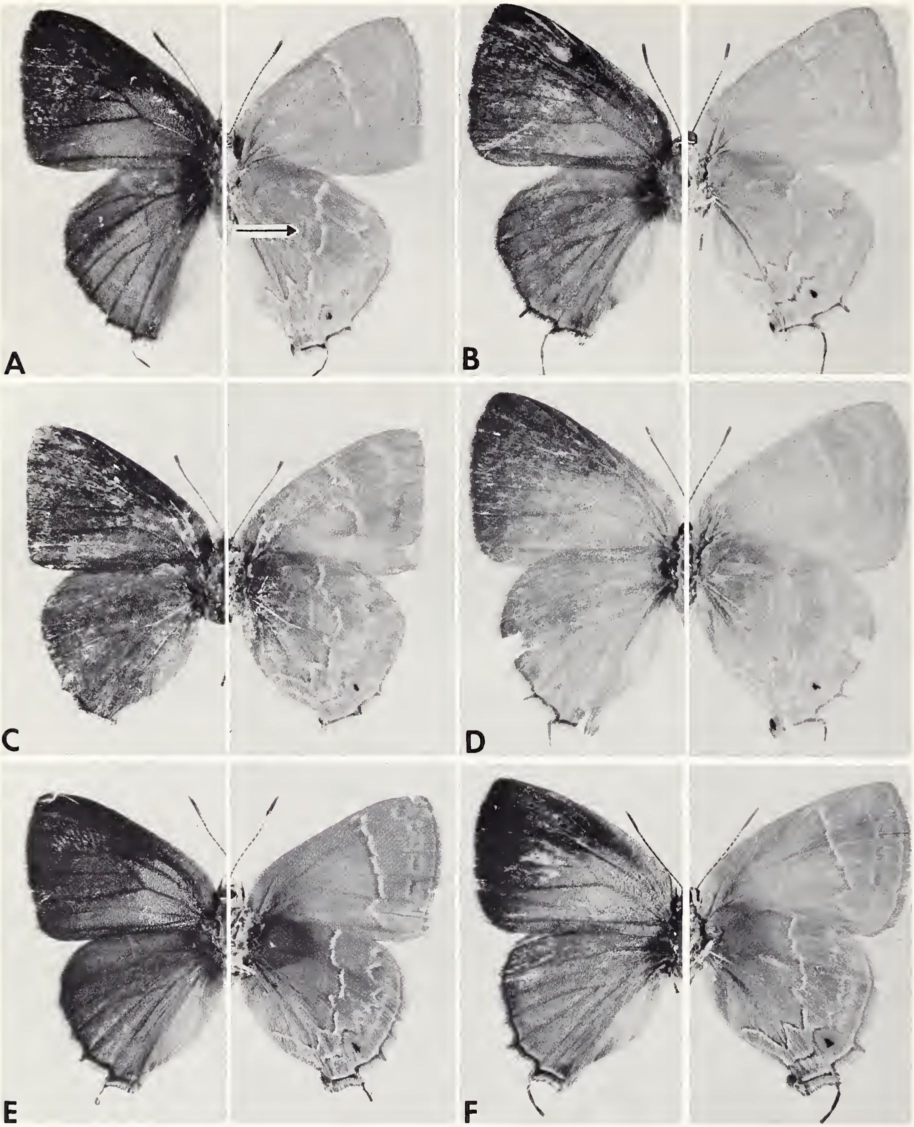

Fig. 2. Adults of *Orcya* (upper surface, left; under surface, right; line in A marks location of parallel cell-end streaks characterizing wing pattern of the genus). A. *O. orcynia* male (Rio Cocorna, Colombia, 800–1,100 m, 21–28 August 1946, AMNH); B. *O. orcynia* female (Villa Neily, Costa Rica, 1,000 m, 22 February 1971, AME); C. *O. cordelia* male (Cachavi, Ecuador, 1 November 1896, BMNH); D. *O. cordelia* female (Interior of Colombia, 20 December 1902, BMNH); E. *O. hewitsoni* holotype male; F. *O. hewitsoni* female (Rio Verde, Ecuador, 1,800 m, BMNH).

Fig. 3. Adults of *Orcya* (upper surface, left; under surface, right). A. *O. catharina* male ("Guapy," Rio de Janeiro, Brazil, 20 July 1927, MPM); B. *O. catharina* female (Petropolis, Brazil, 20 February 1958, MPM); C. *O. anthracia* male (Umuarama, Brazil, 1,800 m, 3–15 February 1937, MPM); D. *O. anthracia* female (data as in C); E. *O. supra,* holotype female; F. *O. supra,* allotype male.

Fig. 4. Adults of *Orcya* (upper surface, left; under surface, right). A. *O. ahola* male (Orizaba, Mexico, March 1908, AMNH); B. *O. ahola* female (datas as in A); C. *O. aunia* male (Cucuta, Venezuela, BMNH); D. *O. aunia* female (Merida, Venezuela, BMNH); E. *O. obliqua,* holotype male; F. *O. cordelia* from Central America (Hda. Montecristo, El Salvador, 2,300 m, 18 July 1981, AME).

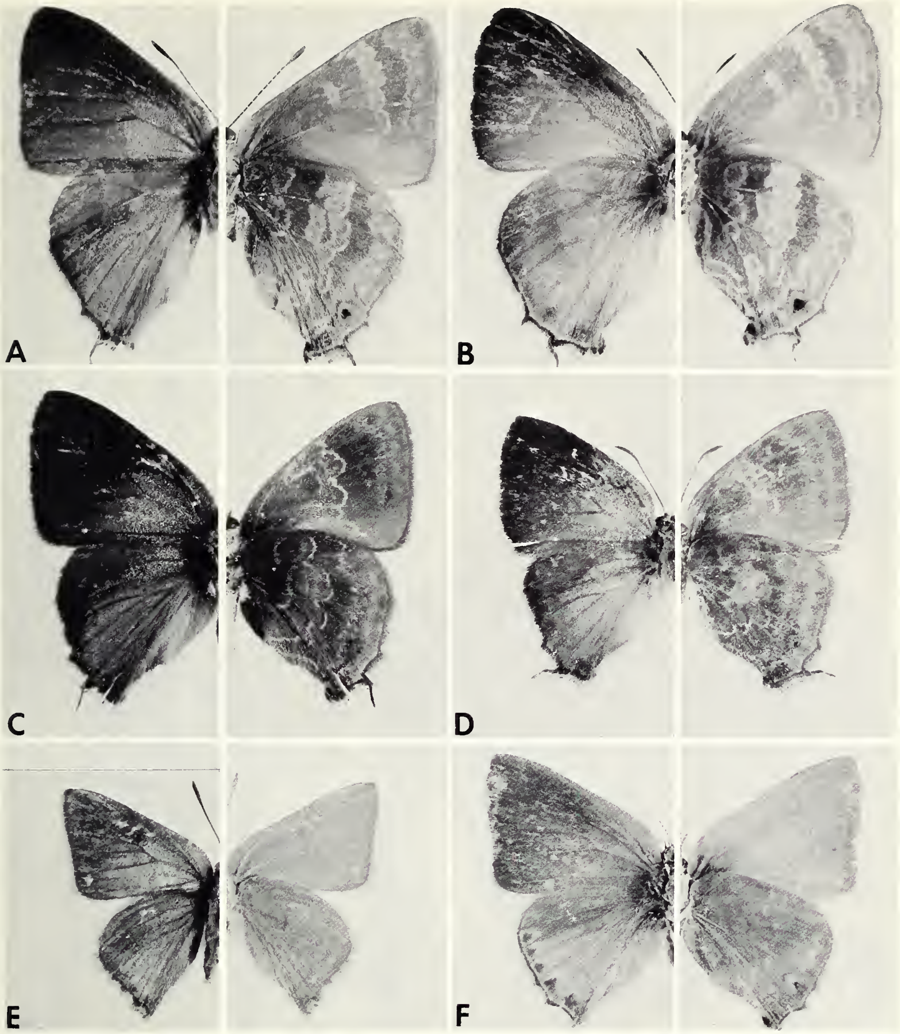

Fig. 5. Adults of *Orcya* (upper surface, left; under surface, right). A. *O. bassania* male (Jalapa, Mexico, 1896, BMNH); B. *O. bassania* female (Orizaba, Mexico, AMNH); C. *O. marmoris* male (Balzapamba, Ecuador, October 1893–February 1894, BMNH); D. *O. marmoris* female (Merida, Venezuela, 1887, BMNH, see Remarks under *O. marmoris*); E. *O. larseni,* holotype male; F. *O. larseni* female (Cafayate, Argentina, IML).

caudo-ventral spurs covering valval terminus. Valvae with bilobed regions (Fig. 6A) variously parabolic or shouldered and caudal extensions (Fig. 6A) constricted and often relatively short. Aedeagus elongate, usually exceeding length of rest of entire genitalia by one-fourth to one-third; terminus with two cornuti (upper, straight spine with serrate terminus; lower, curvate with serrate lateral edge). Brush organs prom-

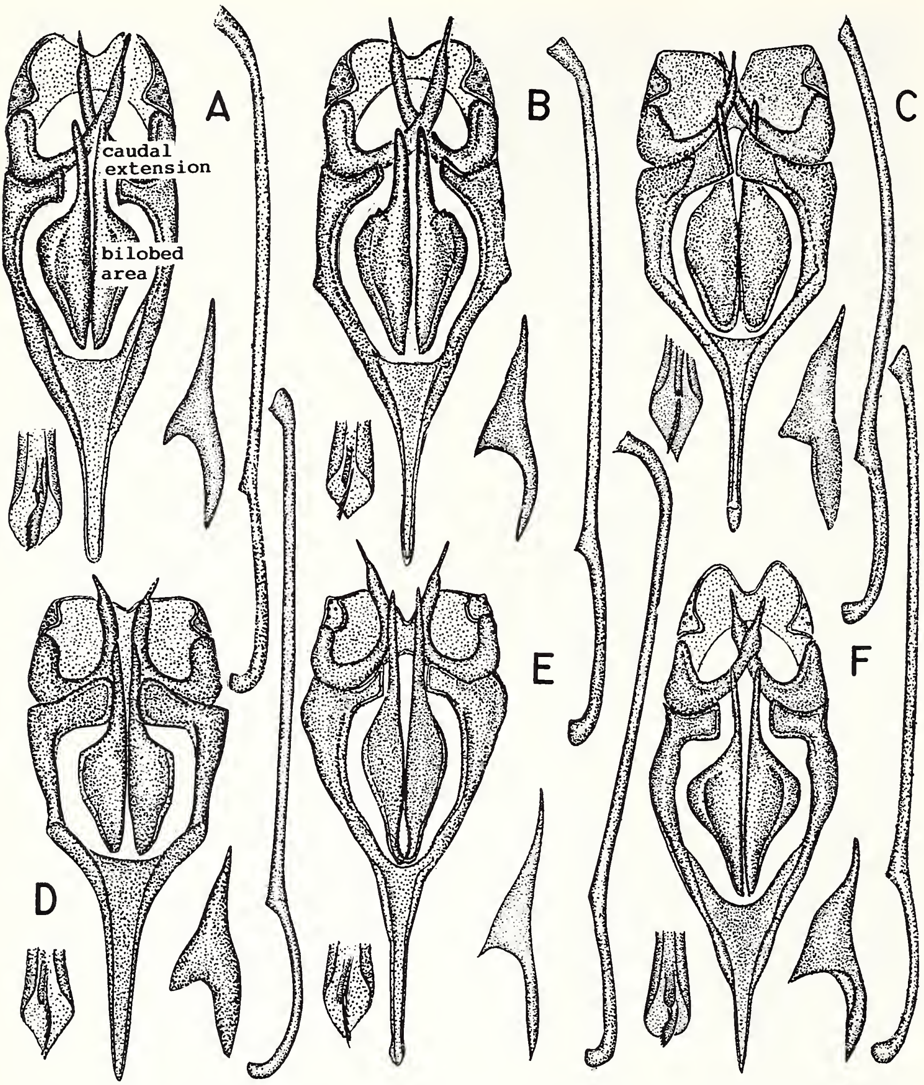

Fig. 6. Male genitalia of *Orcya* (for each entry: ventral view of genitalia with aedeagus removed and placed immediately left or right; lower right, lateral view, valve; lower left, ventral view, aedeagus terminus and cornuti). A. *O. orcynia* of Figure 2 (type see Johnson, 1989a, fig. 7); B. *O. cordelia* of Figure 2; C. *O. hewitsoni,* holotype; D. *O. catharina* of Figure 3; E. *O. obliqua,* holotype; F. *O. anthracia,* paralectotype #5.

inent, variously abutting areas of dorso-cephalic vincular surface, depending on the species. *Female Tergal Morphology and Genitalia.* Figures 7, 9. Eighth tergite unmodified. Genitalia with ductus bursae typified by fluted, heavily sclerotized, caudal and cephalic elements joined centrally by a constricted, flexible, transparent neck.

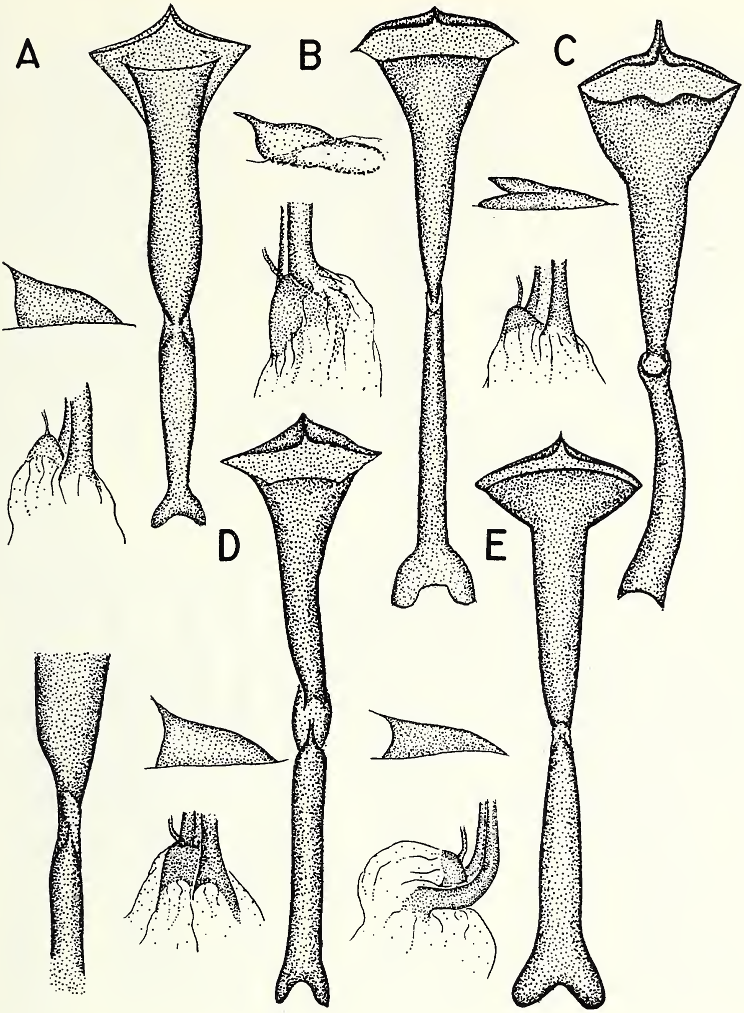

Fig. 7. Female genitalia of *Orcya* (for each entry: right, ventral view, ductus bursae; left above, lateral view, signum; left below, lateral view, juncture of ductus and corpus bursae). A. *O. orcynia* of Figure 2; B. *O. cordelia,* holotype; C. *O. anthracia,* lectotype; D. *O. hewitsoni* of Figure 2 (lateral view of ductus bursae added at left); E. *O. catharina* of Figure 3.

Terminal opening of caudal element thin and surrounded by constricted lamellal lips generally forming a rhomboid shape. Dorsum of lamella postvaginalis centrally produced to a vertically directed keel joining the terminus of the genital apparatus to the membranes connecting the base of the papillae anales and the caudal edge of the eighth tergite (Fig. 1B). Species keel size directly proportional to size of ventral lamellal lips (Figs. 7, 9). Depending on the species, cephalic ductal element with terminus straight or inclined and attached to the corpus bursae by various small

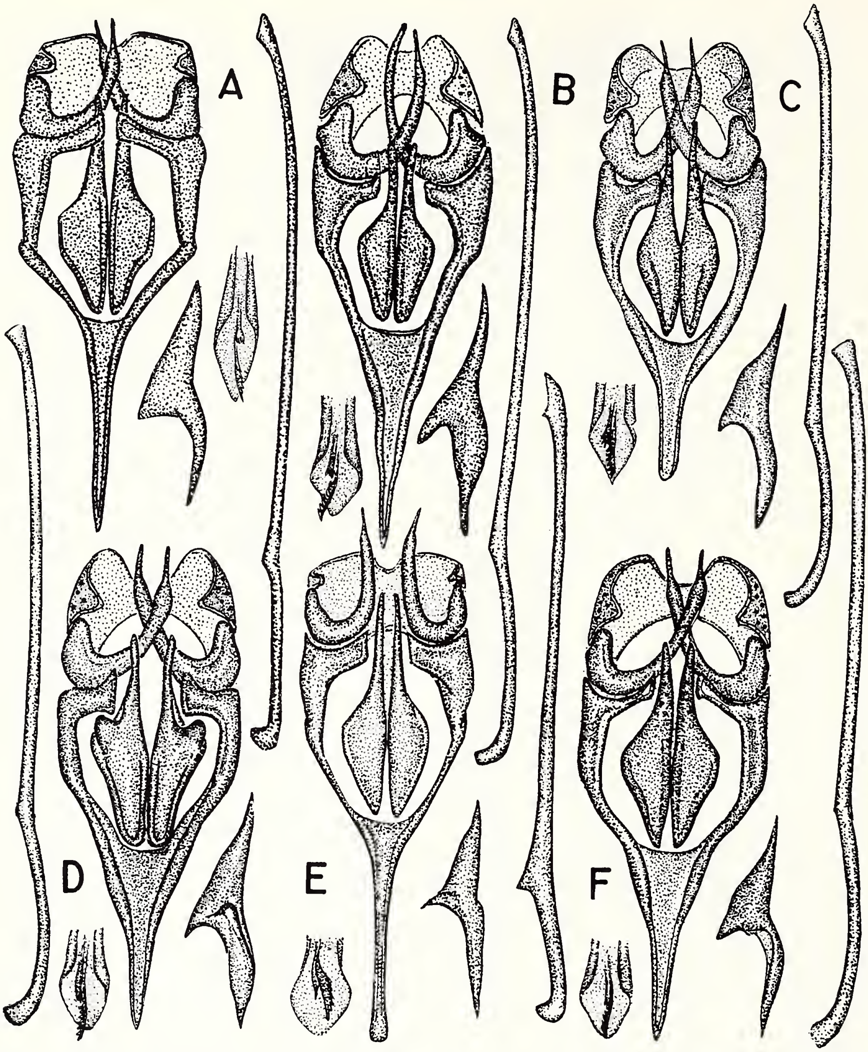

Fig. 8. Male genitalia of *Orcya* (format as in Fig. 6). A. *O. supra,* allotype; B. *O. ahola,* lectotype; C. *O. aunia,* holotype; D. *O. bassania,* holotype; E. *O. larseni,* holotype. F. *O. marmoris,* holotype.

sclerotizations of the cervix bursae (cervix bursae, orcynia Group with small sclerotized dorsal hood [Fig. 7]; ahola and bassania groups, generally with two, short, linular sclerotized struts [Figs. 8, 9]). Ductus seminalis emanating from cervix bursae. Corpus bursae with two spine-like signa. Papillae anales lobate; length of apophyses papillae anales varying with species, extremes of length being characteristic of some taxa.

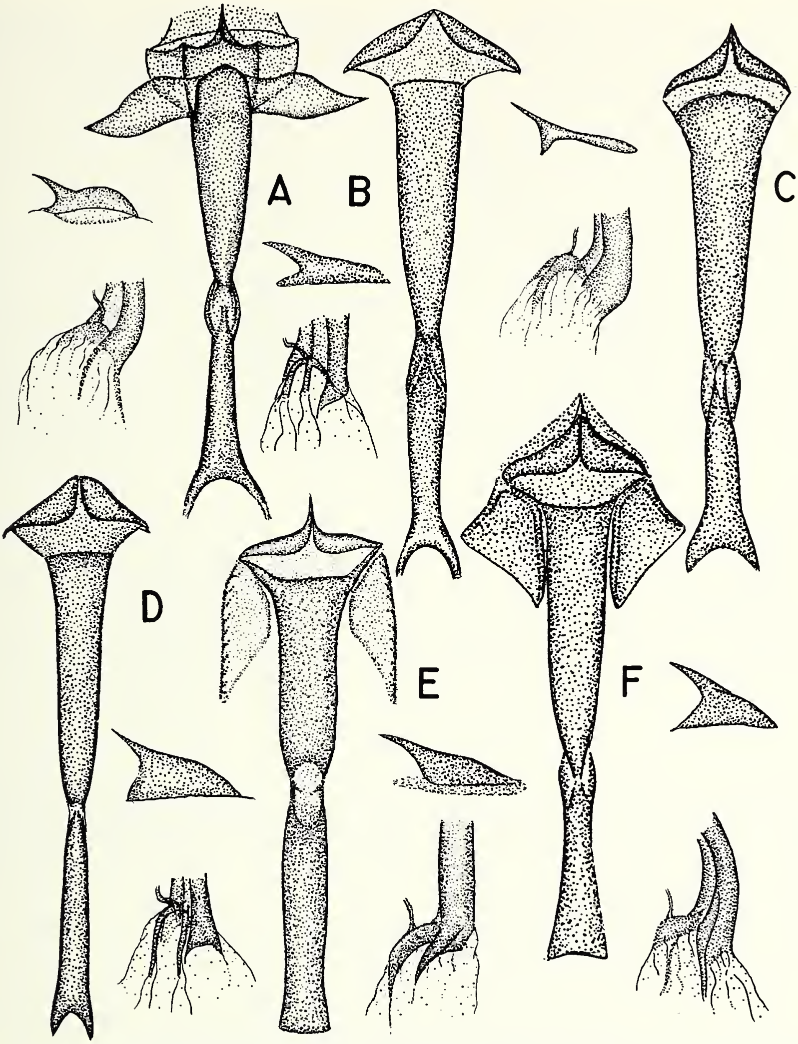

Fig. 9. Female genitalia of *Orcya* (format as in Fig. 7, except as noted). A. *O. supra,* holotype; B. *O. ahola* of Figure 4; C. *O. aunia* of Figure 4 (signum and bursae junctures placed below); D. *O. bassania* of Figure 5 (signa and bursae junctures placed right); E. *O. larseni* of Figure 5. F. *O. marmoris* of Figure 5.

TYPE SPECIES. *Thecla orcynia* Hewitson (1868).

DISTRIBUTION. Figures 10, 11. Four generally sympatric species from central Mexico S to NW Colombia with an additional congener in E Colombia/Venezuela and two others extending from the Andes of Ecuador S to Peru. Two sympatric species in SE Brazil; three allopatric species in disjunct areas of montane Argentina.

BIOLOGY. *Immature Stages.* Unknown. *Foodplants.* Unknown. *Ecology.* Habitats of *Orcya* species are known from data accompanying, and collectors' personal comments about, various samples. There are also published accounts (Brown, 1941; Pallister, 1956; Ross, 1975–1977). Further study of these, and the biology of *Orcya* is important to understanding its species diversity. Some species appear to be "common" (Draudt, 1919) lowland xerophiles occurring in areas both of native and agricultural vegetation. Other species appear cosmopolitan in upland, lowland, disturbed and undisturbed areas across wide regions. A few, seldom-collected, species appear to be montane cloud forest endemics (see individual species entries below).

REMARKS. *Intergeneric Relations.* Apparent cladistic relations of *Orcya* have been elucidated by Johnson (1989a) and summarized above. Draudt (1919) included four species in his "orcynia-Group" which do not belong in *Orcya*: *Thecla fidelia* Hewitson, *T. thoria* Hewitson, *T. keila* Hewitson and *T. gabatha* Hewitson. Morphology of the types of these species (BMNH) is illustrated in Figure 12. *T. gabatha* exhibits the characters of *Strymon* Hübner (Johnson, Eisele and MacPherson, in press); the other species cannot be assigned to any currently described eumaeine genus.

Intrageneric Relations. I divide *Orcya* into three species groups based on homogeneity of wing pattern and morphology. Two of the groups each have respective Central American and SE South American subgroups; the third is limited to Central America and N South America.

ETYMOLOGY. The name is a euphonious Latinized combination taken from the name of the type species. It is considered feminine.

The orcynia Group

Taxa share a simple undersurface pattern comprised of a lineal, medial, forewing and hindwing band, the latter complemented by various cell-end streaks and occasionally by postbasal or submarginal markings. Species level differences in genitalia are apparent but as a group the only shared character is a small dorsal sclerotized shield at the cervix bursae in females.

Central American/northern South American subgroup

Orcya orcynia (Hewitson), **New Combination**

Figs. 2A, B, 6A, 7A

Thecla orcynia Hewitson 1868:11, 1869:(1) 121, (2) pl. 50, figs. 262–265; Kirby, 1871:392; Godman & Salvin, 1879–1901 (2):64, 719; Druce, 1907:603; Hoffman, 1940:714; Comstock & Huntington, 1958–1964 [1962]:42; Robbins & Small, 1981: 315; Zikán & Zikán, 1968:56; Llorente et al., 1986:25; Johnson, 1989a:13.

Thecla anthracia [not *anthracia* Hewitson 1863–1878 [1874]]: Draudt, 1919:788; Comstock & Huntington, 1958–1964 [1962]:42; Bridges, 1988:I.25 (synonymy in error).

Thecla aunia [not *aunia* Hewitson 1863–1878 [1874]]: Draudt, 1919:788; Druce, 1907:603 [misspelled as "anina"]; Godman & Salvin, 1879–1901 (2):64; Comstock & Huntington, 1958–1964 [1962]:42; Bridges, 1988:I.40 (synonymy in error).

Fig. 10. Geographic distributions of orcynia species group of *Orcya.*

DIAGNOSIS. Upper surface of both sexes with dull violet to purplish iridescence from basal to postmedial areas (male brighter than female). Under surface simply marked—medial wing bands thin, slightly jagged, not greatly contrasting ground color, and with a single cell-end streak in the discal cell [this contrasts lavish markings in sympatric congeners *O. cordelia, ahola* and *bassania,* see below]. Male genitalia with base of valvae parabolic [not with upturned "shoulder" as in congeners of bassania Group, see below] and caudal extensions short; female genitalia with areas abutting central constriction generally produced and with structural innovation at the cervix bursae generally characterized by a small distal hood abutting the cephalic ductal terminus.

DESCRIPTION. *Male.* Upper surface of wings: ground iridescent violet to violet-blue, bordered subapically and in the submargins by fuscous. Under surface of wings: ground dingy gray to brown, forewing with whitish, basally darkened, postmedial line from costa to cell CuA1, often angled basally thereafter. Hindwing with single, gray to gray-white, medial line meandering across wing from costa to cell CuA1, thereafter incised in a compact "W"-shape before anal angle and complemented basally in discal cell by a dull cell-end streak. Limbal area with dull orange Thecla-

Fig. 11. Geographic distributions of ahola and bassania species group of *Orcya*.

spot (cell CuA1 submargin). Length of forewing: 14.0–15.5 mm. *Female.* Upper surface of wings: ground gray-brown, slightly hued violet to violet-blue; otherwise marked as male. Under surface of wings: similar to male. Length of forewing: 14.5–16.0 mm. *Male Genitalia.* Figure 6A. Typical of genus but valvae bilobed area widely shouldered and with thin caudal extension (length of bilobes and caudal extension about equal). Saccus elongate, exceeding length of vincular arc by about one-fifth. Brush organs generally abutting the dorso-cephalic angle of vinculum. Aedeagus elongate, length exceeding rest of genital by about one-fourth, caecum comprising about two-fifths aedeagal length. *Female Genitalia.* Figure 7A. Length of caudal element in ductus bursae only slightly exceeding that of cephalic element and with sclerotized areas proxad central transparent juncture notably produced. Juncture of cephalic ductus bursal element with corpus bursae straight, without notable modification of the cervix bursae. Ductus with terminal lamellae pronounced, maximal width of lamellal lips usually exceeding twice that of maximal ductus width. Apophyses papillae anales with length about equalling that of caudal element of ductus bursae.

TYPES. Holotype male, BMNH, labelled "Polochic Valley, F.D.G. and O.S.," "Type, B.M. Type #838," "orcynia," "Polochic valley," "Godman-Salvin Coll. 1911.-93. B.C.A. Lep. Rhop. Thecla orcynia, Hew." Johnson (1989, fig. 7) mentioned the above male and a BMNH female as syntypes. Further study in this revision indicates the latter female is not a type. Confusion concerning BMNH types can result from a series of longhand labels which, like the part typeset/part longhand BMNH labels numbering actual Hewitson syntypes include one of a set of consecutive numbers after the species and authors' name along with a notation including the word "type." On the invalid labels, the longhand notation (poorly written) properly deciphers as "comp. type" (not "co-type") and apparently means "compared to the type." These labels are not the actual BMNH Hewitson type labels which are described below under *T. cordelia* Type.

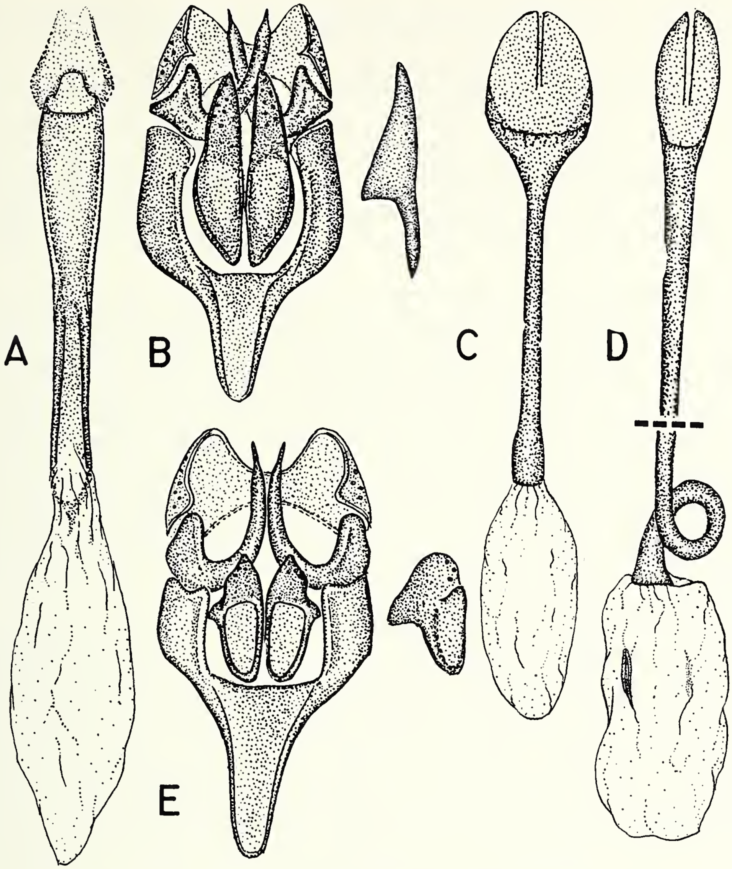

Fig. 12. Genitalia (ventral view) of non-congeners previously associated with the "*Thecla orcynia*-Group" by Draudt (1919). A. *Thecla fidelia* Hewitson, type female; B, C. *T. keila* Hewitson, type male, type female; D. *T. gabatha* Hewitson, type female [properly *Strymon gabatha* (Hewitson)]; E. *T. thoria* Hewitson, type male.

DISTRIBUTION. *Spatial* (Fig. 10): Central Mexico southward to Colombia and Venezuela. *Temporal:* Specimen dates generally span the months November to March and July to September.

REMARKS. *Intrageneric Relations.* Based solely on wing pattern similarity, Draudt (1919) synonymized *T. orcynia, T. anthracia* and *T. aunia.* As documented in individual entries below, morphological study of type specimens and large additional samples indicates this was incorrect. Regionally sympatric *O. cordelia* Hewitson, segregated in upland cloud forest biomes and *O. catharina* Draudt, a SE Brazilian lowland xerophile, are the apparent sister species.

Variation. Compared to samples from other months, specimens from July and August often have more upper surface blue and more pronounced under surface markings (see Colombia, Costa Rica and El Salvador entries in Material Examined).

Some August specimens exhibit a lightly marked costal area on the hindwing and a more pronounced "W"-shaped marking along the anal region. Such minor differences apparently represent seasonal variation since major additional wing pattern elements (like those characterizing *O. cordelia* and taxa of the ahola and bassania groups) do not occur in *O. orcynia* and genitalia are homogeneous throughout its range. Consequently, if superficial differentiation of *O. orcynia* from *O. cordelia* or *O. ahola* is uncertain, presence in these latter species of postbasal streaks (both species) and submarginal crescents (*O. cordelia*) is diagnostic. Godman and Salvin (1879–1901) also noted the minor variation in *O. orcynia* contrasting the disparate wing markings of relatives.

Biology. Draudt's (1919) comment that *O. orcynia* was a "very common" butterfly is reflected by large museum samples. From material examined in this study, it appears *O. orcynia* inhabits diverse lowland and submontane environs. Its prominence in xeric and disturbed biomes contrasts it to *O. cordelia,* a lavishly marked, regionally sympatric congener which appears restricted to montane cloud forests. This habitat difference, readily inferred from recent specimens with detailed collection data, early published accounts and personal communications with field workers (see Acknowlegments; Brown, 1941; Pallister, 1956) appears to explain taxonomic confusion among early workers. With only regional data, striking differences in wing pattern and genitalia led early authors to varied and contradictory views of synonymy (see Remarks under *O. cordelia*).

MATERIAL EXAMINED: COLOMBIA. *Colimba (one male) (AME); Rio Prio, Payande, Mina Vieja area, 950 m, 21 December 1974, leg. S. & L. Steinhauser (one female) (AME); Cauca, Pescador, 1,450 m, 9 February 1974, leg. S & L. Steinhauser (one male) (AME); *Rio Cocorna, Antioquia, 800–1,100 m, 21–28 August 1946 (four males) (AMNH); Bogota (one male) (BMNH); Interior of Colombia (one male) (BMNH); *Cauca District, Pereira (five males, four females) (BMNH); "Colombia", leg. Apollinaire (two females) (BMNH); Bogota (one female) (BMNH); "Colombia" (two females) (BMNH); Onaca, Santa Marta, 2,200 ft, wet season, November–December 1901 (one male, one female) (BMNH). COSTA RICA. *San Mateo (one male) (BMNH); Turrialba, 2,000 ft, 13 July 1971 (one male) (AME); Villa Naily, 3,000 ft, 27 February 1971 (one female) (AME); *Cartago (one male) (AMNH). EL SALVADOR. *San Salvador, 30 August 1971 (one male) (AME). GUATEMALA. *Polochic Valley (one male, four females) (BMNH). HONDURAS. *La Cambre, 19 January 1922, 20 January 1922, 20 January 1922, 1 February 1922, 6 February 1922 (five males) (BMNH); San Pedro Sula (one female) (BMNH). MEXICO. *Rio Sarabia, Oaxaca State, November 1958, leg. T. Escalante (one female) (AME); Catemaeo, Vera Cruz State, leg. T. Escalante, August 1957 (one male), November 1967 (one female), February (one female) (all AME); *Atoyac, Vera Cruz (three males) (BMNH); *Presidio, Vera Cruz State, leg. Hoffman (one male) (AMNH); *Cordoba, Vera Cruz State, leg. Hoffman (one female) (AMNH). NICARAGUA. *Chontales (one male, one female) (BMNH). PANAMA. Colon, 22 February 1969 (one male) (AME); Madden Dam, 24 July 1965 (one female), 2 January 1969 (one male), 26 February 1965 (one male) all leg. H. L. King (AME); Colon, Pina, 100 m, 10 September 1972, leg. H. L. King (one male) (AME); Lion Hill, leg. McLehnan (one male) (CMNH); *Lion Hill (one male) (BMNH); Arce (one male) (BMNH); Calobre (three males, two females) (BMNH); *Chiriqui (three males, one female) (BMNH); Bugaba (one male)

(BMNH). VENEZUELA. Suapure, 9 January 1900 (one male) (CMNH), Las Quiguas, Esteban Valley, 10 March to November (one male) (CMNH).

Orcya cordelia (Hewitson), **New Combination, revised status**
Figs. 2C, D, 4F, 6B, 7B

Thecla cordelia Hewitson 1869–1877 [1870] (4):64; Kirby 1871:388, 1877:774; Druce, 1907:603; Comstock & Huntington, 1958–1964 [1959]:194; Johnson, 1989a:13.
Thecla ahola [not *ahola* Hewitson 1863–1868 [1867]]: Draudt, 1919:788; Comstock & Huntington, 1958–1964 [1959]:65, 194; Bridges, 1988:I. 89 (synonymy in error).

DIAGNOSIS. Male upper surface brilliant azure blue with vivid black apices, subapices and margins; female brilliant aquamarine over entire wing surface to the submargins. Under surface of both sexes lavishing marked—both wings with pronounced undulate medial white band, complemented in the submargins and postbasal areas by white suffusion (forewings) and white crescents (hindwings). These differ from the simple markings of *O. orcynia* and more resemble the South American species of *O. anthracia* (see below) on the upper surface and *O. ahola* and *O. bassania* on the under surface. In the genitalia, *O. cordelia* males exhibit a small, but distinctive, upturned lateral edge between the bilobed area and the caudal extension. Female genitalia are notably slender with juncture of ductus and cervix bursae pronounced and lamellae relatively small. The cephalic element of the ductus bursae is elongate, exceeding length of the caudal element by at least one-fourth.

DESCRIPTION. *Male.* Upper surface of wings: ground brilliant iridescent blue, bordered in subapical and marginal areas by vivid black. Under surface of wings: ground whitish to light gray; forewing with bold white postmedial line bordered basally with brown or black from costa to cell CuA2. Hindwing with bold, jagged, medial white band bordered basally with brown or black from costa to cell CuA1, thereafter incised to pronounced "W"-shape before anal angle and complemented basally in discal cell by one or two white cell-end streaks. Both wings with pronounced white postmedian blotches or chevrons; hindwing with white postbasal line from inner margin through the discal cell. Limbal area with light ground and suffused whitish markings, Thecla-spot (submargin, cell CuA1) pronounced. Length of forewing: 15.0–16.5 mm. *Female.* Upper surface of wings: ground brilliant aquamarine over entire surface except for fuscous apices and margins. Under surface of wings: similar to males, but often with markings more emphatic. Length of forewing: 15.0–17.0 mm. *Male Genitalia.* Figure 6B. Typical of genus but baso-lateral areas of vinculum and valvae more robust and latter with slight, but usually distinctive, caudally directed lateral prong at juncture of bilobed area and caudal extension. Length of bilobes exceeding that of caudal extension by about one-fourth. Saccus and vincular arc of about equal length. Brush organs thickly abutting the dorso-cephalic angle of vinculum. Aedeagus elongate, length exceeding rest of genitalia by about one-third, caecum small, comprising barely one-fourth aedeagal length. *Female Genitalia.* Figure 7B. Ductal elements elongate, with cephalic element length exceeding by at least one-fourth that of the caudal element. Terminal lamellae compressed, small relative to width of the ductus terminus. Juncture of ductus bursae and cervix bursae distinctly pronounced, nearly equalling the lateral expanse of the lamellae; corpus bursae covered with hoodlike distal sclerotizations. Signa broad spines anchored on partially sclerotized bases. Apophyses papillae anales extremely long and robust, length equalling that of the ductus bursae length.

TYPE. ["Holo"]type (see below) female, BMNH, labelled: "B.M. Type No. 843," "Ecuador, Hewitson Coll. 79-69., Thecla cordelia 1" (see Remarks). Historically (Comstock & Huntington, 1958–1964 [1959]; Bridges, 1988), this specimen has been construed as a holotype and the type locality as Curaray, Ecuador. The latter notation is not from the original description but from an unpaginated locality list addended in Hewitson's treatment of butterflies he described from the Buckley Collection (1870). The extant syntype has no locality data. At BMNH, Hewitson Collection type labels are numbered consecutively. However, since there is no notation of the terminal number, it cannot always be ascertained if singularly numbered types are uniques, a problem complicated by syntype specimens sometimes being in three separate areas of the museum. There is no indication in the original description concerning the number of types. Thus, it is possible additional syntype(s) may be at the BMNH. There appears to be no ambiguity concerning the name; the above-noted BMNH type no. 843 is similar to larger series of the species distributed as noted below.

DISTRIBUTION. *Spatial* (Fig. 10): Occurring in disjunct montane cloud forest biomes from El Salvador southward to Colombia and NW Ecuador. *Temporal:* Specimen dates generally span the months October through March, but Central American specimens are also known from July.

REMARKS. *Intrageneric Relations.* Confusingly, Draudt considered *T. cordelia* a synonym of *T. ahola* (see *O. ahola,* below) probably because both have notable (though very different) postbasal markings. More compelling external similarities occur between the *T. cordelia* type, certain Central American specimens of the "orcynia-Group" and *Thecla anthracia* syntypes from Brazil, a fact apparently overlooked by early workers. These specimens have white to gray (at most, beige) under surface grounds [*O. ahola* is always distinctly brown] and distinctive postbasal and submarginal markings. Genitalic examination shows that the distinctive configuration of the *T. cordelia* type occurs congruently with the lavishly marked specimens resembling the type, as does a distinctive male configuration lacking the upturned shoulder of the male valvae occurring in *O. ahola, O. bassania* and *O. marmoris.*

The occurrence of specimens resembling the *T. cordelia* type at disparate localities from El Salvador S through Central America to NW Ecuador is at first confusing until specimens are assembled with detailed collection data. Such data suggest *O. cordelia* is a montane cloud forest endemic with a number of widely allopatric populations (see Variation, below), an inference also readily drawn from personal communication with field workers (Acknowledgments) and correlation of specimens with published ecological notes (Brown, 1941, 1942). Reinforcing this view is a similar habitat disparity documentable for regionally sympatric *T. anthracia* and *T. catharina* in SE Brazil (see below). Based on the wing and morphological data presented in this paper such apparent species distinctions warrant biological study in the field. The distinction of *O. cordelia* is further emphasized by its geographic segregation from *O. hewitsoni* described below.

Variation. South American *O. cordelia* are quite uniform in wing pattern. Probably due to range disjunction, the smaller numbers of specimens representing Central American localities are more variable. Although they exhibit the marked postbasal markings typifying the species, submarginal markings are more reduced and the ground color is characteristically darker (Fig. 4F). Dark ground, however, does not diminish the lavishness of the under surface markings, making the under surface appearance distinctive from the drab browns of regionally sympatric *O. ahola* and the thin, lunular, meandering, postbasal and submarginal markings of *O. bassania* (Fig. 5A, B). Identification of Central American *O. cordelia* is confimed by the characteristic female and male genitalia.

MATERIAL EXAMINED. COLOMBIA. *Bogota to Cachi, 1,700–2,800 m, January 1897 dry season (one male) (BMNH); *Rio Quirata, 2,300 m, 27 December 1945 (one male) (AMNH); Interior of Colombia (one female) (BMNH); *Popayan, 6,800 ft, 15 ii 1935 (one male) (AMNH); *Tolima, 950 m (one female) (AME); Mina Vieja, 24 March 1974 (one female) (AME); *Tolima, Las Guayabas, Rio Cucuana, 500 m, 20 March 1974, leg. S. & L. Steinhauser (one female); *Cali, Western Cordillera, 5,500 ft, 19 February 1935 (one male) (AMNH). COSTA RICA. *Irazu, 6–7,000 ft, leg. H. Rogers (one female) (BMNH); *Cachi (one male) (BMNH); Irazu, 7,000 ft (one female) (BMNH); *Mont Pons, May (*one male) (BMNH); *Volcan Irazu, leg. Fassl (one male) (MNHN). ECUADOR. *Cachavi, 1 November 1896, leg. Rosenberg (one male) (BMNH); *Paramba, Imbabura, 1902, leg. Fleming (one male) (BMNH) [these two historical localities noted by Brown, 1941 as "humid tropical zone, hills"]; *Cotundo, 640 m, October 1975 (one male) (AME). EL SALVADOR. *Cloud Forest, Hda. Montecristo, Miranmundo, Metapan, 2,300 m, 18 July 1981, leg. S. and L. Steinhauser (one male, two females) (AME). PANAMA. *Volcan Chiriqui (one male) (BMNH).

Orcya hewitsoni, new species
Figs. 2E, F, 6C, 7D

Thecla anthracia [not *anthracia* Hewitson, 1863–1878 [1874] ("Brazil")]: Hewitson, 1863–1878 [1874] (misidentification, in part, of syntype series, see Remarks).

Thecla orcynia [not *orcynia* Hewitson, 1868]: Draudt, 1919:788; Druce, 1907:603; Comstock & Huntington, 1958–1964 [1959]:73; Bridges, 1988:I.25 (synonymized *T. anthracia* with *T. orcynia* in error).

DIAGNOSIS. Like *O. anthracia* of SE Brazil (under surface medial bands brightly contrasting light ground color and hindwing anal elements in pronounced "W"-shape) but with medial band baso-costally directed (as in *O. obliqua* of Argentina) and generally without parallel cell-end streaks. Upper surface structural color brilliant from base to submargin in both sexes. Hindwing with bipartite black and white marginal band extending from orange anal lobe. Lacking under surface postbasal and submarginal crescents and suffusion typifying regionally adjacent *O. cordelia.* Male genitalia with distinctive widely lobate valves and vincular spurs. Female genitalia with ductus bursae dorsally produced and slightly curvate in the caudal section; apophyses papillae anales extremely long, much exceeding length of the terminal ductal section.

DESCRIPTION. *Male.* Upper surface of wings: ground brilliant iridescent azure blue, bordered by black apices and margins. Anal lobe orange, bordered variously distad by a thin white marginal line. Under surface of wings: ground light gray to light gray-brown; forewing white postmedial line, costa to cell CuA2; hindwing with baso-costally directed white medial line, bending to pronounced "W"-shape toward anal margin and seldom, if ever, complemented in the discal cell by cell-end streaks. Limbal area mostly unmarked; Thecla-spot dull orange. Length of forewing: 15.5 mm (holotype), other specimens 14.0–15.5 mm. *Female.* Upper surface of wings: ground brilliant aquamarine to greenish except for thin, unevenly bordered, fuscous apices and margins. Hindwing with white marginal line pronounced over blackish ground. Under surface of wings: similar to males. Length of forewing: 14.5–15.5 mm. *Male Genitalia.* Figure 6C. Vinculum rather "pear"-shaped as in *O. obliqua,* valvae with bilobed areas more widely parabolic than any congener and with thin caudal extensions. Vincular spurs extremely large. Brush organs thickly clustered at dorso-cephalic edge of vinculum. Aedeagus curvate and relatively short for the genus, length exceeding rest of genitalia by only about one-fifth, caecum comprising about one-fourth aedeagal length. *Female Genitalia.* Figure 7D. Bursal elements of about equal length, caudal element of ductus bursae dorsally produced and cephalically recurvate. Neck joining bursal sections thickened as in no other species. Cephalic bursal element not inclined and joining corpus bursae without structural innovation at the cervix bursae. Apophyses papillae anales extremely elongate, exceeding by one-fourth length of either bursal section. Signa very robust spines.

TYPE. Holotype male (Fig. 2E), BMNH, fixed from Hewitson *Thecla anthracia* syntype series as follows (see Remarks below and Types and Remarks under *O. anthracia*): "Ecuador, Hewitson Coll. 79-69., Thecla anthracia 6" "Ecuador." Consistent with BMNH Hewitson collection type labels, the notation "Thecla anthracia 6" refers to the original number assigned the syntype by BMNH staff; remaining *T. anthracia* syntypes ("1"–"5") are all from SE Brazil and are treated in the *O. anthracia* entry below.

DISTRIBUTION. *Spatial* (Fig. 10): Humid montane forest and adjoining margins from N Ecuador S to central Peru. *Temporal:* Wide distribution of dates on the few dated specimens suggests the species may occur in every month of the year.

REMARKS. *Intrageneric Relations.* This new species was evident from recent Andean samples and also represented by a single specimen in Hewitson's syntype series of *Thecla anthracia* (type series Ecuador and SE Brazil). On advice of P. Ackery (BMNH) I have fixed the Ecuadorian syntype as holotype of *O. hewitsoni* and a Brazilian syntype as lectotype of *T. anthracia.* The wing markings and morphology of *O. hewitsoni* differ distinctly from *O. cordelia.* The NW Ecuadorian break in their respective distributions, at the southern extreme of the Colombian Central Cordillera, appears compatible with most interpretations of historical endemism (e.g., Brown, 1982) and makes the *O. cordelia*/*O. hewitsoni* distributions congruent with those of *O. bassania* and *O. marmoris* of the bassania Group (see below and Figs. 10, 11). Consistent with its southerly distribution, *O. hewitsoni* appears closely akin to *O. obliqua* of montane Argentina (see below).

Variation. As with South American *O. cordelia, O. hewitsoni* is remarkably stable in wing pattern. Confusion concerning these species in the past appears to have resulted from spotty samples.

Biology. Except for relatively rare *O. ahola* and *O. marmoris, O. hewitsoni* is the sole congener represented in collections from Ecuador southward through Peru. This is significant since the comparatively large number of records indicate *O. hewitsoni* occurs in more diverse habitats than its upland congener *O. cordelia* found to the north. Review of ecological notes in Brown (1941) and Pallister (1956) indicates *O. hewitsoni,* though primarily noted from montane humid forest, also occurs in marginal xeric and disturbed areas. Such habitat diversity has been noted for *O. ahola* in areas where it is the common congener (Ross, 1964, 1975–1977).

ETYMOLOGY. Patronym, referring to Hewitson's original designation of the holotype as syntype of another species.

MATERIAL EXAMINED. BOLIVIA. Las Juntas, Bolivia (one male, one female) (CMNH). ECUADOR. *Abitagua, 15 September 1937, leg. Macintyre (one male) (AMNH); *Chanala, Zamora, 6 February 1939, leg. F. M. Brown (one female) (AMNH); Pichincha, flanks of Antisana, 2,950 m, July 1971, leg. R. de Lafabre (AME); *Macas (male) (AMNH); *Macas, Rio Upono, 1,050 m, 25 January 1939 (female) (AMNH); *Abitagua, Rio Pastaza, 1,300 m, 20 October 1936 (female) (AMNH); *Palmara (one female) (AMNH); Azmona [Amazon?] (one male) (BMNH); *Zamora, 3–4,000 ft (one female) (BMNH); "Ecuador" (two males, two females) (BMNH); *Equateur, Ent. d'Ambato (two females) (BMNH); Balzabamba (one male) (BMNH). PERU. *Chanchamayo (one male, two females) (BMNH); *Rio Tabaconas 6,000 ft. Peru (one female) (BMNH); San Ramon 6,000–8,000 ft (two females) (BMNH); Upper Rio Tono, La Merced, July–September 1901 (one female) (BMNH); *Chaquimayo, SE Peru, April 1920 (one female) (BMNH); "Amazons" (one male) (BMNH); *Huaca Huayabamba, SE of Chanchapoyas, 3,500 ft (one male) (BMNH); *Rio Tono, C. Peru, 1,200 ft Watkins (one male) (MNHN); *Chanchamayo, 3–4,000 ft (four males) (MNHN).

Southern South American subgroup, west and south of Amazon Basin

Orcya catharina (Draudt), **New Combination**

Figs. 3A, B, 6D, 7E

Thecla catharina Draudt 1917–1924 [1920]:788, pl. 156, fig. k; Comstock & Huntington, 1958–1964 [1959]:179; Bridges, 1988:I.73; Johnson, 1989a:13.

Thecla orcynia [not *orcynia* Hewitson, 1868]: Zikán & Zikán, 1968:56 (ambiguous misidentification referring to SE Brazil).

DIAGNOSIS. Restricted to SE Brazil and there contrasting sympatric *O. anthracia* by dull violet, basally restricted, upper surface structural color (*O. anthracia* brilliant azure distally to the submargins) and simple under surface markings comprised of an unemphatic, slightly jagged medial band somewhat "W"-shaped along the anal angle and usually without cell-end streaks (*O. anthracia* with all these pattern elements pronounced). Genitalia distinctive from all congeners (see below), particularly differentiating *O. catharina* from NW Argentine *O. supra* by latter's highly modified genital terminus in females. Ecologically distinctive as noted in Remarks below.

DESCRIPTION. *Male.* Upper surface of wings: ground dull iridescent violet, restricted rather basally with wide areas of subapices and submargins fuscous. Under surface of wings: ground gray-brown; forewing with dull white to cream postmedial line, costa to cell CuA2; hindwing with dull white to cream medial line from costa to cell CuA1, thereafter incised in a compact "W"-shape before anal angle; cell-end streak obsolescent, if present at all. Limbal area dully marked, Thecla-spot dull orange. Length of forewing: 14.5–15.5 mm. *Female.* Upper surface of wings: ground dull violet to violet-hued brown, subapices and margins fuscous. Under surface of wings: similar to males. Length of forewing: 14.5–16.0 mm. *Male Genitalia.* Figure 6D. Typical of genus but with vincular spurs widely lobate, saccus relatively wide, and valvae characterized by bilobed area rather constricted caudad the saccus and with short, thin, caudal extensions. Brush organs in thick bundles abutting the dorsocephalic surface of the vinculum. Aedeagus very long, length exceeding rest of genitalia by about one-third, caecum small, comprising only about one-fifth aedeagal length. *Female Genitalia.* Figure 7E. Distinctive among congeners: caudal and cephalic ductus element somewhat symmetrical, cephalic element dorsally inclined at the cervix bursae; both ductal elements with distally expansive termini (large concave knob at cervix bursae, with sclerotization extending as a hood over distal end of bursal sac; widely expansive lamellae at the caudal terminus). Signa broad and flat with short distal spines. Length of apophyses papillae anales equalling that of caudal ductus section.

TYPES. MNHN contains two reputed syntype males labelled by Lathy [G. Bernardi, pers. comm.] as follows: one male with handwritten red label "type," typeset voucher label "TYPE" and handwritten locality data "Timbo, Blumenau, St. Catharina [sic], Modt. 11/8/27, (H.?) Kobsch[. . . unreadable] Dresden, ex. C. S. Larsen coll."; one male with identical labels except no specific mention of Timbo, Blumenau". As noted by Johnson (in press) G. Bernardi (pers. comm.) indicates that on Larsen Collection labels, data following "Modt." (located on a second label line following collection data, if provided) includes data concerning purchase. Thus, the 11/8/27 label date does not invalidate these specimens as types and the Dresden locality of purchase is interesting (OD was from Wernicke Collection specimens). I have compared the specimens (see Johnson, in press, fig. 16, forewing 15.0 mm) with the OD (TL "Sa. Catharina") and nothing from this comparison appears to objectively invalidate the specimens as types. To be prudent, however, I do not designate a lectotype.

DISTRIBUTION. Known from numerous lowland and submontane localities in SE Brazil and adjacent Paraguay (altitudes noted up to 600 m).

REMARKS. *Intrageneric Relations.* This species appears to exhibit ecological segregation from its regionally sympatric congener *O. anthracia* like Central American *O. orcynia* does from *O. cordelia.* Early workers like Draudt (1919), probably working from regionalized data, viewed the extremes of wing pattern in SE Brazilian specimens and suggested *anthracia* and *orcynia* were clinal and synonymous. Catalogers Comstock and Huntington (1958–1964 [1959]) and Bridges (1988) noted the original descriptions and treated *catharina* as a species; local collectors Zikán and Zikán (1968) followed Draudt but had not seen the types. The differences between *O. anthracia* and *O. catharina* are apparent when one examines morphology and long series with detailed collection data. Similar to *O. orcynia, O. catharina* is a common insect in xeric and disturbed lowland and submontane areas. In contrast, specimens of *O. anthracia* are either very old (perhaps indicating restriction of current habitat) or, if with current data, indicative of upland humid forest biomes now widely threatened in SE Brazil. This apparent habitat segregation accounts for the hiatis in characters between the two taxa but needs to be verified by field work if still possible.

Variation. As noted in *O. orcynia,* some specimens are more blue on the upper surface with more pronounced under surface markings. These require more careful separation from *O. anthracia* by the genitalia. Unlike samples of *O. orcynia,* there does not appear to be any seasonal correlation with this slight variation.

Biology. As noted above, data indicate *O. catharina* is best characterized as a coastal lowland and submontane (up to circa 600 m) xerophile, widely adapted to disturbed and agriculturally-utilized land.

MATERIAL EXAMINED. BRAZIL. Castro, Paraná State, 2,400 ft, 28 March 1900 (one female) (AME); Petropolis, 1939–1941 (one female) (CMNH); Novo Teutonia 1944 (one female) (CMNH); *Annaburg, Santa Catarina, (two males) (AMNH); *Salesopolis (Boracea) Sao Paulo, Travassos Filho & Pearson 30 xi 1948 (one male) (AMNH); *"Guapy", Rio de Janeiro, 20 July 1937, leg. Gagarin (two males, one female) (MPM); *Independencia, Petropolis, 24 July 1936, leg. Gagarin (one male) (MPM); *"Rio Leata", Rio de Janeiro, 26 October 1930, leg. Gagarin (one female), 30 May 1950, leg. Gagarin (one male) (MPM); *Espirito Santo (four males, four females) (BMNH); Minas Geraes (sic) (two males) (BMNH); *"Brazil" (seven males, four females) (BMNH); "Rio" (four females) (BMNH); *Castro, Paraná (four males, five females) (BMNH); Castro, 7 May 1910 (one male) (BMNH); Iguassu, Paraná (two females) (BMNH); Novo Friburgo (three females) (BMNH); Petropolis (one female) (BMNH); Tucunduva, Paraná, 650 m, 17 February 1913 (one male, one female) (BMNH); Tibagy, Paraná (one female) (BMNH); *Timbo, Blumenau, Santa Catarina (one male, one female) (MNHN). PARAGUAY. *S Paraguay, leg. Perens (two males) (BMNH); "Paraguay" (one female) (BMNH).

Orcya anthracia (Hewitson), **New Combination, revised status**

Figs. 3C, D, 6F, 7C

Thecla anthracia Hewitson 1863–1878 [1874] (1):166, (2):pl. 76, fig. 604–606; Kirby, 1877:777; Druce, 1907:63. Comstock & Huntington, 1958–1964 [1959]:73, [1962]: 42; Johnson, 1989a:13.

Thecla orcynia [not *orcynia* Hewitson 1868]: Draudt, 1919:788; Comstock & Huntington, 1958–1964 [1959]:73; Bridges, 1988:I.25 (synonymy in error); Zikán & Zikán, 1968:56 (ambiguous misidentification referring to SE Brazil).

DIAGNOSIS. Upper surface of both sexes more brilliantly iridescent blue than any congener and with basal area of anal lobe distinctly bright orange. Hindwing under surface with medial band and cell-end streaks pronounced, band radically W-shaped near the anal margin, lacking postbasal markings, and with base of anal lobe vividly orange. Male genitalia with basal shape of valves distinctly "spindle"-shaped (cephalic terminus of valves constricted, contrasting greatly produced distal lobes and an extremely thin caudal extension); female genitalia with cephalic ductal element recurvate.

DESCRIPTION. *Male.* Upper surface of wings: ground brilliant azure blue bordered in subapices and submargins with black. Anal lobe bright orange. Under surface of wings: ground gray-brown; forewing with white postmedial line, costa to cell CuA2; hindwing with white medial line, bordered basally with brown or black, from costa to cell CuA1, thereafter incised in pronounced "W"-shape before anal angle; single pronounced cell-end streak in discal cell. Limbal are generally unmarked but Thecla-spot vividly orange. Length of forewing: 15.0–16.5 mm. *Female.* Upper surface of wings: ground iridescent blue to aquamarine bordered in apices and margins with fuscous; anal lobe orange. Under surface of wings: similar to males. Length of forewing: 15.5–17.0 mm. *Male Genitalia.* Figure 6F. Typical of the genus but with valvae in distinct "spindle"-shape (cephalic area of bilobes extremely constricted, distal lobes produced and caudal extension short and thin), cephalic constriction distending vinculum caudad the saccus. Saccus funnel shaped, about same length as valvae. Vincular spurs and falces robust for genus. Brush organs in thick bundles abutting the dorso-cephalic surface of the vinculum. Aedeagus very long, length exceeding rest of genitalia by about one-third, caecum small comprising only about one-fifth aedeagal length. *Female Genitalia.* Figure 7C. Typical of genus but with cephalic section of ductus bursae shorter by one-fourth to one-third than caudal section, and recurvate. Signa short, wide-based, with a rather thick medial spine. Apophyses papillae anales short, length only about one-half that of caudal bursal section.

TYPES. Among six syntypes, BMNH, two species were represented. Of five syntypes which are conspecific (two males and two females labelled "Brazil" and one female labelled "Rio") I designate the latter female as lectotype. It is labelled "Rio, Hewitson Coll. 79-69., Thecla anthracia 4" "Rio," "designated lectotype by K. Johnson, 1989." This designation follows BMNH procedural advice of P. Ackery, Curator, requiring I also fix as paralectotypes the remaining four specimens. These specimens, in addition to being labelled "designated paralectotype by K. Johnson, 1989" are labelled "Brazil, Hewitson Coll. 79-69., Thecla anthracia" "1," "2," "3" and "5," respectively, these numbers corresponding to the original syntype numbers assigned by BMNH staff to the Hewitson Collection types. The remaining syntype ("6," labelled "Ecuador") is holotype of the *O. hewitsoni* described above.

DISTRIBUTION. Apparently limited to tropical montane coastal forest in SE Brazil (altitudes noted from 900–2,000 m).

REMARKS. *Intrageneric Relations.* As noted under treatment of *O. hewitsoni,* the original syntype series of *Thecla anthracia* included specimens of both taxa with respective Ecuadorian and Brazilian locality data. On the advice of Phillip Ackery (BMNH), I have designated a Brazilian lectotype for *T. anthracia* because (1) it is in this region that the species must be distinguished from sympatric congener *O. catharina* and (2) such designation is consistent with the literature usages for *T. anthracia* (Ecuadorian syntypes were not mentioned in literature following the original description). A new Ecuadorian species has been described above and I designated the Ecuadorian syntype of *T. anthracia* as its holotype; this is appropriate since the new taxon must be distinguished primarily from *O. cordelia* which enters Ecuador in the northwest.

Variation. Specimens of *O. anthracia* are very uniform in wing pattern and genitalic traits.

Biology. Remarks under *O. catharina* (above) pertain.

MATERIAL EXAMINED. BRAZIL. Brusque, Santa Catarina State, 15 December 1967, leg. V. Becker (one male) (AME); *"Parque Viacatie," Petropolis, 1 August 1931 (one male) leg. Gagarin (MPM); *"Guapy," Rio de Janeiro, 14 May 1937, leg. Gagarin (male) (MPM); *Petropolis, 8 May 1938 leg. Gagarin (male) (MPM), 20 November 1938, 900 m, leg. Gagarin (one female) (MPM), 7 January 1935 leg. Gagarin (one male) (MPM); *Independencia, Petropolis, 1936 (male) leg. Gagarin (MPM), 20 September 1936 (male) leg. Gagarin (MPM) 25 August 1938 (one male) leg. Gagarin (MPM), 20 September 1956 (male) leg. Gagarin (MPM), 21 September 1936 (male) leg. Gagarin (MPM); 2 October 1936 (male), leg. Gagarin (MPM), 19 August 1956 (male) leg. Gagarin (MPM); "Adhemar Costa," Rio de Janeiro (male) leg. Gagarin (MPM); "Icata," Rio de Janeiro, 20 July 1950, leg. Gagarin (male) (MPM); Gavea, Paraná, 20 June 1939, leg. Gagarin (MPM); *"Castonua," Rio de Janeiro, 28 June 1939 (female) leg. Gagarin (MPM); Corupa, Santa Catarina, November 1956, ex. Niedhofer Coll. (MPM); *Massaranduba-Blumenau, Santa Catarina (three males, five females) (AMNH); *Annaburg, Santa Catarina (one male, one female) (AMNH); *Londrina, N. Paraná, 9 x 1935 (one female) (AMNH); Espirito Santo (one male, four females) (BMNH); Minas Geraes [sic] (two males) (BMNH); *"Brazil" (seven males, four females) (BMNH); *"Rio" (four females); Santa Teresa, Espirito Santo State, 900 m, 7–8 April 1973, leg. C. Callaghan (one female) (AME); Petropolis, Rio de Janeiro State, 900 m, 2 April 1971, leg. C. Callaghan (four males) (AME); *Umuarama, São Paulo, 1,800 m, 3–15 February 1937, leg. Gagarin (one male, one female) (MPM).

Orcya larseni (Lathy), **New Combination**

Figs. 5E, F, 8E, 9E

Thecla larseni Lathy 1936:230, pl. 8, fig. 7; Comstock & Huntington, 1958–1964 [1961]:106.

DIAGNOSIS. A tailless species, also easily distinguished by dull, restricted, upper surface iridescence and cryptic tawny under surface. Upper surface with dull purplish blue patches (suffused distally with silver) occurring basally and medially on male forewing and from cell M2 to anal margin on hindwing of both sexes. Under surfaces with tawny suffusion often obscuring medial and cell-end markings typifying the genus. Male genitalia distinctively elongate and distended in ventral shape; female genitalia markedly robust (see below).

DESCRIPTION. *Male.* Upper surface of wings: ground generally tawny brown with iridescent purplish blue (distally tinged silverish) basal to medial on forewing and cell M2 to anal margin on hindwing. Wing shape rather angled for genus; hindwing without tails. Under surface of wings: ground tawny-brown; forewing with vague cream postmedial line, costa to cell CuA2; hindwing with brown overscaling obscuring jagged cream medial line [from costa to cell CuA1, thereafter incised in a compact "W"-shape before anal angle, complemented in discal cell by single cream cell-end streak. Limbal area generally unmarked; Thecla-spot and base of anal lobe prominently orange. Length of forewing: 12.5–14.0 mm. *Female.* Upper surface of wings: marked similar to male but iridescence limited to cell M2 to anal margin of hindwing. Under surface of wings: similar to males. Length of forewing: 12.5–14.5 mm. *Male Genitalia.* Figure 8E. Dorsal area of vinculum very compact; area adjoining saccus consequently greatly distended with saccus extremely elongate. Falces robust and located more dorso-terminally than in congeners. Valvae with bilobed area parabolic, caudal extension thinly tapered. Brush organs in bundles abutting the thin dorso-cephalic surface of the vinculum. Aedeagus with shaft rather straight but caecum displaced somewhat ventrally and comprising only about one-fifth aedeagal length. *Female Genitalia.* Figure 9E. Typical of genus in overall structural but extremely robust and with cervix bursal shield outstanding. Terminus with lateral flaplike sclerotizations as in *O. marmoris* and *O. supra,* but not as robust as in these species. Signa robust and broad-based tapering to conspicuous distal spine. Apophyses papillae anales robust and terminally lobate, cephalic length slightly exceeding constricted section of ductus bursae.

TYPES. Holotype male (Fig. 5E, 13.0 mm), MNHN labelled "specimen typicum Thecla larseni Lathy," "Mendoza 28/12 1906, Argentina," "Coll. C. S. Larsen, Faaborg."

DISTRIBUTION. *Spatial* (Fig. 10): montane northwestern to central Argentina. Temporal: specimen dates range from December to February.

REMARKS. *Intrageneric Relations.* This small, cryptic, species would not be readily associated with *Orcya* by wing pattern. Genitalia confirm the generic assignment and close examination of specimens without heavy under surface suffusion reveals the hindwing pattern typifying *Orcya* taxa. The taxon has been poorly known and is only well-represented in the C. S. Larsen Collection (MNHN), early collections by J. Steinbach (BMNH) and K. Hayward (IML) and recent Argentine samples of R. C. Eisele and B. MacPherson (see Johnson, Eisele and MacPherson, 1988 & in press). *O. larseni* is apparently an allopatric sister species of the *O. catharina/O. anthracia* complex, as is the new Argentine species described immediately below.

Biology. The habitat of *O. larseni* appears diverse. Of the localities listed below, "Cucho" is mesic to hydric upland forest (Johnson, Eisele and MacPherson, 1988), "Cafayate" is xerophytic Monte (Johnson, Eisele and MacPherson, 1988 & in press) and "Rio Lazano" is grassland with immediately adjacent quebrada forest (Johnson, Eisele and MacPherson, in press). Species composition of MNHN "Mendoza" thecline samples (see e.g., *Chlorostrymon patagonia* Johnson, 1989c) suggests MNHN samples of *O. larensi* are xerophilic.

MATERIAL EXAMINED. ARGENTINA. Jujuy Province, Rio Lazano, Morro de Alizar, 1,800 m, 1 February 1970, leg. R. Eisele (one male) (REC), Cucho, 22 February 1979, leg. B. MacPherson (one female), same data but 29 December 1980 (one female) (AMNH); Mendoza Province, "Mendoza," 13 December 1906 (two males, one female), 28 January 1906 (two females), 3 December 1908 (two males, one female), [collector unknown] C. S. Larsen Collection (MNHN); Salta Province, Salta, Cerro San Bernardo, 1,450 m, 1 December 1964, leg. R. Eisele (REC), Cafayate, February 1952, leg. K. Hayward (one male) (IML); Tucumán Province, Villa Nougues, January 1929, leg. K. Hayward (one male, one female), same data but January 1928 (one male) (IML), "Tucumán," 5 February 1922 (two females), "Tucumán," leg. J. Steinbach (one male, one female), same data but 1,100 m, January–February 1905 (one male) (BMNH).

Orcya supra, new species
Figs. 3E, F, 8A, 9A

DIAGNOSIS. Under surface wing pattern most similar to *O. catharina* but upper surface more brilliant blue and distally expansive as in *O. anthracia.* Forewings with inner margin uniquely disto-caudally produced. Female genitalia extraordinary—among several structural innovations (see below), most salient are lateral, flaplike, sclerotizations extending widely from the base of the lamella antevaginalis to the margins of the eighth tergite.

DESCRIPTION. *Male.* Upper surface of wings: ground bright iridescent azure blue with crisp fuscous borders in subapices and margins. Forewing inner margin disto-caudally produced. Under surface of wings: ground gray-brown; forewing with cream postmedial line, costa to cell CuA2; hindwing with jagged cream medial line from costa to cell CuA1, thereafter incised in a compact "W"-shape before anal angle, complemented in discal cell by single cream cell-end streak. Limbal area generally unmarked; Thecla-spot dull orange. Length of forewing: 12.0 mm (allotype). *Female.* Upper surface of wings: ground dull iridescent aquamarine bordered by uneven fuscous along the apices and margin. Forewing inner margin disto-caudally produced. Under surface of wings: similar to males. Length of forewing: 15.0 mm (holotype); 15.0 mm (paratypes). *Male Genitalia.* Figure 8A. Somewhat resembling *O. catharina* but with vincular spurs and saccus thinner and valvae less robust and more angled along the margins of the bilobed configuration (see Remarks). Brush organs in bundles abutting the thin dorso-cephalic surface of the vinculum. Aedeagus rather straight for genus with caecum not outstanding; aedeagus length exceeding rest of genitalia by about one-fourth, caecum comprising about one-fourth aedeagal length. *Female Genitalia.* Figure 9A. Typical of genus in overall structural but exhibiting the following supralimital characters: terminal lamellae, in addition to dorsal keel, fused laterally into circular configuration and with additional ventral lobe from which extend laterally wide, flaplike, sclerotizations. Neck between cephalic and caudal sections of ductus swollen, and sclerotized along the edges. Juncture of cephalic ductal section and corpus bursae widely invaginated and dorsally inclined. Signa with rather round, produced, base, tapering to conspicuous distal spine. Apophyses papillae anales robust, cephalic length exceeding constricted section of ductus bursae (see Remarks).

TYPES. Holotype female (Fig. 3F), Mosconi, Salta Province, Argentina, 9 June 1975, leg. B. MacPherson; allotype male (Fig. 3E), 2 km N San Pedro, Jujuy Province, Argentina, 26 April 1979, leg. R. Eisele. Both deposited AMNH. Paratypes. AMNH: Agua Blanca, Quebrada (Arroyo) Remanso, Salta Province, 450 m, 25 January 1972, leg. R. Eisele (one female) (AMNH); same data but 9 August 1989 (one female) (REC).

DISTRIBUTION. Known only from chaco habitats and their margins in northwestern Argentina.

REMARKS. *Intrageneric Relations.* Typical of numerous NW Argentine lowland xerophilic endemics (see Johnson, Eisele and MacPherson 1988, in press) *O. supra* appears most closely related to a xerophilic SE Brazilian congener, *O. catharina.* Insular distribution probably accounts for the supralimital characters of the female genitalic terminus; similar additional sclerotized components are currently known only from *O. marmoris* and *O. larseni.* Also typifying regional zoogeography, *O. supra* does not appear closely related to montane *O. obliqua* of montane La Rioja Province. This species is an apparent southern segregation of the Andean *Orcya* fauna (see Remarks under *O. hewitsoni* and *O. obliqua*).

Biology. The type locality is a chaco and chaco-xeric woodland margin locality. Endemism here is attested by Mosconi's being the type locality for five species and two genera of recently described butterflies (Johnson, 1988; Johnson, Eisele & MacPherson, 1988 & in press). However, thirty years of concerted collecting in the area by Eisele and MacPherson has yielded only the types of *O. supra* and the species is not represented in the extensive holdings of the IML.

ETYMOLOGY. The name is Latin (meaning "above" or "beyond") and refers to the supralimital genitalic characters.

Orcya obliqua, new species

Figs. 4E, 6E

DIAGNOSIS. Under surface medial hindwing band bright white over dark brown ground, slanted obliquely (costo-basally) with two pronounced cell-end streaks immediately adjacent in the discal cell. Like *O. aunia,* known specimen small (FW 12.5 mm). Genitalia with "pear"-shaped vinculum and extremely elongate bilobed area of the valvae greatly distending the saccus.

DESCRIPTION. *Male.* Upper surface of wings: dull iridescent dark blue-green with crisp fuscous subapices and margins. Under surface of wings: ground chocolate brown; forewing with bright white postmedial line, costa to cell CuA2. Hindwing with bright white medial line directed baso-costad at top of wing, in anal area from cell CuA1 incised in a compact "W"-shape before anal angle. Discal cell with two vivid cell-end streaks disjunct from medial band. Limbal area generally unmarked; Thecla-spot small and orange. Length of forewing: 12.5 mm (holotype). *Male Genitalia.* Figure 6E. Compared to congeners similar only to *O. hewitsoni* in rather "pear"-shaped vinculum. Valvae extremely elongate both in the bilobed region (which distends the elongate saccus) and in the caudal extensions. Brush organs comparatively short for genus because of vincular shape. Aedeagus with caecum displaced laterally from plane of shaft and with shaft terminus markedly recurved; aedeagal length exceeding rest of genitalia by about one-fourth, caecum comprising only about one-fifth aedeagal length.

TYPES. Holotype male (Fig. 4E), La Rioja, Argentina, leg. Giacomelli, deposited BMNH (see Remarks).

DISTRIBUTION. Known only from the type locality.

REMARKS. As noted by Johnson, Eisele and MacPherson (1988 & in press), La Rioja material of Giacomelli contains numerous undescribed endemics, usually representing upland montane or lowland chaco environs. Unique small samples of Giacomelli material survive because he sent such specimens to the BMNH hoping for identifications. Most of the specimens with dates affixed are from the period 1910–1914. Consistent with the character resemblance of *O. obliqua* and *O. hewitsoni,* contrasting the apparent sister species relationship of *O. catharina* and *O. supra,* I speculate that *O. obliqua* represents montane habitat.

ETYMOLOGY. The name is taken from the Latin for "oblique" referring to the distinctive position of the under surface medial hindwing band.

The ahola Group

Taxa of this group have somewhat duller upper surfaces and brown under surfaces; generally with postbasal patterns complementing the medial band and cell-end streak;

in male genitalia the vinculum is distended near the saccus to accommodate innovations in the basal structures of the valvae; like the bassania Group, the cervix bursae generally has two small sclerotized struts.

Orcya ahola (Hewitson), **New Combination**

Figs. 4A, B, 8B, 9B

Thecla ahola Hewitson 1863–1878 [1867] (1):82, (2):pl. 35, figs. 73, 74; Kirby, 1871: 383; Druce, 1907:603; Godman & Salvin, 1879–1901 (2):64; Huntington, 1933: 2; Hoffman, 1940:714; Comstock & Huntington, 1958–1964 [1959]:64; Ross, 1964: 23, 1975–1977 [1976]:197, [1977]:168; Johnson, 1989a:13.

Thecla cordelia [not *cordelia* Hewitson 1869–1877 [1870]]: Draudt, 1919:788; Comstock & Huntington, 1958–1964 [1959]:65; Bridges, 1988:I.89 (synonymy in error).

DIAGNOSIS. Upper surface with structural color on both sexes limited to basal to postmedial areas only (male more iridescent than females); under surface with dull brown ground and distinctive postbasal lines (cell Sc+R1 through discal cell and base of cell CuA2) complementing jagged, thin, medial line and one to two adjacent cell-end streaks. Male genitalia with vinculum near saccus greatly distended (saccus length almost twice exceeding width of vincular arc) and valvae comparatively small.

DESCRIPTION. *Male.* Upper surface of wings: ground brilliant iridescent blue with crisp fuscous borders in the subapices and submargins. Under surface of wings: ground brown; forewing with thin, whitish postmedial line, costa to cell CuA2; hindwing with thin, dashed, jagged, medial white line from costa to cell CuA1, thereafter incised in a compact "W"-shape before anal angle. Discal area with one or two crisp white cell-end streaks; postbasal area with thin, white, line (cell Sc+R1 through discal cell and base of cell CuA2). Limbal area generally unmarked; Thecla-spot pronounced, colored dull orange. Length of forewing: 15.0–16.5 mm. *Female.* Upper surface of wings: ground bright iridescent aquamarine bordered crisply in subapices and margins with fuscous. Under surface of wings: similar to male. Length of forewing: 15.0–17.0 mm. *Male Genitalia.* Figure 8B. Typical of genus but with vinculum greatly distended toward saccus and length of latter greatly exceeding that of vincular arc. Falces very thin for genus; valvae thinly parabolic in the bilobed area, then tapered abruptly to short caudal extensions. Brush organs in elongate bundles abutting the distended dorso-cephalic surface of the vinculum. Aedeagus elongate, length exceeding the rest of genitalia by about one-fourth, caecum comprising slightly more than one-fourth aedeagal length. *Female Genitalia.* Fig. 9B. Caudal and cephalic elements robust, latter exceeding length of former by about one-fourth. Lamellae distally expansive compared to group member *O. aunia* (see below). Juncture of ductus and cervix bursae with small struts; signa with elongate base and distal spine. Apophyses papillae anales elongate, exceeding length of caudal element of ductus bursae.

TYPES. Syntype male, BMNH, labelled "Bogota, Colombia, Hew. Coll. 79-69, Thecla ahola, Hew. (1)," "B. M. Type No. Rh. 841," hereby designated lectotype, and "Mexico, Hew. Coll. 79-69, Thecla ahola Hew. (2)," "B. M. Type No. Rh. 842" hereby designated paralectotype (BMNH practice).

DISTRIBUTION. Known from central Mexico S to the Guyana Shield and montane Ecuador.

REMARKS. *Intrageneric Relations.* This common species has always been considered distinctive and here has only required further distinction from some taxa variously considered synonyms by early authors. Typical of character homogeneity in *O. ahola,* the syntypes (though from disparate localities) are indistinguishable by wing and genitalic features. I make the Colombia syntype lectotype since its locality is central in the species' range.

Variation. Despite widespread distribution, wing character variation in *O. ahola* is slight, dark brown under surface ground with white postbasal line being diagnostic throughout. There is slight variation in the brilliance and distal expanse of upper surface iridescence in both sexes. Stability of these characters in *O. ahola* makes the species of the following two entries more outstanding.

Biology. Ross (1964, 1975–1977 [1976]) reports *O. ahola* from disparate habitats. This is consistent with the distributions of museum specimens indicating widespread sympatry of *O. ahola* and other congeners, particularly lowland xerophiles but also upland *O. cordelia.* This cosmopolitanism in *O. ahola* probably accounts for its overall character homogeneity.

MATERIAL EXAMINED. BRAZIL. *Mt. Roraima, 5,800 ft, 28 February 1927 (female) (AMNH). COLOMBIA. *Cali, Western Cordillera, 19 February 1935 (male) (AMNH); *Rio Quirata, 27 December 1945 (female) (AMNH); San Miguel (male) (AMNH); Valle del Cauca, Colima, 1,500 m, 12 April 1974, leg. S. & L. Steinhauser (one male) (AME); *Bogota, 1,700–2,800 m, dry season (one male) (BMNH); *Interior of Colombia, garden (three females) (BMNH); "Colombia" (four females) (BMNH). ECUADOR. *Balzabamba (one male) (BMNH); "Ecuador" (five males) (BMNH); GUATEMALA. Chimaltenango, Panajabal, 1,250 m. Mpia. San Pedro Yepocapc, 2 January 1966, leg. E. Welling (one female) (CMNH); *Polochic Valley (one male) (BMNH). HONDURAS. *La Cambre, 11–12 February 1922 (three males) (BMNH). MEXICO. Santa Rosa, Comitan, September 1961 (one male), July 1967 (one female), both leg. T. Escalante (both AME); Presidio, Vera Cruz State, March 1944, May 1945, September 1949, September 1939, May 1945, leg. T. Escalante (five males) (AME); Santa Rosa, Comitan, Chiapas State, September 1961, leg. T. Escalante (one male) (AME); Fortin, Vera Cruz State (seven females) (CMNH); "Mexico" (one male) (BMNH); Rio "Quatal," January 1909, 1,800 m (one male) (BMNH); *Orizaba, Vera Cruz, March 1908 (one male, one female) (AMNH); *Presidio, Vera Cruz (male) (AMNH); Huigra, 16 July 1914 (male) (AMNH); *Piedrancha Marino, 3 May 1966 (one male, one female) (AMNH). PANAMA. *La Boca, Canal Zone, 22 December 1907 (one female) (AMNH). VENEZUELA. Piedel, Cerro La Victoria, Aragua, CM Expedition, 6 May 1929 (one male) (CMNH); *"Venezuela," leg. Druce (two males) (BMNH).

Orcya aunia (Hewitson), **New Combination, revised status**

Figs. 4C, D, 8C, 9C

Thecla aunia Hewitson 1863–1878 [1874] (1):167, (2):pl. 65, figs. 464, 465; Druce, 1907:603 [misspelled as "*anina*"]; Godman & Salvin, 1879–1901 (2):64; Comstock & Huntington, 1958–1964 [1959]:71, 85; Johnson, 1989:13.

Thecla orcynia [not *orcynia* Hewitson]: Godman & Salvin, 1879–1901 (2):64; Draudt, 1919:788; Comstock & Huntington, 1958–1964 [1959]:71, 85; Bridges, 1988:I.40, I.258 (synonymy in error).

DIAGNOSIS. Notably small for genus (FW 13.5–14.5 mm). Wing upper surfaces comparatively dull, males resembling females (see Types and Remarks). Under surface similar to *O. orcynia* but duller and with obsolescent post-basal slashes complementing the single cell-end streak. Differing from *O. ahola* on the upper surface as above and on the under surface with more pronounced and meandering pattern to the postbasal and medial markings. In the genitalia, male valvae thin with bilobes and caudal extension steeply tapered; saccus shorter than congeners, not equalling width of vincular arc or length of valvae; female genitalia robust with diminutive lamellae and caudal ductal element.

DESCRIPTION. *Male.* Upper surface of wings: ground dull iridescent dark blue-green with crisp fuscous borders in the subapices and margins. Under surface of wings: ground brown; forewing thin, dull postmedial line, costa to cell CuA2. Hindwing with thin, meandering, white medial line from costa to cell CuA1, incised in slight "W"-shape before anal angle. Discal cell with thin white cell-end streak; postbasal area with thin, obsolescent line (cell Sc+R1 through discal cell and base of cell CuA2). Limbal area generally unmarked; Thecla-spot reduced, colored dull orange. Length of forewing: 13.5–14.5 mm. *Female.* Upper surface of wings: ground dull, dark iridescent silver-tinged blue with unevenly bordered fuscous apices and margins. Under surface of wings: similar to males. Length of forewing: 14.0–14.5 mm. *Male Genitalia.* Figure 8C. Valvae with bilobed area and caudal extension both elongate and slender compared to congeners; saccus notably short for genus and brush organs robust, abutting thickened dorso-cephalic surface of vinculum. Aedeagus relatively short for genus, but exceeding shorter overall genital configuration by about one-third, caecum comprising slightly more than one-fourth aedeagal length. *Female Genitalia.* Figure 9C. Ductus bursae robust for genus, with terminal lamellae and cephalic element of ductus bursae both diminutive (length of cephalic ductal element about one-half that of caudal element). Cervix bursae with wide sclerotized struts nearly conjoined by sclerotin as in *O. marmoris.* Signa relatively small for genus, flat-based with short, inwardly directed, spine. Length of apophyses papillae anales about equal to that of caudal ductus element.

TYPES. BMNH holotype, labelled female, but is actually a male, labelled "T. aunia type Hew." Venezuela, Druce Coll.," "Druce Coll. ex Kaden Coll." "female, B.M. Type 839," "Godman-Salvin Coll. 1911-93. B.C.A. Lep. Rhop. Thecla orcynia Hew." (see Remarks).

DISTRIBUTION. Appears to be an insular Guyana Shield species, presently known from scattered localities in Venezuela and the "Guianas."

REMARKS. *Intrageneric Relations.* Distinctiveness of the type specimen is attested by its traditional diagnosis as a female (Hewitson, 1863–1878 [1874]; Godman and Salvin, 1879–1901). Accordingly, Godman & Salvin (1879–1901) distinguished the "male" of *T. aunia* as a synonym of *T. orcynia* with Draudt (1919) and subsequent authors following this interpretation. The type specimen had never been dissected. Specimen search in this study has located small samples from scattered locales on the Guyana Shield which share the characters of the type and distinguish the apparent companion females. Genitalia suggest membership in the ahola Group, consistent with the slight postbasal band appearing on most specimens.

MATERIAL EXAMINED. VENEZUELA. *Cucuta (one male) (BMNH); *Cucuta (two males) (MNHN); *Merida (one male, one female) (BMNH).

The bassania Group

Taxa share lunular pattern elements in the forewing and hindwing medial bands complemented by additional lunular postbasal, discal and submarginal markings; male genitalia exhibit distinctive lateral keels on the ventral valval surfaces; female genitalia are generally elongate relative to congeners and usually have two small sclerotized struts at the cervix bursae.

Orcya bassania (Hewitson), **New Combination**

Figs. 5A, B, 8D, 9D

Thecla bassania Hewitson 1868:14; 1869:(1) 117; (2) pl. 47, figs. 217, 218; Kirby, 1871:388; Godman & Salvin, 1879–1901 (2):66, 719; Hoffman, 1940:714; Comstock & Huntington, 1958–1964 [1959]:92; Bridges, 1988:I. 48; Johnson, 1989a:13.

DIAGNOSIS. Pattern elements of under surface bands distinctly lunular, complemented on the forewing by additional discal lunules and, on the hindwing, postbasal and discal lunules. Though outstanding among *Orcya* taxa, these lunular markings must be distinguished from those of *O. marmoris* (see below). On the latter, the lunular markings are webbed between the discal and medial areas, particularly on the forewing. Male genitalia exhibit distinctive lateral keels at the juncture of each bilobed area and caudal extension.

DESCRIPTION. *Male.* Upper surface of wings: ground bright iridescent blue bordered with crisp fuscous subapices and margins. Under surface of wings: ground brown patterned with prolific gray to tawny lunular markings—forewing with postmedial line and marginal lines, costa to cell CuA2; hindwing with medial, postbasal and discal lines, lunular elements most emphatic toward costa and often suffused distally with tawny or gray. Limbal area usually with white, crennate, intercellular markings framing bright orange Thecla-spot. Length of forewing: 15.0–16.5 mm. *Female.* Upper surface of wings: ground bright aquamarine to gray-green with uneven fuscous apices and margins. Under surface of wings: similar to males. Length of forewing: 15.0–17.0 mm. *Male Genitalia.* Figure 8D. Typical of genus but with valval marked by ventrally directed keels at each juncture of the bilobed area and caudal extension followed by thinly tapered termini. Vincular spurs wide and lobate, saccus funnel shaped and about equal in length to the valval. Brush organs in thick bundles abutting dorso-cephalic surface of vinculum. Aedeagus elongate, length exceeding rest of genitalia by about one-third, caecum comprising somewhat less than one-third aedeagal length. *Female Genitalia.* Figure 9D. Cephalic section of ductus bursae robust and elongate, exceeding length of caudal section by one-third to one-forth (excluding length of attachment to cervix bursae). Terminal lamella with wide, cephalically directed flaps. Juncture of ductus bursae and cervix bursae greatly concave but without additional sclerotizations at distal end of corpus bursae. Signa broad-based with a short, inwardly directed, spine. Apophyses papillae anales about equal to length of caudal ductus section.

TYPES. Holotype male, BMNH labelled, "Mexico," "Hewitson Coll. 79.-69. Thecla bassania (1)," "Type," "Thecla bassania Hew.," "B.M. Type No. R.H. 848."

DISTRIBUTION. Mexico S through Panama.

REMARKS. *Intrageneric Relations.* Along with *O. orcynia* and *O. ahola, O. bassania* has long been considered distinctive. It requires superficial distinction only from *O. marmoris,* a seldom-collected sister species occurring in Ecuador and, perhaps, Venezuela (see Remarks under *O. marmoris*).

Variation. The wing pattern is generally stable with only a few insular populations (particularly in Central America) showing exaggeration of the lunular markings in the costo-medial area of the hindwing. Genitalia appear homogeneous throughout the species range.

Biology. Distribution of museum specimens indicates widespread sympatry with other *Orcya* taxa, particularly lowland xerophiles *O. orcynia* and *O. ahola. O. bassania* also occurs in uplands where it has been taken with *O. cordelia.*

MATERIAL EXAMINED. COSTA RICA. Volcan, Barba, San Jose, 5 July 1971, H. L. King (one male) (AME); Tree Rios, 5,000 ft, January (one female) (CMNH); *"Costa Rica," leg. Gillott (eight males) (BMNH); *Azahardo Cartago (one female) (BMNH); Irazu (two females) (BMNH). EL SALVADOR. *La Libertad, 26 April 1964, leg. S. & L. Steinhauser (one male); Los Planes, San Salvador, 1,000 m, 20 July 1967, leg. S. & L. Steinhauser (one male) (AME). GUATEMALA. Guatemala City (one male, one female) (CMNH); *Polochic Valley (one male) (BMNH). MEXICO. Presidio, Vera Cruz State, leg. T. Escalante, June 1941, February 1939, July 1942, September 1941 (four males), May 1945, April 1939, May 1938, September 1942, May 1940 (five females) (all AME); Michoacan, Tzararacua Falls, 6 mi S Urupan, Parkland Forest, 1,500–1,580 m, 8 August 1973, leg. L. D. and J. Y. Miller (one male) (AME); Ochuc., Chiapas State, 27–30 June 1971, leg. Wind (one female) (AME); Orizaba, June–July 1904, leg. A. Hill (one female) (AME); Hildalgo, 4 mi NE Chappulhacan, 800 m, moist forest, leg. L. D. and J. Y. Miller (one female) (AME); Yantepec, Morelas State, October 1961, leg. T. Escalante (one female) (AME); Mexcala, Gerrero State, August 1960, leg. T. Escalante (one female) (AME); Avavidaro, June 1960, leg. T. Escalante (one female) (AME); Tenancingo, March 1969, leg. T. Escalante (one female) (AME); 19 mi E Concordia, Sinaloa State, 25 October–1 November 1961 (six males, four females) (CMNH); Ajijic, Jalisco State, 5,400 ft, 7 December 1966 (one male) (CMNH); San Carlos, 60°51'N, 25 May 1969 (one male) (CMNH); Jalapa, May 1900 (one male), Jalapa (three males, two females) (all CMNH); *Jalapa (five males, five females) (AMNH); *Coatepec (one male) (AMNH); *Orizaba, Vera Cruz (one female) (AMNH); "Mexico" (three males) (AMNH); *Jalapa (four males, five females), April 1896 (five males), February 1896 (one male) (all BMNH); Orizaba, March 1888 (two females) (BMNH); *Cordoba (two females) (BMNH); Yucatan (one male) (BMNH); "Mexico" (one female) (BMNH). PANAMA. Chiriqui, Potrerillos, 3,600 ft, leg. H. L. King, 26 December 1965 (one male), 28 December 1964 (one female), 8 February 1978 (one male), 8 January 1978 (one male), 8 January 1973 (three females) (all AME); *El Volcan, Chiriqui, 29 February 1936 (male) (AMNH); Colon, 200 m, 22 October 1949, leg. Pina (one female) (AME); Calif, Chiriqui, 5,000 ft, leg. H. L. King, 15 December 1972 (one male), 21 December 1972 (one male) (both AME); Chiriqui Mountains, Bonere (two males) (AME); *Chiriqui (three males, one female) (BMNH).

Orcya marmoris (Druce), **New Combination**

Figs. 5C, D, 8F, 9F

Thecla marmoris Druce 1907(3):604; Comstock & Huntington, 1958–1964 [1961]: 162; Bridges, 1988:I.215; Johnson, 1989a:13.

DIAGNOSIS. Resembles *O. bassania* because of the marked lunular pattern elements. However, in *O. marmoris* these markings are meshed in a webbed pattern between the discal and medial areas of the forewing and basally to the postbasal area on the hindwing. In the genitalia, males have a rather square vinculum and lack the ventral valval keels prominent on *O. bassania.* Females exhibit additional sclerotized components distad the lamellae terminus, similar only to those in *O. supra* and *O. larseni* of the orcynia Group.

DESCRIPTION. *Male.* Upper surface of wings: ground bright iridescent blue with crisp fuscous borders in the subapices and margins. Under surface of wings: ground brown, patterned with prolific lunular and weblike markings. Forewing with thin, wavy, white postmedial line meshed basally to meandering white discal markings. Hindwing with this, meandering medial line meshed basally with diverse discal and postbasal markings in a web-like fashion. Limbal area with prominent white intercellular markings; Thecla-spot dull orange. Length of forewing: 14.5–15.0 mm. *Female.* Upper surface of wings: ground bright iridescent aquamarine to gray-green with uneven fuscous apices and margins. Under surface of wings: similar to males. Length of forewing: 14.5–15.5 mm. *Male Genitalia.* Figure 8F. Typical of genus but with valvae stout and obliquely triangular in shape (wide shoulder at the bilobed area but tapering abruptly cephalad and caudad). Saccus length exceeding length of vincular are but not greatly, resulting in rather robust vincular configuration. Aedeagus length exceeding rest of genitalia by about two-fifths; caecum comprising about one-third aedeagal length. *Female Genitalia.* Figure 9F. Terminus of ductus bursae with additional sclerotized components extending distally to the eighth tergite. Length of caudal ductal element exceeding that of cephalic element by more than one-third and with latter dorsally included before the cervix bursae. Length of apophyses papillae anales exceeding that of caudal element of ductus bursae.

TYPES. Holotype male, BMNH, labelled "T. marmoris, type H. H. Druce," "Colombia, 1898, Purchased from Rosenberg, 99-268," "type," "R.M. No. Rh. 842."

DISTRIBUTION. Known from montane Ecuador and a disjunct Venezuelan population (see Remarks).

REMARKS. This distinctive species is poorly represented in collections and has been generally ignored in the literature. The additional terminal sclerotized components characterizing the female genitalia (Fig. 9F) occur in both the Venezuelan and Ecuadorian disjuncts of this species, causing me to consider these populations conspecific.

MATERIAL EXAMINED. ECUADOR. *Canar, Angas, 1,000 m, December 1974, leg. LaFebre (two males) (AME); *Balzapamba, Bolivar Province, leg. de Methan 1893–1894 (sixteen males) (BMNH); *Chimbo, 1891, leg. de Methan (two males) (BMNH); Nonegalito, 26 August 1956 (one female) (MPM). VENEZUELA. *Merida, 1887 (one male, one female) (BMNH).

DISCUSSION

Orcya is comprised of several familiar, widespread and common Neotropical hairstreak butterflies. It also includes some little-known species from areas of South America seldom visited by collectors. The geographic distribution of *Orcya* (Central America and South America outside the Amazon Basin) is typical of many eumaeine groups and generally congruent with the range of the structurally more apomorphic sister group *Noreena/Contrafacia* (Johnson, 1989a). Particularly distinctive of *Orcya*, however, is the occurrence of four sympatric taxa in the region from Central America southward to northern South America.

Orcya appears comprised of three major lineages: the orcynia, ahola and bassania Groups. Of these, only the orcynia Group has sympatric taxa both north and south of the Amazon Basin. From Central America southward to northern South America, members of all three lineages show broadly sympatric and generally congruent geographic distributions. The more structurally apomorphic ahola and bassania Groups have representatives only north of the Amazon Basin. South of the Amazon Basin the orcynia Group shows further diversity, three taxa localized in ecologically stratified regions of the Argentine Andes. This distributional pattern may suggest an ancestral distribution for *Orcya* predating Amazonian disjunction, with disjunction restricting radiation of the ahola and bassania groups solely to the north.

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FOSSIL AND EXTANT MACROCHELID MITES (ACARI: MACROCHELIDAE) PHORETIC ON DROSOPHILID FLIES (DIPTERA: DROSOPHILIDAE)

George O. Poinar[1] and David A. Grimaldi[2]

[1]Department of Entomological Sciences, University of California,
Berkeley, California 94720, and
[2]Department of Entomology, American Museum of Natural History,
New York, New York 10024

Abstract.—A drosophilid specimen in Dominican amber, *Protochymomyza miocena* Grimaldi, has phoretic macrochelid mites attached to it. This find is compared with extant phoretic associations between macrochelid mites and adult drosophilids.

It is well documented that many Mesostigmata, Prostigmata and Astigmata Acari (mites) are phoretic on a wide variety of insects from various orders, but information on the ages of such behavior, as indicated in the fossil record, is very sparse. During routine examination of amber for examples of symbiosis in the fossil record, we have found several examples of mite phoresy on insects in samples of amber from the Dominican Republic. Due to the rapid and very complete method of preservation provided by amberization examples of behavior in the fossil record can be excellently preserved.

MATERIALS AND METHODS

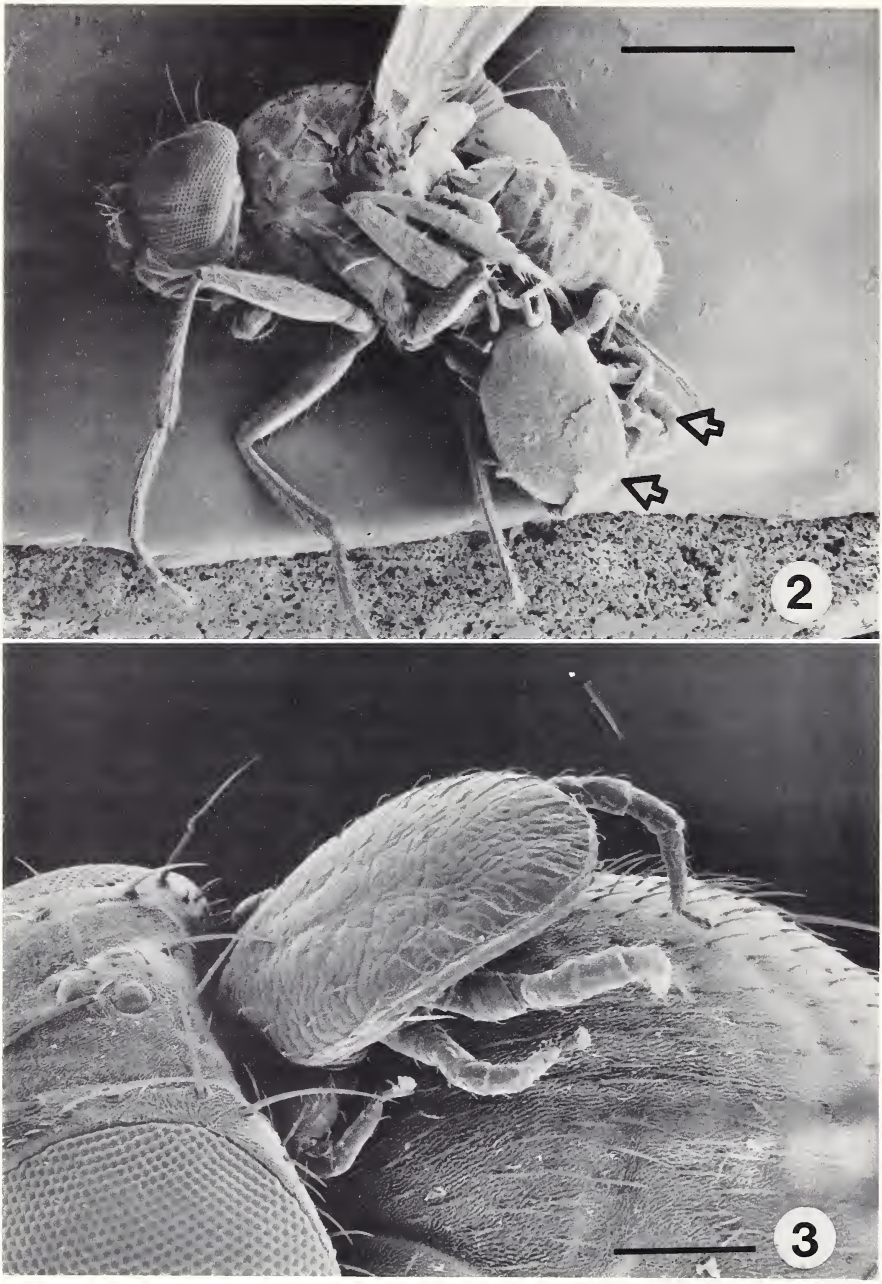
An amber piece containing three mites attached to a drosophilid fly was recognized by the senior author during an examination of samples of Dominican Republic amber (Fig. 1). These deposits have been estimated to range from Lower Miocene to Upper Eocene in age (25–40 million years) and represent the oldest known fossil invertebrates from the West Indies and probably all Mesoamerica. The adult fossil drosophilid fly, *Protochymomyza miocena,* was described by Grimaldi (1987). The fossil and extant mites were identified as belonging to the Macrochelidae by G. W. Krantz. For his assistance we are very appreciative.

Extant cases of phoretic mites on adult Drosophilidae were found by the junior author on material swept in the field. Specimens were critical point dried from absolute ethanol, sputter-coated with 200Å gold and examined with a scanning electron microscope under a 10 KV beam current.

RESULTS AND DISCUSSION

Extant collections of adult Drosophilidae revealed individuals with several types of phoretic mites, including macrochelids. Figures 2 and 3 illustrate how macrochelid mites position themselves on the flies. Figure 2 shows a male *Neotanygastrella* sp. collected from Arima, Trinidad, with two macrochelid mites on the ventral surface of the abdomen. Another macrochelid mite, lodged in the cervical membrane between

Fig. 1. Fossil male drosophilid (*Protochymomyza miocena* Grimaldi) in Dominican amber, showing two (arrows) of the three macrochelid mites attached to the ventral and latero-ventral portions of the abdomen (scale bar = 0.5 mm). Insert shows terminal view of the fossil, revealing all three mites (arrows).



Figs. 2, 3. Macrochelids on extant drosophilids. 2. *Neotanygastrella* sp. from Arima, Trinidad, with two mites attached to the abdomen (arrows) (scale bar = 0.5 mm). 3. *Drosophila* sp. from Trinidad with a mite lodged in the cervical membrane (scale bar = 200 μm).

the head and thorax (dorsal) of *Drosophila* sp. collected in Trinidad, is shown in Figure 3.

The fossil male *Protochymomyza miocena* has three macrochelid mites attached to the ventral and latero-ventral surface of the abdomen.

Macrochelid mite phoresy on members of adult Drosophilidae would be restricted to habitats supporting the developmental stages of both fly and mite. Extant *Neotanygastrella* and their close relatives in the genus *Chymomyza* breed in decaying bark (e.g., Grimaldi, 1986), a natural environment also for macrochelid mites. It is likely that the fossil species (being closely related to extant *Chymomyza* species) also bred in decaying bark. These flies normally feed on fungal (basidiomycetes) infested wood.

It is interesting that in extinct and extant situations, the mites are attached to the ventral or ventral-lateral surface of the abdomen. In the case of extant relationships of macrochelid mites on drosophilids, there has never been found more than 3 mites per fly (as is found in the fossil) and they are always in a position that does not unbalance the fly during flight. Normally, if 3 mites are on one fly, two would always be attached just lateral to the median line on the same but opposite parts of the fly's body. The third would usually be located on the ventral median line either between the other two mites or slightly anterior or posterior to them. This is the position of three mites on the fossil drosophilid.

The primary benefit of any type of phoresy is dispersal (Binns, 1982). Specifically, by these mites being dispersed by drosophilids, they are tracking a potential food since macrochelids are known to feed on fly eggs (Farish and Axtell, 1971). Drosophilids can benefit since macrochelid mites may attack natural fly parasites. Macrochelids are well known for feeding on nematodes in culture (Kinn and Witcosky, 1977), and drosophilids are parasitized by allantonematid nematodes (Welch, 1959), and in some cases this can be a major factor in mortality (Montague and Jaenike, 1985). Thus it is interesting that another fossil drosophilid, *Chymomyza primaeva* (Grimaldi, 1987), recovered from the same deposits as *P. miocena,* was parasitized by allantonematid nematodes (Poinar, 1984). Thus, by feeding on the free-living infective stages of allantonematid nematodes, macrochelid mites could lower the rate of drosophilid infection. Presumably, the relationships between macrochelids, drosophilids, and allantonematids was established some 25–40 million years before present.

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BIOLOGY AND IMMATURE STAGES OF *COENIA CURVICAUDA* (DIPTERA: EPHYDRIDAE)

B. A. Foote
Department of Biological Sciences, Kent State University,
Kent, Ohio 44242

Abstract.—Information is presented on the life cycle and larval feeding habits of *Coenia curvicauda* Meigen, a widely distributed and common species of the ephydrid subfamily Ephydrinae. The larvae are trophically generalized and are able to utilize a wide variety of algae as well as decomposing plant detritus. However, certain algal foods seemingly are more suitable, as they permit larval growth to be completed more quickly. In northeastern Ohio, the life cycle can be completed in 16–25 days, and there are 9–12 generations a year. The egg, mature larvae, and puparium are described and illustrated. The larval morphology is compared to that of *Paracoenia fumosalis* Cresson.

The genus *Coenia* Robineau-Desvoidy, a member of the subfamily Ephydrinae, is considered by Mathis (1979) to be relatively close phylogenetically to *Lamproscatella* Hendel, *Scatella* Robineau-Desvoidy, and certain other related genera within the tribe Scatellini but to be relatively distantly related to another scatelline genus, *Paracoenia* Gresson. This latter conclusion is in distinct contrast to earlier workers who tended to place *Coenia* close to *Paracoenia* (Wirth, 1965). In fact, Sturtevant and Wheeler (1954) considered *Paracoenia* to be a subgenus of *Coenia*. Wirth (1965) included *Coenia* in the tribe Scatellini, but Mathis (1979) has recently concluded that this tribe is paraphyletic and merely an assemblage of convenience.

Coenia includes few species that only occur in northern areas of the Holarctic Region. *Coenia palustris* (Fallén) is limited to Europe; *C. alpina* Mathis apparently is restricted to North America; whereas the third species, *C. curvicauda* (Meigen), has a Holarctic distribution (Mathis, 1975). In the Nearctic Region, *C. curvicauda* ranges from eastern Canada to Alaska and south to New Jersey, Ohio, Nebraska, and Montana (Mathis, 1975, map 3).

Nothing has been published on the life cycle, larval feeding habits, or morphology of the immature stages of any species of *Coenia* (the paper by Beyer, 1939, on *Cänia fumosa* Stenhammar actually deals with a European species of *Paracoenia*). The present paper outlines the life history; elucidates the larval feeding habits; and describes and illustrates the egg, third larval instar, and puparium of *C. curvicauda*.

MATERIALS AND METHODS

All observations were made between 1982 and 1988 in Portage County, Ohio near the city of Kent. Life-cycle information was obtained under laboratory conditions of a constant temperature (ca. 22°C) and a photoperiod of 16L:8D. To determine larval food preferences, monocultures of algae were established on nutrient agar in sterile petri dishes. Most of the algal cultures were obtained from The University of Texas Culture Collection of Algae. Species of algae utilized, and their UTEX strain numbers, are listed below. Species lacking strain number were obtained in nature or from the phycology laboratory at Kent State University. Feeding tests were performed as outlined in Zack and Foote (1978).

Cyanophyceae: *Anabaena flos-aquae* (1444), *Anabaena variabilis* (B377), *Calothrix* sp., *Cylindrospermum* sp. (LB942), *Gloeocapsa alpicola* (B589), *Lingbya spiralis* (B1831), *Oscillatoria tenuis* (B428), *Synechococcus leopoliensis* (625).

Chlorophyceae: *Chlamydomonas eugametos* (9), *Chlorococcum* sp., *Cosmarium botrytis* (175), *Scenedesmus quadricauda* (76).

Bacillariophyceae: *Navicula pelliculosa* (668).

Xanthophyceae: *Botrydiopsis alpina* (295).

LIFE HISTORY

Adults of *C. curvicauda* usually are found in open or partially shaded wetlands having noticeable accumulations of decaying organic material. Deonier (1964) collected adults from mud-shore and limnic-wrack habitats, and Scheiring and Foote (1974) found them to be abundant on muddy shores and common in the limnic-wrack habitat. The latter workers recorded adults between early April and early October, but noted that populations were much reduced in July and August. They found larvae in moist to wet substrates having high concentrations of organic matter. Apparently, *C. curvicauda* can also occur in coastal habitats, as adults have been taken in salt marshes and wrack beds (Dahl, 1959; Simpson, 1976). I found adults most abundantly in open wetlands having relatively little emergent vegetation, but having high levels of decaying organic matter within or covering the substrate. They were particularly common over foul-smelling mud along a small, shallow drainage ditch that carried the effluent of a small sewage treatment plant. Larvae were abundant in the sewage-impregnated mud bordering the ditch. Other species of Ephydridae commonly collected with *C. curvicauda* included *Paracoenia fumosalis* Cresson, *Scatella favillacea* Loew, *S. picea* (Walker), *S. stagnalis* (Fallén), *Ochthera tuberculata* Loew, *Pelina truncatula* Loew, *Parydra aquila* (Fallén), *P. quadrituberculata* Loew, *Dichaeta caudata* (Fallén), and *Discocerina obscurella* (Fallén).

The flight period in northeastern Ohio extended from early March (5 March) to mid-October (17 October), with a definite decline in adult populations during the summer months. Fall populations were somewhat larger than those of summer, but distinctly smaller than those encountered in May and early June. No direct information is available on overwintering habits, but the collection of adults, including gravid females, during early March suggests that overwintering occurs as imagines.

Deonier (1972) reported that guts of field-collected adults contained about equal amounts of diatoms and other algal groups. The gut of a female that I collected on 5 March 1983, near Kent, Ohio, contained mostly diatoms.

The longevity of adults obtained in the laboratory rearings ranged from 10 to 27 days ($\bar{x} = 18$, N = 12). Males usually died a few days before females. The premating period averaged 3 days (N = 5).

Mating was resource based (Alexander, 1975), as it always occurred at sites possessing food resources (algae) required by the female. There did not appear to be any distinctive courtship behavior, and mating seemingly involved little more than efforts by males to initiate copulation with any suitably sized fly species. No evidence of lekking or territorial behavior was observed, and mating activities generally resembled those described for *Scatophaga stercoraria* (L.) (Scathophagidae) by Parker (1970). Mating occurred immediately after a receptive female was encountered, males did not "ride" females between copulations (Foote, 1983), and each copulation lasted from about a minute to nearly five minutes. At least in the laboratory breeding chambers, females mated repeatedly with the original male or with a series of males over a period of several days. Oviposition generally began two or three days after the initial copulation and continued nearly throughout a female's life span.

A female that was collected on 5 March on a warm (temperature reached 20°C), partly sunny day contained partially developed eggs. One ovary possessed 11 ovarioles; the other, 12. The number of recognizable eggs per ovariole ranged from 8 to 11 and averaged 9. These results suggest that early spring females have a potential fecundity of at least 198 eggs (9 eggs/ovariole × 22 ovarioles). Females confined to laboratory breeding jars deposited between 95 and 147 eggs ($N = 3$). One field-collected female deposited between 0 and 30 eggs daily between 12 April and 28 April, when she died. Between 13 April and 19 April, she laid an average of 15.4 eggs daily (11–30 eggs/day), but her daily production dropped to 0–2 during the last 7 days of life. Interestingly, all eggs obtained in the laboratory rearings were surrounded and partially covered by liquified fecal material deposited by the ovipositing female.

In the laboratory, females placed eggs into a lawn composed of a mixed culture of algae that covered a nutrient agar substrate in petri dishes. Most eggs were oriented horizontally and only slightly imbedded in the algal growth. In all cases the nipple end of the egg, which probably acts as a plastron (Hinton, 1960), was exposed to air. Eggs were found in nature similarly positioned in algae that covered sediments that were enriched by sewage effluent. Other eggs were found in finely divided detritus derived from decomposing plant material. Apparently eggs must retain contact with atmospheric air, as several that were forcibly held under water in small petri dishes failed to hatch. The incubation period lasted 2 to 3 days, with most eggs hatching in 2 days ($N = 30$). Hatching occurred through an eclosion line that developed just below the protruding nipple on the micropylar end of the egg.

Newly hatched larvae did not move more than few mm away from the egg shells before embedding themselves into the sediments and initiating feeding movements. In general, larvae remained buried in the food substrate up to their posterior spiracles but were able to feed for short periods (up to a few minutes) while completely immersed and out of spiracular contact with the overlying air. However, larvae that were forcibly retained below the surface of sediments died within 24 hours. When touched, larvae quickly retracted the breathing tube into the sediments but within several seconds again renewed contact with the surface. Larvae did not actively burrow through the sediments but remained relatively immobile except for continuous probing movements by the anterior end. Feeding consisted of rapid forward and backward movements by the mouthparts, with the mouthhooks dragging the microbially-enriched sediments towards the oral opening located on the ventral side of the cephalic segment. The conspicuous comb-like structures on the facial mask (Fig. 11) undoubtedly also aided in moving food materials into the preoral cavity. The floor of the tentoropharyngeal sclerite possesses 9 Y-shaped ridges, with each ridge bearing apically a series of closely-spaced lamellae that collectively served as

Table 1. Results of larval feeding tests for *Coenia curvicauda* on different algal monocultures.

	Percent reaching different instars				
Algal species	n	2L	3L	P	A
Cyanophyceae					
Anabaena flos-aquae	10	100	100	70	70
Anabaena variabilis	10	40	30	30	10
Calothrix sp.	20	100	80	80	80
Cylindrospermum sp.	10	0	—	—	—
Gloeocapsa alpicola	10	0	—	—	—
Lingbya spiralis	20	40	20	15	0
Oscillatoria tenuis	20	80	70	55	55
Synechococcus leopoliensis	15	90	60	55	47
Chlorophyceae					
Chlamydomonas eugametos	10	100	100	60	60
Chlorococcum sp.	10	100	80	0	—
Cosmarium botrytis	10	20	0	—	—
Scenedesmus quadricauda	30	60	23	0	—
Bacillariophyceae					
Navicula pelliculosa	10	100	100	100	90
Xanthophyceae					
Botrydiopsis alpina	10	100	80	20	10

a filtering mechanism. This filter functioned to separate small particles from the semiliquid medium that was drawn into the pharynx and concentrated the particles into a bolus that was subsequently passed backwards to the foregut (Dowding, 1967). Guts of field-collected larvae contained a wide assortment of detrital particles, algal cells, yeast colonies, fungal hyphae, and bacteria. Larvae were reared successfully in the laboratory on a diet of crushed, decaying lettuce as well as on monocultures and mixed cultures of microorganisms. Table 1 presents the results of exposing newly hatched larvae to 14 different algal monocultures. The data suggest that the larvae are rather non-selective feeders, as they were able to complete development and produce adults on 8 of the algal species tested. Another indication that the larvae are polyphagous is the fact that they were able to utilize rotting lettuce, mud rich in sewage, mixed yeast cultures, and a variety of decaying basidiomycete fungi, although they failed to develop on pure cultures of the bacterium *Escherichia coli* (Migula) Castellani and Chalmers and the yeast *Rhodotorula aurantiaca* (Saito) Lodder. Larvae probably are best characterized trophically as being relatively non-selective microphages.

Although larvae were able to complete development on 8 species of algae, the total developmental time (combined larval and pupal periods) varied considerably among the different algal substrates (Table 2). Thus, *Navicula pelliculosa* and *Anabaena variabilis* gave the shortest developmental times (16.0 and 17.0 days, respectively), whereas the combined larval and pupal period was distinctly lengthened when *Botrydiopsis alpina* served as the larval food (29.5 days).

Table 2. Developmental time in days for *Coenia curvicauda* reared on different algal monocultures.

Algal species	Larval period		Pupal period		Combined period	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Anabaena flos-aquae (N = 7)	10.3	0.49	8.9	0.69	19.0	0.82
Anabaena variabilis (N = 1)	11.0	—	6.0	—	17.0	—
Calothrix sp. (N = 17)	8.5	1.33	9.6	0.79	18.1	1.07
Oscillatoria tenuis (N = 6)	8.0	0.63	10.3	0.82	18.3	1.03
Synechococcus leopoliensis (N = 3)	9.7	0.78	9.3	0.58	19.0	2.00
Chlamydomonas eugamatos (N = 6)	12.0	2.19	11.3	1.86	23.3	3.61
Navicula pelliculosa (N = 9)	8.9	0.78	7.1	0.78	16.0	1.12
Botrydiopsis alpina (N = 2)	18.0	0.00	11.5	0.71	29.5	0.71

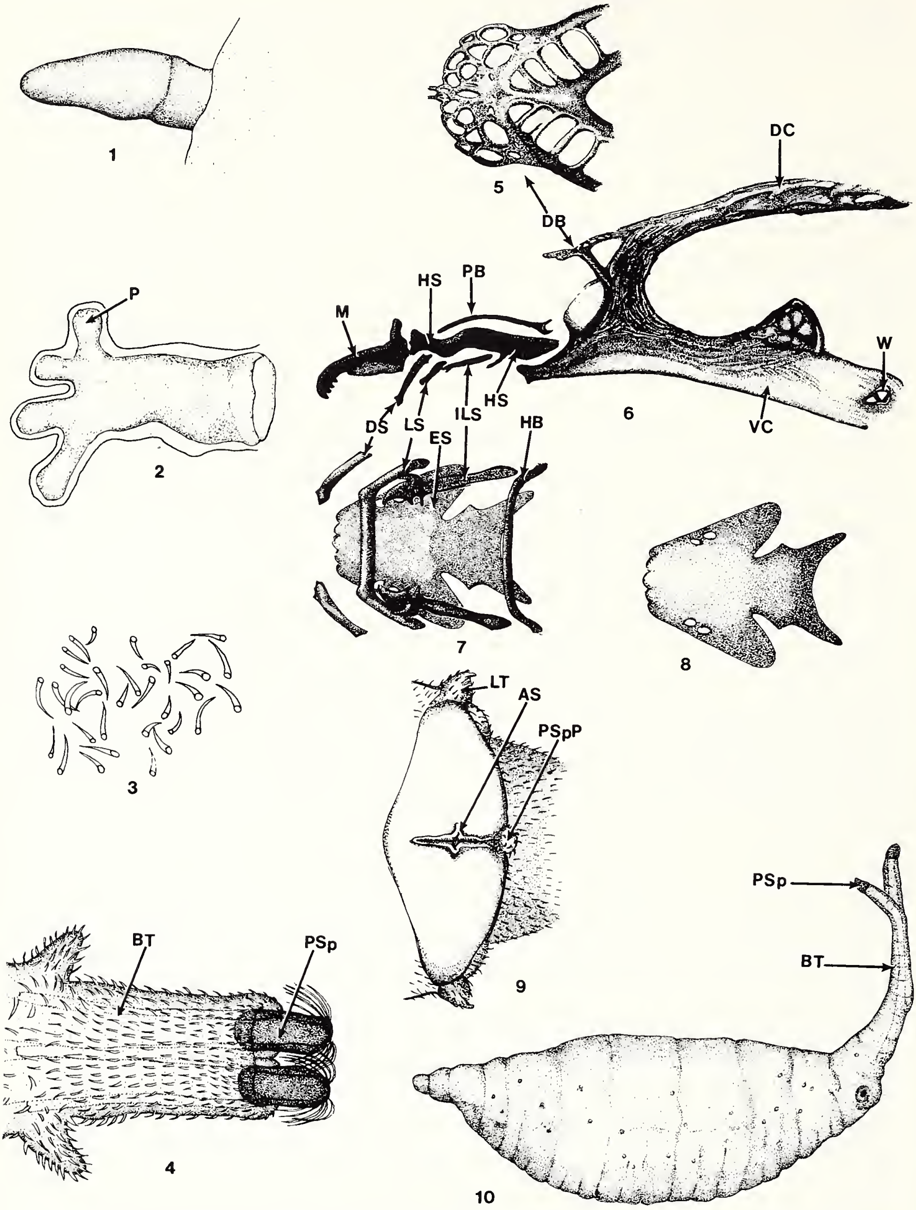
Mature larvae ceased feeding, emptied their gut contents, and increased their wandering activities prior to pupating. Many larvae moved to somewhat higher and possibly drier areas within the rearing dishes where they became relatively inactive and soon formed puparia. Other larvae crawled out of the dishes and eventually desiccated on the laboratory table. This behavior suggests that the larval microhabitat may not be the preferred site for pupation and that mature larvae move to somewhat drier areas before forming puparia.

When larvae were reared on *N. pelliculosa,* a diatom, the first larval stadium lasted an average of 1.7 days; the second, 1.7 days; and the third, 5.5 days (N = 9). The pupal period lasted 5–8 days and averaged 7 days (N = 5). The total developmental period from deposition of eggs to emergence of adults ranged between 14 and 20 days. This suggests that 9 to 12 generations could be produced during a warm season that in northern Ohio lasts from mid-April to mid-October (180 days).

DESCRIPTIONS OF IMMATURE STAGES

Egg. Length: 0.55–0.68 mm, $\bar{x} = 0.62$ mm; width: 0.19–0.23 mm, $\bar{x} = 0.21$ mm (N = 10). Elongate-ovoid, micropylar end with short, broad nipple arising on dorsal side; opposite end rounded. Chorion striated, ends of egg more reticulated. White.

Mature larva. Length: 7.2–8.0 mm, $\bar{x} = 7.6$ mm; width: 1.3–1.6 mm, $\bar{x} = 1.4$ mm (N = 5). Muscidiform, tapering anteriorly, caudal segment elongated to form retractile breathing tube; integument covered with fine pubescence of slightly darkened spinules, spinules uniform, none broadened to form dorsal patterns. Thoracic and abdominal segments bearing 2 kinds of sensilla; each rayed sensillum with slender tubular base and 4–5 elongate apical branches; each rosette sensillum short and peglike. Last two thoracic and first 7 abdominal segments each with 7 pairs of rayed sensilla: 1 dorsal, 2 dorsolateral, 1 lateral, 1 ventrolateral, and 2 ventral pairs; caudal segment with 6 pairs of sensilla: 3 ventral and 3 lateral along length of segment. Each body segment except caudal one also with 3 pairs of rosette sensilla: one pair adjacent to dorsal rayed sensilla, another pair next to dorsolateral rayed sensilla, and third pair adjacent to ventrolateral rayed sensilla; caudal segment with only 2 pairs of rosette sensilla, one pair adjacent to anteromost pair of ventral rayed sensilla, and second pair next to anteromost pair of lateral rayed sensilla.



Figs. 1–9. *Coenia curvicauda*, mature larva. 1. Antenna. 2. Anterior spiracle. 3. Integumentary spinules. 4. Dorsal view of posterior end. 5. Dorsal view of dorsal bridge of tentoropharyngeal sclerite. 6. Lateral view of cephalopharyngeal skeleton. 7. Ventral view of sclerites associated with hypopharyngeal sclerite. 8. Dorsal view of epipharyngeal sclerite. 9. Perianal pad. 10. Lateral view of puparium. ABBREVIATIONS: AS = anal slit; BT = breathing tube; DB = dorsal bridge; DC = dorsal cornu; DS = dental sclerite; ES = epipharyngeal sclerite; HB

Cephalic segment (Fig. 11) retractile, bilobed; each antennomaxillary lobe bearing antenna apicodorsally and circular sensory plate apicoventrally, antenna (Fig. 1) elongate and appearing 2-segmented, circular sensory plate consisting of incomplete ring enclosing 4–6 peg-like structures; facial mask (Fig. 11) with several rows of comb-like structures anterior of and lateral to preoral cavity, teeth of combs long and slender, directed posteriorly. Prothoracic segment spinulose, bearing anterior spiracles posterolaterally; each spiracle (Fig. 2) with slender, tubular base and 4–6 finger-like apical papillae. Thoracic segments encircled by fairly distinct bands of somewhat darkened spinules, lacking prolegs ventrally but with indication of creeping welt on metathoracic-first abdominal segmental boundary; abdominal segments rather uniformly spinulose (Fig. 3) and lacking distinct spinule bands, with ventral creeping welts at segmental boundaries; breathing tube of caudal segment (Fig. 4) with pair of pointed fleshy protuberances laterally at midlength, tube branched apically with each branch bearing deeply pigmented spiracles at tip; perianal pad (Figs. 9, 12) transversely elongate, tapered laterally, pad bordered posteriorly by spinule patch behind anal slit and laterally by pointed fleshy tubercle.

Posterior spiracles (Fig. 4) with 4 narrowly oval spiracular openings radiating out from ecdysial scar; 4 spiracular hairs present around margin of spiracular plate, hairs profusely branched dichotomously and arising on peritreme near outer border of each spiracular opening; ecydsial scar somewhat blackened, situation on inner side of spiracular plate.

Cephalopharyngeal skeleton (Fig. 6) mostly deeply pigmented. Tentoropharyngeal and hypopharyngeal sclerites separated; dorsal cornua slender, narrower than ventral cornua and connected anteriorly by fenestrated dorsal bridge (Fig. 5); ventral cornua with conspicuous dorsal lobe at midlength and small window apically; pharyngeal filtering mechanism present. Hypopharyngeal sclerite (Fig. 7) with 2 transverse bridges connecting lateral arms; parastomal bars slender, apparently fusing with epipharyngeal sclerite anteriorly; labial sclerites slender in lateral view, not fusing with each other apically. Mandibles deeply pigmented, relatively narrow; hook part slightly decurved and with 4–5 accessory teeth along ventral margin; basal part slightly broader than hook part and usually with elongate window near ventral border; dental sclerites rod-like in lateral view.

Puparium (Fig. 10). Length: 7.0–8.2 mm, $\bar{x} = 7.5$ mm; width: 1.4–1.7 mm, $\bar{x} = 1.6$ mm ($N = 4$). Posterior end narrowed and upturned to form distinct breathing tube. Integumentary structure as in mature larva.

DISCUSSION

In the following section, the eggs, mature larvae, and puparia of *Coenia* are compared to those of *Paracoenia*.

Eggs of the two genera are distinctive and easily separated. Eggs of *Paracoenia*

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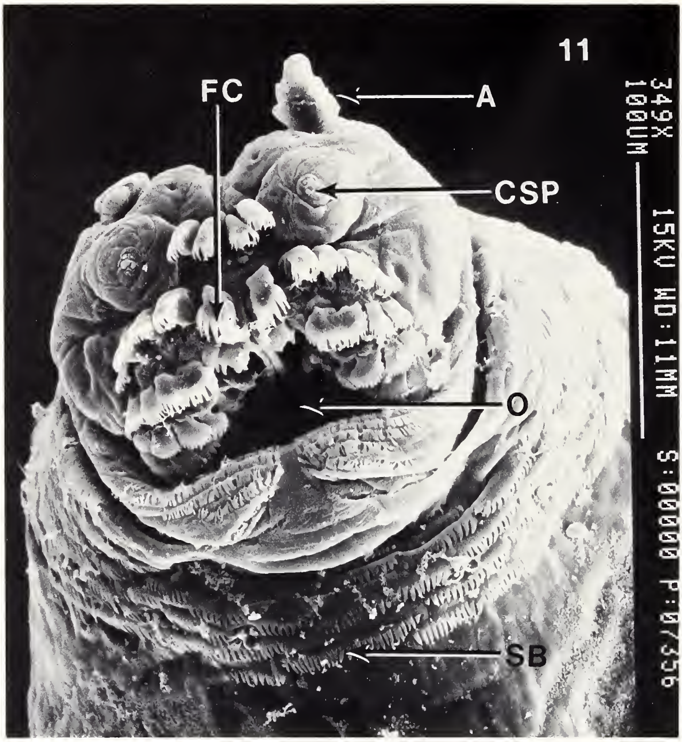
= hypopharyngeal bridge; HS = hypopharyngeal sclerite; ILS = internal longitudinal sclerite; LS = labial sclerite; LT = lateral tubercle; M = mandible; P = papilla; PB = parastomal bar; PSp = posterior spiracle; PSP = postanal spinule patch; VC = ventral cornu; W = window.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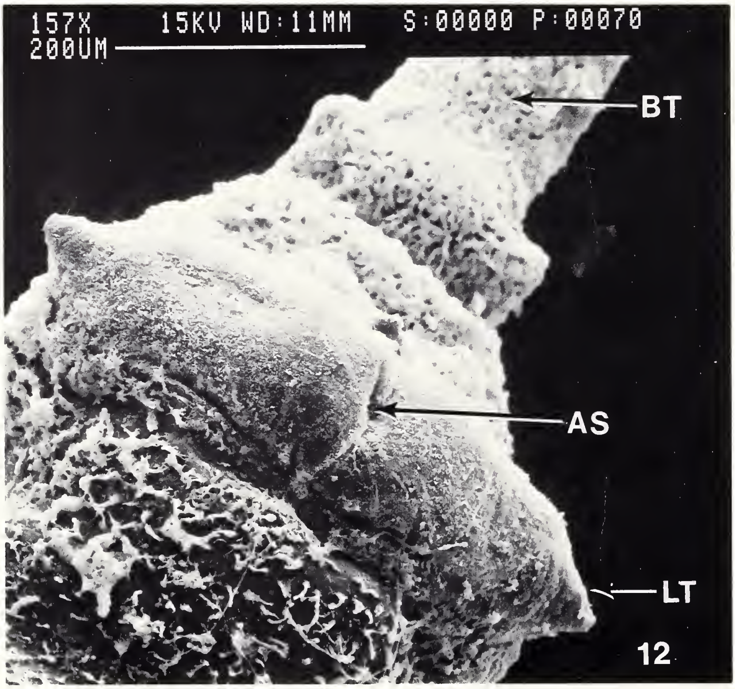
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have a long, slender filament extended away from the micropylar end of the egg, whereas those of *Coenia* possess a short, nipple-like extension that is only slightly longer than broad.

The mature larvae of the two genera are also distinctive. Larvae of *Paracoenia* are considerably larger, averaging 9.0 mm from the anterior end to the base of the perianal pad; larvae of *Coenia* average only 5.8 mm in this dimension. Larvae of both genera have an elongate, retractile breathing tube that when extended is 5–8 times its basal width. The shape of the perianal pad is dramatically different in the two genera. In *Paracoenia* the pad is nearly circular. In *Coenia* the pad is transversely elongate, being somewhat wide medially and tapering laterally to a distinct tubercle. The anterior spiracles are also distinctive. In *Paracoenia* the spiracles are narrowly elongate and bear only 2–3 apical papillae, but in *Coenia* the anterior spiracles are somewhat hand-shaped and bear 4–5 papillae along the distal margin.

The puparia of the two genera are best distinguished by the distinctive shape of the perianal pad, as described in the larval characteristics.

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Figs. 11, 12. *Coenia curvicauda*. 11. Facial mask. 12. Perianal pad. ABBREVIATIONS: A = antenna; AS = anal slit; BT = breathing tube; CSP = circular sensory plate; FC = facial comb; LT = lateral tubercle; O = oral opening; SB = spinule band.

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NOTES ON REPLETES, MYRMECOPHILES, AND PREDATORS OF HONEY ANT NESTS (*MYRMECOCYSTUS MEXICANUS*) (HYMENOPTERA: FORMICIDAE) IN ARIZONA

John R. Conway

Department of Biology, University of Scranton, Scranton, Pennsylvania 18510

Abstract.—Three nests of the honey ant, *Myrmecocystus mexicanus,* were excavated near Portal, Arizona and 548 of the 692 repletes in one colony were analyzed by color: 249 dark amber, 230 amber, 68 milky and 1 clear. Crop fluid of milky repletes contained the most protein. Replete abdomens were 6–12 mm long and weights ranged from 0.09–0.98 g. Dark amber and amber repletes had larger average abdominal lengths and weights than milky and clear ones. Replete chambers ranged in depth from 0.3–1.6 m. The number of repletes per chamber varied from 8–240. A wingless queen was in each nest but one colony also contained 112 winged males and 110 winged females. Probable predation by badgers on two nests was noted. An ant-loving cricket (*Myrmecophila* sp.) and collembolans in one nest are new myrmecophiles for this species.

Honey ants in the genus *Myrmecocystus* inhabit arid and semiarid areas of western North America and are unusual in producing swollen workers called repletes to store the seasonal flow of nectar (McCook, 1882; Wheeler, 1908; Snelling, 1976).

This paper discusses excavations of three *M. mexicanus* nests along the San Simon road about 4 kilometers northeast of Portal, Arizona at an elevation of about 1,433 m during the summers of 1982, 1985 and 1986.

MATERIALS AND METHODS

A *M. mexicanus* nest was carefully excavated 26 July–3 August 1986 by first digging two right-angle trenches about 1.8 m deep and 1 m from the entrance with a backhoe. The color, turgidity, and abdominal length of 548 repletes were noted and the ants weighed on a Mettler PB 300 balance. The Lowry procedure (Sigma Protein Assay Kit No. P5656) was used to quantitatively analyze soluble proteins in 148 repletes. Crop contents were extracted using a syringe with a 26 gauge needle and analyzed with an IBM-9420 UV-Visible spectrophotometer to determine total protein (μg/ml) at 540 nm absorbance. Two other nests were excavated manually with picks, shovels, and trowels in June 1982 and July 1985.

RESULTS AND CONCLUSIONS

Replete chambers. The average depth at which repletes were first encountered was 1.7 times greater in three Arizona ($\bar{x}$ = 49.7 cm) nests than in three Colorado ($\bar{x}$ = 29.3 cm) nests (Table 1). Others (McCook, 1882; Wheeler, 1910; Slocumb, 1966) also report the uppermost repletes in Colorado at shallow depths (8–35 cm). Perhaps the deeper Arizona chambers protect repletes from dehydration at higher tempera-

Table 1. Comparison of Arizona and Colorado nests of *Myrmecocystus mexicanus*.

Nest location, date	Depth of uppermost replete chambers (m)	Number of replete chambers	Number of repletes per chamber (min–max)	Total number of repletes	Maximum nest depth (m)
Portal, AZ July–Aug, 1986	0.58	11	8–240	692	1.6
Portal, AZ July, 1985	0.61	—	—	—	1.2
Portal, AZ June, 1982	0.30	—	—	—	1.4
Colorado Sprgs, CO June, 1973	0.17	19	1–149	806	1.8
Colorado Sprgs, CO Jan, 1973	0.20	21	1–348	1,030	1.4
Colorado Sprgs, CO Oct, 1972	0.51	7	2–28	—	1.1
Mean	0.40	14.5	—	843	1.4

tures. Rissing's (1984) excavation of an Arizona nest went even deeper, 1.3 m, without finding repletes.

Ninety-one percent of 692 repletes were in the bottom half of the Arizona nest (below 81.5 cm). In two Colorado nests, fewer repletes were in the lower half: 469 of 1030 (46%) and 348 of 806 (43%) (Conway, 1975). Thus, distribution of repletes in nests varies and may change in the same nest at different times of the year.

The 1986 Arizona nest had 11 replete chambers and the number in three Colorado colonies varied from 7–21. Snelling and George (1979) report more than 20 chambers in some nests. The number of repletes per chamber varied from 8–240 in the Arizona nest vs. 1–348 in Colorado nests (Table 1) (Conway, 1983). Variations in the number of chambers and repletes per nest probably indicate differences in colony age and/or abundance of food.

Maximum depths of Arizona nests, 1.2–1.6 m ($\bar{x} = 1.4$ m), are similar to Colorado nests, 1.1–1.8 m ($\bar{x} = 1.4$ m) (Table 1) (Conway, 1983). Other reports (McCook, 1882; Cazier and Mortenson, 1965; Slocumb, 1966) indicate greater variation, 0.8–2.3 m, and Snelling and George (1979) found a nest in California 4 m deep.

Myrmecophiles. Two new myrmecophiles were found in the 1986 Arizona excavation. An ant-loving cricket, *Myrmecophila* sp. (Family Gryllidae, Subfamily Myrmecophilinae) was in the deepest replete chamber (1.63 m) and springtails (Order Collembola) were in a chamber at 1.42 m. *Cremastocheilus* beetles are well-known myrmecophiles of *Myrmecocystus* in the Portal area that eat ant larvae. Cazier and Mortenson (1965) found 4–18 *C. stathamae* beetles in *M. mexicanus* nests. In 1986 I collected 4 *Cremastocheilus* beetles in surface passages and the 1982 excavation yielded 12 beetles between 17.8–55.9 cm.

Predators. Predation on honey ants seems low. In 1982 I found two *M. mexicanus* colonies partially unearthed, possibly by a badger (*Taxidea taxus*) (Chew, 1979). The first nest had a large burrow 27.9 cm from the entrance with an opening 27.9 cm by

Table 2. Analysis of repletes by color from 1986 excavation of *Myrmecocystus mexicanus* nest near Portal, Arizona.

Color of abdomen	Number of repletes N = 548	Protein content (μg/ml) N = 148	Mean abdominal length (mm) N = 548	Mean weight (g) N = 547
Dark amber	249	944.2 N = 60	10.76	0.67
Amber	230	927.3 N = 78	10.01	0.55
Milky	68	9,686.7 N = 9	9.36	0.30
Clear	1	1,700 N = 1	9.00	0.09
Range		230–26,900	6–12	0.09–0.98
Mean		1,472	—	0.57

38.1 cm. At the second colony the opening was 38.1 cm from the entrance and measured 20.3 cm by 25.4 cm. The only other predation I observed were spiders (*Euryopsis* sp.) carrying dead workers on scrub oaks in Colorado (Conway, 1985).

Reproductives. One wingless queen is in each *M. mexicanus* nest. The queen from the 1986 nest lived longer (473 days) than seven captured after their mating flights in Colorado (181 to 384 days, $\bar{x}$ = 297.6) (Conway, 1981). The 1982 excavation uncovered 112 winged males and 110 winged queens as well as the wingless queen. The number of winged reproductives I counted in Colorado nests ranged from 56–209 queens and 100–110 males (Conway, 1980a, 1983). These numbers suggest the reproductive potential of colonies differs considerably.

Analysis of Repletes

Coloration. Numbers, colors, and percentages of 548 repletes from the 1986 excavation were: 249 dark amber (45.4%), 230 amber (42%), 68 milky (12.4%) and 1 clear (0.2%). Dark amber and amber repletes were also more abundant in Colorado nests. Replete coloration may relate to different food sources. Amber and dark amber ants contain glucose and fructose and probably store nectar from flowering plants, galls and homopterans. Clear repletes contain large quantities of water and small amounts of sucrose (McCook, 1882; Snelling, 1976; Conway, 1977, 1980a). Milky repletes contain oil droplets and may store fluids from insect prey (Snelling, 1976). Burgett and Young (1974) found biphasic repletes in an Arizona *M. mexicanus* colony, containing carbohydrate and lipid layers.

Clear repletes were more numerous in two Colorado nests (22 and 35) (Conway, 1975) than the Arizona nest (1), but milky repletes (68) were only in the Arizona nest (Table 2). These findings are difficult to explain since we might expect more clear repletes in Arizona nests to store scarce water and milky repletes in Colorado nests to store dead insects that were brought back (Conway, 1980b).

Abdominal turgidity and gas. Abdomens of 548 Arizona repletes were categorized as turgid, turgid with gas bubbles, flaccid, or flaccid with gas bubbles. The majority of dark amber (98%) and amber (76%) repletes were turgid. The single clear replete had a bubble filling most of the abdomen. Flaccidity and bubbles were also more common in milky repletes perhaps indicating digestion or fermentation of crop contents.

Protein analysis. Mean total protein for 148 repletes was 1,472.0 μg/ml, but varied according to abdominal color. Protein content was about equal in amber (927.3) and dark amber repletes (944.2), but 1.8 times greater in the clear replete (1,700) and over 10 times more in milky repletes (9,686.7) (Table 2). The higher concentration in clear repletes is difficult to explain if their function is to store water, but was not totally unexpected since a previous analysis revealed amino acids (Conway, 1977). Higher protein in milky repletes is consistent with insect storage.

Abdominal length and weight. Abdominal lengths of 548 Arizona repletes ranged from 6–12 mm. Average lengths varied by color: dark amber ($\bar{x} = 10.76$ mm); amber ($\bar{x} = 10.01$ mm); milky ($\bar{x} = 9.36$ mm); and clear (9 mm). Weights of 547 repletes ranged from 0.09–0.98 g ($\bar{x} = 0.57$ g). If a replete is defined as having an abdominal length 10 mm or more, then 420 were repletes (mean weight = 0.64 g). The remaining 127 semi-repletes had a mean weight = 0.33 g. Mean weights varied by color: dark amber ($\bar{x} = 0.67$ g); amber ($\bar{x} = 0.55$ g); and milky ($\bar{x} = 0.30$ g) (Table 2).

The progression from most numerous, heaviest and longest to least numerous, lightest and shortest was: dark amber; amber; milky; and clear. Low weights of milky and clear ants seem related to more abdominal gas, flaccidity and smaller size. Clear repletes also contain fewer dissolved solids (Conway, 1977). The weight of full turgid dark amber repletes increased an average of 0.08 g for each 0.5 mm increase in length.

The average replete, 0.64 g, is 299 times heavier than a worker (mean dry weight = 2.14 mg) (Chew, 1987). Total "honey" stored in the 692 swollen ants ($\bar{x} = 0.57$ g) of the 1986 Arizona nest is about 394 g.

Development from workers. Semi-repletes developed from workers in Colorado laboratory colonies given only water and repletes formed in colonies given sugar water. Semi-repletes appeared in 8 nests 15–89 days ($\bar{x} = 50.4$) after introduction of sugar water or water and repletes developed in 4 nests 14–222 days ($\bar{x} = 77.3$) after the addition of sugar water. Thus, it takes about 4 weeks longer, on average, for a semi-replete to become fully distended (Conway, 1975, 1977). These times are longer than other reports. Wheeler (1910) believed repletes develop only from callows and reported 28–42 days to form semi-repletes and repletes. I saw semi-repletes and repletes form from both callows and mature workers (Conway, 1975) and Rissing (1984) also formed repletes in 24 days from non-callow workers fed honey water and crickets.

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ON THE SPIDER FAMILY ANAPIDAE (ARANEAE, ARANEOIDEA) IN THE UNITED STATES

Norman I. Platnick and Raymond R. Forster
Department of Entomology, American Museum of Natural History,
Central Park West at 79th Street, New York, New York 10024

Abstract.—The only known Nearctic anapid, *Chasmocephalon shantzi* Gertsch from California and Oregon, is not congeneric with the Australian type species of *Chasmocephalon* and is placed in the new genus *Gertschanapis.*

The tiny orb-weaving spiders of the family Anapidae are quite common in tropical and south temperate forests of both the Old and New Worlds, but the distribution of the family in north temperate areas is patchy, including the Mediterranean region, Nepal, Korea, and Japan. In the United States, only a single species is known, described as *Chasmocephalon shantzi* by Gertsch (1960) and apparently endemic to California and Oregon.

The genus *Chasmocephalon* was described by O.-P. Cambridge (1889) for the Australian species *C. neglectum*; over the ensuing century, the genus has served as a dumping ground for a wide variety of dissimilar species from South Africa, New Zealand, and Australia as well as the United States. Forster (1959) and Brignoli (1981) corrected several of these misplacements but, like the other authors involved, did not examine *C. neglectum,* instead basing their concept of the genus on the much more fully described Tasmanian species *C. minutum* Hickman (1943). As Brignoli (1981:112) indicated, "the lack of an adequate description of the generotype leaves open many doubts on the real identity of this genus." Although Brignoli did not study specimens from the United States, he noted (1981:113) that "The puzzling *Ch. shantzi* Gertsch, 1960 from California and Oregon has a specialized femur and a very long embolus: it does not fit in any of the genera I know."

In the course of a recently completed revision of the anapid faunas of Chile, New Zealand, New Caledonia, and Australia (Platnick and Forster, in press), we were able to examine the holotype female of *C. neglectum,* and to confirm (from modern material) that it is a Western Australian endemic (because the holotype was found by O.-P. Cambridge attached to the leg of a much larger mygalomorph spider, long after that mygalomorph was collected in Western Australia, it could easily have become accidentally associated with that specimen and could actually have come from some other region entirely). *Chasmocephalon* has proved to be a sizable genus, containing seven other species from various parts of Australia, but none of the taxa previously associated with *C. neglectum* are actually congeneric with that species. Hence we describe here the new genus needed to contain *C. shantzi*; interestingly, this American species does seem to be more closely related to true *Chasmocephalon* than to the other known New World genera or to the misplaced Tasmanian species that supported previous misconceptions of *Chasmocephalon.*

We thank Mrs. C. M. Tibbetts for supplying illustrations. Material was obtained

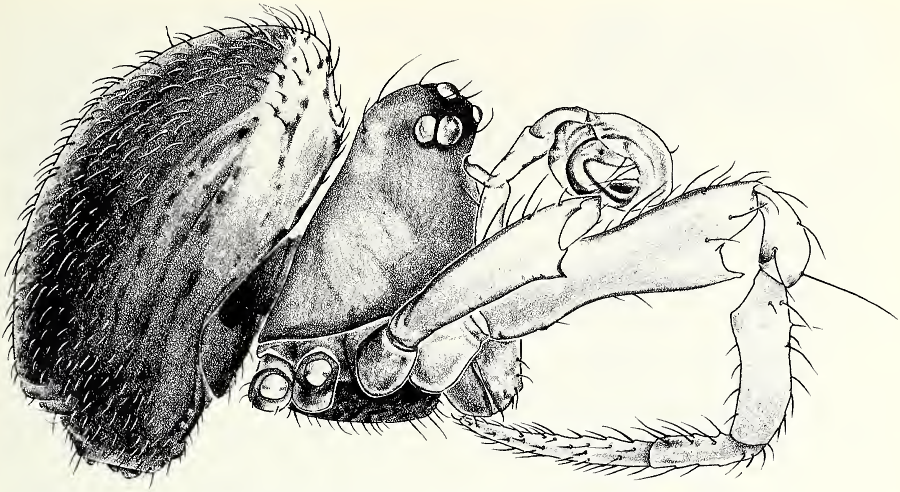


Fig. 1. *Gertschanapis shantzi* (Gertsch), male, lateral view.

from the collection of the American Museum of Natural History (AMNH) and from Dr. H. W. Levi of the Museum of Comparative Zoology, Harvard University (MCZ), Dr. E. I. Schlinger of the University of California at Berkeley (UCB), and Mr. S. Frommer of the University of California at Riverside (UCR); the assistance of those curators is much appreciated. This research was supported by NSF grants BSR-8312611 and BSR-8406225 to the first author.

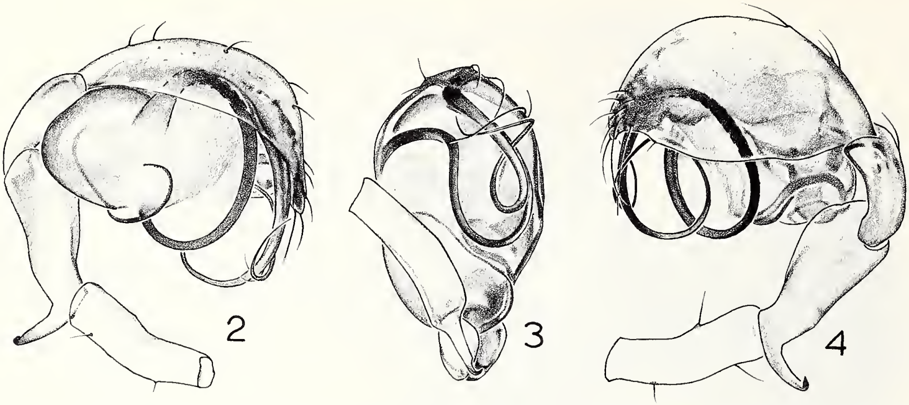
Gertschanapis, new genus

Type species. Chasmocephalon shantzi Gertsch (1960).

Etymology. The generic name is in honor of Willis J. Gertsch, a pioneer in the study of American Anapidae, and is feminine in gender.

Diagnosis. Members of this genus can be recognized by the enlarged ventral tubercle situated subdistally on femora I and II in both sexes (Fig. 1). Males have an elongated, dorsally directed apophysis situated proximally on the palpal patella (Figs. 2–4). Females have uniquely spiralled ducts in the internal genitalia (Fig. 5).

Relationships. Two putative synapomorphies associate *Gertschanapis* more closely with a group of Australasian genera than with any of the other American anapids (three Neotropical genera revised by Platnick and Shadab, 1978, 1979, and six temperate South American genera revised by Platnick and Forster, in press). These characters are, first, the incorporation of the anterior pair of spiracles into the anterior abdominal suctum and the anterior displacement of those spiracles to a position about halfway between the epigastric furrow and pedicel, and second, the rotation of the cephalic porepit onto a sclerite that is reflexed under the lateral margin of the carapace and that thus separates the dorsal edge of the palpal endites from the carapace. The Australasian anapids sharing these characters include some of the genera from New Zealand and Australia, and all the genera known from New Caledonia (Platnick and Forster, in press).



Figs. 2–4. *Gertschanapis shantzi* (Gertsch), left male palp, prolateral, ventral, and retrolateral views.

Description. Relatively large anapids (total length over 1 mm). Eight eyes, anterior medians much smaller than others. Cephalic porepit on reflexed sclerite situated between endites and anterolateral corners of carapace. Abdomen with dorsal scutum in males, anterior scutum incorporating advanced anterior spiracles supplying tracheae to both abdomen and cephalothorax (contrary to the statement of Gertsch, 1960:5); posterior tracheae lost (Forster, 1958, fig. 27). Femora I and II with enlarged ventral tubercle situated subdistally. Female palpal segments beyond coxa represented only by small knob on endites. Female genitalia haplogyne.

Gertschanapis shantzi (Gertsch), new combination
Figs. 1–5

Chasmocephalon shantzi Gertsch, 1960:5, figs. 2–8 (male holotype from Hastings Natural Reservation, Monterey Co., California, in AMNH, examined).

Diagnosis. With the characters of the genus and genitalia as in Figures 2–5.

Male. Described by Gertsch (1960).

Female. Described by Gertsch (1960), who correctly indicated that there is no external epigynum. The internal genitalia are of unusual complexity for the family, including a pair of dorsolateral flaps partially enclosing a pair of rounded receptacula on long, spiralled ducts (Fig. 5).

Variation. The size of the enlarged ventral tubercles on femora I and II is somewhat variable, with the largest tubercles (as shown in Fig. 1) occurring on specimens from the San Francisco Bay area.

Material examined. UNITED STATES: **California:** *Amador Co.:* 2 mi NE Jackson, Apr. 16, 1957 (L. M. Smith, R. O. Schuster, AMNH), 1♀. *Butte Co.:* Chico, Sept. 4, 1958 (L. M. Smith, R. O. Schuster, AMNH), 1♂. *Calaveras Co.:* 2 mi W San Andreas, Mar. 25, 1958 (L. M. Smith, R. O. Denning, AMNH), 1♂, 2♀. *Contra Costa Co.:* Moraga, Oct. 5, 1981 (D. G. Denning, AMNH), 1♀; no specific locality, June 3–4, 1983 (D. G. Denning, AMNH), 1♀. *Los Angeles Co.:* SE end, Bouquet Reservoir, Nov. 17, 1980, pack rat nest under oak (K. W. Cooper, UCR), 3♂, 3♀; Glendale,

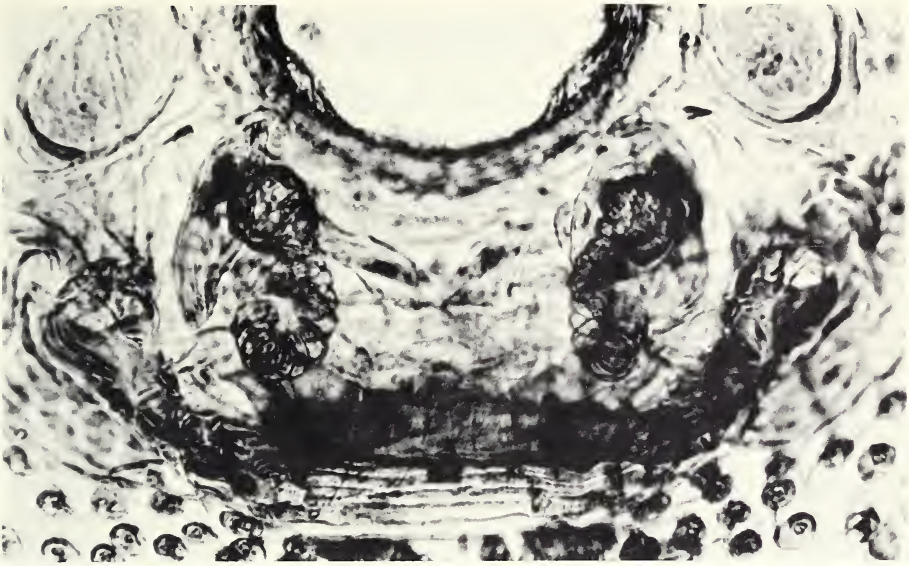


Fig. 5. *Gertschanapis shantzi* (Gertsch), internal female genitalia, dorsal view.

Nov. 24, 1950 (E. I. Schlinger, AMNH), 1♀; Los Angeles, Aug. 5, 1931 (W. Ivie, AMNH), 1♀; Montrose, Dec. 31, 1932 (W. Ivie, AMNH), 2♂, 3♀. *Marin Co.:* Bolinas, Mar. 24–Apr. 7, 1960 (R. O. Schuster, AMNH), 13♂, 8♀; 1 mi S Inverness, May 17, 1953 (D. D. Linsdale, UCB), 1♂, 1♀; 1 mi W Inverness, Mar. 1, 1960 (Grigarick, L. M. Smith, R. O. Schuster, AMNH), 2♂, 2♀; 6 mi E Point Reyes Station, Mar. 1, 1960 (Grigarick, L. M. Smith, R. O. Schuster, AMNH), 1♂, 2♀; San Geronimo, Sept. 19–21, 1963–1965 (J. and W. Ivie, AMNH), 2♀; Taylor State Park, Sept. 21, 1965 (J. and W. Ivie, AMNH), 1♀. *Mendocino Co.:* Inglenook Fen, 4 mi N Fort Bragg, Aug. 12–Dec. 15, 1973, elev. 30–50 ft, dune, fen areas, vacuum samples (C. E. Griswold, UCB), 14♀, 4♂. *Monterey Co.:* Hastings Natural History Reservation, Mar. 13, 1936, wood-rat nest (J. M. Linsdale, AMNH), 1♂, 1♀ (types). *Napa Co.:* Mt. St. Helena, May 30, 1949 (E. I. Schlinger, AMNH), 1♂; Napa Valley Ranch, Apr. 12, 1958 (L. M. Smith, AMNH), 1♂. *Nevada Co.:* Chicago Park, July 26, 1950 (A. E. Cott, S. F. Bailey, AMNH), 1♀. *Placer Co.:* 4 mi W Newcastle, Mar. 19, 1959 (L. M. Smith, R. O. Schuster, AMNH), 1♂. *San Diego Co.:* Cleveland National Forest, near Henshaw Reservoir, July 30, 1956 (V. Roth, W. J. Gertsch, AMNH), 1♂; Mt. Palomar, June 18, 1955 (R. O. Schuster, AMNH), 1♀. *San Francisco Co.:* San Francisco, July 10, 1904 (AMNH), 1♀. *San Luis Obispo Co.:* beach NW San Simeon, Sept. 16, 1964 (J. and W. Ivie, AMNH), 1♂. *San Mateo Co.:* S Woodside, Sept. 17, 1964 (J. and W. Ivie, AMNH), 1♂. *Santa Clara Co.:* Stevens Creek, June 2, 1957 (R. O. Schuster, AMNH), 1♂. *Santa Cruz Co.:* Bonny Doon Road, 1.2 mi E intersection with Route 1, Apr. 4–5, 1980, redwood litter (J. Coddington, MCZ), 3♂, 5♀. *Shasta Co.:* Burney Falls, June 18, 1954 (R. O. Schuster, AMNH), 4♀. *Sonoma Co.:* 10 mi S Santa Rosa, Mar. 22, 1957, magnolias (L. M. Smith, R. O. Schuster, AMNH), 1♂. *Ventura Co.:* Matilija, near Ojai, June 16, 1955 (R. O. Schuster, AMNH), 1♀. *Yolo Co.:* 3 mi N

Rumsey, July 29, 1959 (L. M. Smith, R. O. Schuster, AMNH), 1♀, Aug. 29, 1959 (L. M. Smith, R. O. Schuster, AMNH), 1♂; 4.5 mi SW Winters, Apr. 23, 1959 (F. C. Raney, AMNH), 1♂, 2♀; 5.4 mi SW Winters, Jan. 17, 1960 (L. M. Smith, R. O. Schuster, AMNH), 6♀, May 29, 1959 (F. C. Raney, L. M. Smith, R. O. Schuster, AMNH), 1♂, 2♀. **Oregon:** *Benton Co.:* Corvallis, Oct. 15, 1949 (V. Roth, AMNH), 1♀. *Hood River Co.:* Perham Creek, 5 mi W Hood River, July 1, 1954 (V. Roth, AMNH), 1♀. *Washington Co.:* Forest Grove, Feb. 1941 (J. C. Chamberlin, AMNH), 1♂, 1♀. *Yamhill Co.:* Peavine Ridge, near McMinnville, Nov.–Dec. 1947 (K. M. Fender, AMNH), 2♀.

Distribution. Widely distributed in California and Oregon.

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J. New York Entomol. Soc. 98(1):113–122, 1990

OBITUARY

PETER D. ASHLOCK
1929–1989

The premature death of Peter Ashlock from heart failure at Lawrence, Kansas on 26 January 1989 brought to an end the career of one of America's leading Hemipterists. To those of us who have known him over the years it also brought the loss of a friend.

Ashlock's death, following so closely that of Wayne Gagné in Hawaii, brings to an end a long era in North American Hemipterology that was centered in California. This era started with E. P. Van Duzee and was continued in a distinguished manner by Robert L. Usinger and his protege, Peter Ashlock.

It is perhaps a deep irony that Ashlock died just as the new catalogue of North American Hemiptera has appeared as the first successor to the Van Duzee catalogue of 1917. We feel that his outstanding contribution to this new catalogue, in a format that he argued for so vigorously, must have given him a great deal of satisfaction.

Pete Ashlock was born 22 August 1929 in San Francisco and became interested in insects as a boy. He was really always a Californian although he spent most of his mature years elsewhere. California was where his heart was and he had intended to retire there in the summer of 1989. On 5 October 1970 he visited his home in California and wrote, "It was great to smell the odor of California Bay leaves." His wife learned to avoid making stewed tomatoes, for the perfume of bay floating upstairs to the study always brought on an attack of homesickness. Over the years he applied unsuccessfully for positions at three major California academic institutions. Each lack of success was a personal loss, and his letters express in a poignant understated way his sadness over not being able to go back where he belonged, to the place where he felt he could make a major contribution.

He received his B.S. in entomology from the University of California (Berkeley) in 1952, where he first came under the influence of Robert Usinger. The Korean War intervening, he then served two years as an ecological entomologist in the army at the Dugway Proving Grounds in Utah.

In Utah he developed the lifelong interest in the Lygaeidae that led him to the University of Connecticut at Storrs, where he worked with one of us (JAS), earned his masters degree in 1956 and met his future wife, Virginia (Jinny) Harris. [They were married in Greensboro, North Carolina on 25 June 1956.]

After their marriage the Ashlocks returned to Berkeley, where Peter began his doctoral work on a revision of the difficult and economically important genus *Geocoris.* In 1958 he accepted a position in Washington with the Entomology Research Division (USDA) at the National Museum of Natural History where he became a close friend of Harry Barber, at that time the dean of American lygaeidologists in the twilight of a distinguished career.

Here Ashlock developed a deep interest in the tribe Lethaeini, and it seems that almost with relief he left the geocorines, ostensibly because the Montandon types

Fig. 1. Peter D. Ashlock, ca. 1955.

were in the California Academy of Sciences. He enrolled in a doctoral program at the University of Maryland with Reece Sailer as his major professor.

Ashlock was never really happy in Washington. He did the routine identification tasks carefully and thoroughly, but felt that with the immense collections and library facilities available there that basic systematic studies should have been more strongly emphasized.

In 1960 (after a period of Ashlockian agonizing that only those of us who knew him intimately could appreciate), he returned to Berkeley, once again switched his thesis topic, this time into the Orsillinae that Professor Usinger, for his own doctoral dissertation, had explored so brilliantly in the Hawaiian islands. He remained at Berkeley for three years and with Usinger sailed on the *Golden Bear* to participate for three months in the 1964 Galapagos International Scientific Project to the Galapagos, Ecuador and Cocos Island.

In 1964 Ashlock accepted a position in Hawaii with the Bishop Museum. Here he found a stimulating work environment and collected on all of the major Hawaiian islands as well as in Laos, Vietnam, Thailand and Japan. He completed his Ph.D. work while in Hawaii and was awarded his degree from Berkeley in 1966. However, once again Ashlock seemed to be under an unlucky star, for while he found the working conditions ideal, the low salary, lack of security and high living costs for a family in Hawaii gradually eroded his enthusiasm and confidence.

Thus, when one of us (JAS) took a sabbatical leave, Pete took over teaching duties at the University of Connecticut for the 1967–1968 academic year on a leave from the Bishop Museum. In 1968 the Ashlocks made their last move, to the University of Kansas, where he became a full professor in 1981.

While not primarily a field man Ashlock, in addition to his travels while at the Bishop Museum, did some notable field work while at Kansas, most of which has not been published. He collected in Panama with Dodge Engleman and made an extensive trip, partially by sailboat, to the Marquesas and Tahiti in search of lygaeids that he believed would clarify some apparent vicariance distribution patterns in the Pacific.

He was not a society activist, but Peter was a member of the Pacific Coast Entomological Society, Entomological Society of America, Entomological Society of Washington, Kansas Entomological Society, Society of Systematic Zoology, Sigma Xi and the American Society of Plant Taxonomists.

Peter was a devoted student of the systematics of the Lygaeidae. He was the first to explore in detail the complex nature of the use of the aedeagus for both specific and higher group relationships. His several taxonomic revisions, especially his outstanding world revision of the Orsillinae, are all models of conscientious and detailed analysis and will be of great value for decades to come. He was always grateful for the careful editorial work of his wife Jinny, a professional editor who watched his always erratic spelling and kept an eagle eye on clarity and syntax.

However, Ashlock's systematic papers only give a faint hint of the enthusiasm which he had for the insects with which he worked. It is not every student who can look through his microscope at a dull brown insect 3 mm long and exclaim ecstatically, "Wow, look at that, have you ever seen such a beauty. Wow!" He always had that sense of wonder that sets apart the true first-rate worker. He had it from the day that he started his work and he never really lost it.

When he was a young student at the University of Connecticut he would come into the laboratory in the morning smoking the omnipresent cigarette and saying, "I couldn't get to sleep last night, so I kept trying to list all of the genera of Lygaeidae that I knew and then tried to put them into some kind of order relative to each other."

He was a complex man and we hope that in a small way we can bring a little of Peter D. to life, for he would, we think, like to be remembered not only for his science but for himself as a unique individual.

Most entomologists, and certainly almost all other taxonomists, do not know that Ashlock was one of the first American systematists to discover and understand what has come to be called the cladistic approach to systematics. In April 1961 he was at Berkeley while the late Pedro Wygodzinsky was there on a fellowship. Wygodzinsky had read Hennig's original papers in German and led a seminar on "phylogenetic systematics" that stimulated Ashlock along a path that he never really left, despite later verbose disagreements with the "true believers." These disagreements stemmed partly from his defense of paraphyly, but probably more from the widely held belief that he was a disciple of Ernst Mayr. This was only to a limited extent true, although Mayr respected Ashlock's views as evidenced by his asking him to co-author a revised edition of Mayr's book on the principles of systematic zoology.

Wygodzinsky was, to our knowledge, the first person to bring Hennig's philosophy to workers in the United States, and Ashlock was an avid "learner" of this new approach to establishing relationships. His acceptance of cladistics antedated that of the much better recognized advocates of this approach in vertebrate systematics by nearly a decade. It is ironic that Wygodzinsky and Ashlock, two of the earliest proponents of the cladistic approach, were in the end not really leaders in the adoption of the methodology in North America. This was probably in large part because of the personalities of the two men. Ashlock was aware of this, for in a letter to JAS in 1961 he intimated that Wygodzinsky recognized the storm of controversy Hennig's ideas would raise, but, said Ashlock, "Pedro will just sit back and grin and watch the fun." Ashlock also lamented the fact that he himself was by nature a quiet man, who avoided controversy and was not at his best in quick verbal repartee at meetings.

Ashlock believed that, while cladistic analysis is fundamental, classification by no means has to be based upon monophyletic (to him, holophyletic) units. He spent much time arguing in the literature and at meetings that the terms monophyly and holophyly—and associated concepts—were essential if one actually intended to use cladistic analysis for classification purposes. It was, we feel, an example of clear analytical thinking, if current ideas about primitive cosmopolitanism and peripheral speciation are correct, but unfortunately it came at a time when paraphyly was bad doctrine in the emotional rush to establish cladistic theory and methodology. Ashlock's defense of paraphyly lost him much of his standing in the coterie of new cladists.

Peter was not always the solemn theoretician. His handing out at meetings of a number of bright yellow buttons showing a cladogram with lines of different lengths and the motto "Preserve Paraphyly" was a source of amusement to him and to many others, but it also revealed the canonical commitment of those who were offended by the button—and there were many.

Although theoretical work was not his true love, Peter felt it necessary for advancement and recognition. It did not readily bring him the former, and although he was elected to the Governing Board of the Society of Systematic Zoology he was never a strong leader in the theoretical circles of North American systematists.

We venture to suggest Ashlock's career should be examined carefully as an example of what may be both good and bad in American systematics today. Ashlock felt that to obtain the scientific recognition and institutional promotion that he both needed and wanted that it was not enough to be one of the finest lygaeid taxonomists in the world, but that he needed to establish himself on a larger stage (read "conceptual"), to which end he spent an enormous amount of time attempting to develop a method of quantifying cladogenesis and anagenesis into an integrated system. We suggest that this problem in American science goes well beyond Pete Ashlock; while the pressure has been the spark of many careers it has poisoned many others. It did not poison his, but it certainly was a reason we are left with a lesser body of systematic work than we might have been from this outstanding man.

Peter was truly a nice person. We do not remember him having a mean bone in his body, and the many kind gestures that he made by way of advice and encouragement will live for a very long time in the minds of those who received them. As one of the authors of this note I (JAS) can attest to the important part that Ashlock played in suggesting and implementing the work of several of my graduate students, in some cases when I was not succeeding as well as I should have liked. No one was more generous with ideas or specimens.

Peter was not easy on himself. It is probably true that he was uneasy with authority, but it is not for us as entomologists to probe the reason for this. The lack of ease was counterbalanced by strongly held scientific convictions and by an enormous devotion to those he considered worthy and to whom he turned for advice. His admiration for Robert Usinger was complete and pure. Usinger had stimulated him when Ashlock was an undergraduate at Berkeley. While Usinger lived he played a

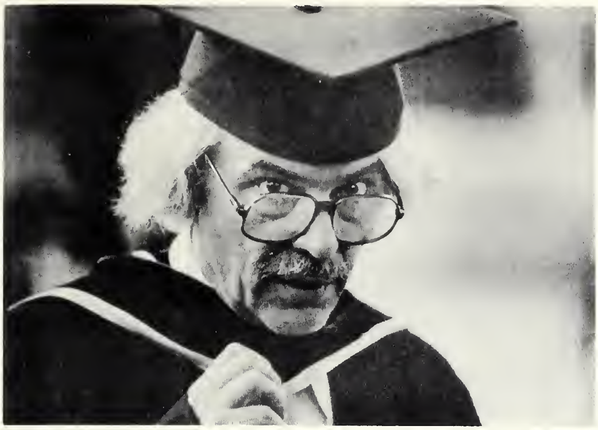

Fig. 2. Peter D. Ashlock, 1978.

major role in Ashlock's life. The death of Usinger, also at 59, was to Ashlock a grief that few of us really understood.

Neither was Ashlock introspective and he all too often was unaware of the nuances he created in those with whom he worked. His overwhelming enthusiasm for the Lygaeidae often made it difficult for him to believe that other subjects could possibly be of equal interest. This complete absorption sometimes had amusing consequences. One of us (JAS) cannot refrain from recalling a field trip several of us took to the Adirondacks immediately after a major New England hurricane in the 1950's through flooded roads in a car with such bad wheel alignment it could barely be kept on the road. We camped that night in the mud after a long frustrating day. As soon as we arrived Pete disappeared and in a couple of hours came back bubbling with joy over the rare lygaeids he had caught and pleased that the tents were up, sleeping gear arranged, food cooked, etc. Although he later traveled to dangerous places—Southeast Asia, Central America and widely in the Pacific—as I recall the look in the eyes of Richard M. Baranowski I do not think Peter Ashlock was ever nearer physical damage than he was at that moment.

His overwhelming desire to work on his insects and later on his phylogeny ideas conflicted several times with the demands and desires of those for whom he worked, and conflicted with the norms of academia. In his later years he took on the appearance of the proverbial absent-minded professor with a carelessness of dress and a sweeping mane of handsome white hair.

Ashlock's actual accomplishments, impressive as they are, by no means indicate his breadth of knowledge and the many things that he hoped to do. He was the kind of man whose best work at times seemed to be in starting others along paths that he saw first—and he saw a great many of them.

Some men pass in the fullness of time and while we miss what they might have contributed we feel that they have in a sense completed a successful career. Such men we admire and respect but for some reason we do not have such a personal sense of loss.

With Ashlock's passing we feel a different kind of loss, that of the fallible, very human man. The man who could be an enthusiastic member of several entomological societies *and* the International Wizard of Oz Club.

What his death means to Hemipterology is perhaps appropriately summarized by a comment one of our colleagues attributes to Einstein—that the death of a man is like a library burning to the ground. All is lost.

But what his death means to his friends is more in the nature of the opening of a recent novel "The Prince of Tides" when a young girl believes her mother has made the sun rise out of the Carolina tidal marshes, stands in wonder and says "Momma please make it come up again."—*James A. Slater, Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut 06268 and John T. Polhemus, University of Colorado Museum, 3115 S. York, Englewood, Colorado 80110.*

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3. 1959a A new species of *Discocoris* from Colombia (Hemiptera, Thaumastocoridae). Proc. Entomol. Soc. Wash. 61(1):25–26, 2 figs. [J. A. Slater and P.D.A.].
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8. 1960c New synonymies and generic changes in the Lygaeidae (Hemiptera-Heteroptera). Proc. Biol. Soc. Wash. 73(34):235–238.
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contribution 30. Pages 233–235 *in:* R. I. Bowman (ed.), *The Galápagos: Proceedings of the Galápagos International Scientific Project.* Berkeley and Los Angeles: University of California Press. [R. L. Usinger and P.D.A.].

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26. 1970b A new genus and new species of Saileriolinae (Hemiptera: Urostylidae). Pacific Insects 12(3):629–639, 10 figs. [C. W. Schaefer and P.D.A.].
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28. 1971b A key to the nymphs of the families of Hemiptera (Heteroptera) of America north of Mexico. Florida Entomol. 54(3):207–212, 13 figs. [J. L. Herring and P.D.A.].
29. 1972a The Lygaeidae of the Galápagos Islands (Hemiptera: Heteroptera). Proc. California Acad. Sci., fourth ser. 39(8):87–103, 15 figs.
30. 1972b Monophyly again. Systematic Zool. 21(4):430–438, 5 figs.
31. 1974 The uses of cladistics. Ann. Rev. Ecology and Systematics 5:81–99, 10 figs. Translated into Chinese, 1983, pp. 40–54, *in* Minchen Chow, Mee-mann Chang, & Xiabo Yu, *Selected Papers on Cladistic Systematics.* Beijing, Science Publication Corporation. Reprinted, 1985, as chap. 21. Pages 339–357 *in:* T. Duncan, and T. F. Stuessy (eds.), *Cladistic Theory and Methodology.* New York, Van Nostrand Reinhold Co.
32. 1975 Toward a classification of North American Lygaeinae (Hemiptera-Heteroptera: Lygaeidae). Jour. Kansas Entomol. Soc. 48(1):27–32, 4 figs.
33. 1976a The African genus *Hyalonysius* Slater (Hemiptera-Heteroptera: Lygaeidae). Jour. Entomol. So. Africa 39(1):87–96, 12 figs. [P.D.A. and J. A. Slater].
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37. 1979b Phylogenetic relationships. Pages 29–37 *in:* J. A. Slater, 1979, The systematics, phylogeny, and zoogeography of the Blissinae of the world (Hemiptera, Lygaeidae). Bull. Amer. Mus. Nat. Hist. 165(1):1–180. [J. A. Slater and P.D.A.].
38. 1979c An evolutionary systematist's view of classification. Systematic Zool. 28(4):441–450, 2 figs.

39. 1980a On a collection of Heteroptera (Hemiptera) from the Galápagos Islands. Pan-Pacific Entomol. 56(1):43–50. [C. W. Schaefer, J. Vagvolgyi, and P.D.A.].
40. 1980b The genus *Camptocoris* Puton with descriptions of two new species from South Africa (Hemiptera: Lygaeidae). Jour. Entomol. So. Africa 43(1):441–450, 5 figs. [J. A. Slater and P.D.A.].
41. 1980c Cytotaxonomy of the Lygaeidae (Hemiptera-Heteroptera). Univ. Kansas Sci. Bull. 51(26):717–801, 136 figs. [N. Ueshima and P.D.A.].
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46. 1984b A revision of the *Bergidea* group: a problem in classification and biogeography (Hemiptera-Heteroptera: Lygaeidae). Jour. Kansas Entomol. Soc. 57(4):675–688, 14 figs.
47. 1987a Classification: philosophies and methods. Chap. 6, pp. 42–51 *in:* R. S. Boardman, A. H. Cheetham, and A. J. Rowell, *Fossil Invertebrates.* Palo Alto, Blackwell Scientific Publications.
48. 1987b A revision of the genus *Bryanellocoris* with thirty-five new species from the southwest Pacific (Hemiptera-Heteroptera: Lygaeidae). Kansas Sci. Bull. 53(8):393–435. 42 figs. [Chen Jian-xiu and P.D.A.].
49. 1988 The Lygaeidae. Pp. 167–245 + portion of bibliography and index, in T. J. Henry and R. C. Froeschner. *Catalogue of the Heteroptera, or true bugs, of Canada and the continental United States.* Leiden and New York: E. J. Brill. [P.D.A. and A. Slater].

NAMES PROPOSED BY PETER D. ASHLOCK

Names proposed are followed by the number of the paper, and in parentheses the year (century omitted) with a serial letter, and following the colon a page number where the name was proposed.

LYGAEIDAE

ANTILLOCORINI 15(64b): 420
Arphnus
  melanotylus 9(61a): 21
Atrazonotus 16(68a): 154
Austronysius 21(67b): 30
  sericus 21(67b): 30

Balionysius 21(67b): 39
  maculatus 21(67b): 39
Bergidea
  atrata 46(84b): 681
Bryanellocoris
  adustus 47(87): 426
  antennellus 47(87): 426
  cornutus 47(87): 401
  coxaspinosus 47(87): 406
  cretatus 47(87): 406
  exophthalmus 47(87): 404
  fijiensis 47(87): 414
  furcatus 47(87): 402
  gagnei 47(87): 421
  globosus 47(87): 409

  gressitti 47(87): 419
  hebridensis 47(87): 410
  hexacanthus 47(87): 407
  humeralis 47(87): 410
  impensus 47(87): 421
  incultus 47(87): 408
  longirostris 47(87): 424
  maculatus 47(87): 425
  magnacornis 47(87): 408
  megalopsus 47(87): 404
  micrommatus 47(87): 416
  notatus 47(87): 423
  oculatus 47(87): 405
  piceus 47(87): 420
  pilosus 47(87): 411
  planifrons 47(87): 433
  porrectus 47(87): 415
  rostellus 47(87): 420
  russatus 47(87): 424
  samuelsoni 47(87): 421
  sedlaceki 47(87): 428
  spinulus 47(87): 417
  strongylus 47(87): 417
  tensus 47(87): 431
  unicolor 47(87): 431

Camptocoris
  rostratus 40(80b): 56
  thunbergi 40(80b): 59
Coleonysius 21(67b): 40
  dimorphus 21(67b): 41
Crompus
  nesiotes 20(69c): 501

Darwinysius 21(67b): 42
  wenmanensis 29(72a): 95
Dimorphopterus
  lepidus 24(69c): 722
  rondoni 24(69c): 722

Eremocoris
  cupressicola 36(79c): 150
Eurynysius 21(67b): 31
  meschioides 21(67b): 31
Extaramorphus 24(69c): 698
  magnatarsus 24(69c): 699

Geoblissus
  mekongensis 24(69c): 727
Glyptonysius
  amicola 19(66d): 814

Hyalonysius
  fumosus 33(76a): 91
  gilvus 33(76a): 94
  pallidomaculatus 33(76a): 93

Ischnodemus
  ambiguus 24(69c): 706
  fumidus 24(69c): 708
  nigrocephalus 24(69c): 710
  sinuatus 24(69c): 714

LEPIONYSIINI 21(67b): 23
Lepionysius 21(67b): 23
  grossi 21(67b): 23
Lipostemmata
  major 25(70a): 307
  scutellatus 25(70a): 305
Lygaeus
  bahamensis 6(60a): 117

Macropes
  comosus 24(69c): 680
  harringtonae 24(69c): 688
  lobatus 24(69c): 682
  minor 24(69c): 679
  pilosus 24(69c): 685
  pseudofemoralis 24(69c): 684
  yoshimotoi 24(69c): 694
Malezonotus
  arcuatus 2(58a): 206
  barberi 2(58a): 206
  obrieni 13(63a): 264
Metrarga
  elinguis 19(66d): 817
  molokaiensis 5(59c): 102
  swezeyi 5(59c): 103
Micrymenus
  brevalatus 46(84b): 685

Neocrompus
  fijiensis 18(66c): 691
  pallax 18(66c): 692

  vevarus 18(66c): 688
  zimmermani 18(66c): 689
Neseis (*Trachynysius*)
  legnotus 19(66d): 816
  neochinai 43(83a): 43
  pallasatus 19(66d): 815
Nesocryptias
  comis 19(66d): 820
  oahuensis 5(59c): 111
Nysius
  beardsleyi 19(66d): 822
  hardyi 19(66d): 821
  liliputanus 23(69b): 722
  palor 11(63a): 225
  usitatus 29(72a): 89
  wekiuicola 44(83b): 48

Oceanides
  euphoriae 19(66d): 807
  gressitti 19(66d): 808
  humeralis 19(66d): 812
  yoshimotoi 19(66d): 811

Ortholomus
  usingeri 29(72a): 91
Ozophora
  heydoni 6(60a): 123

Pachybrachius
  nesovinctus 29(72a): 98
Pamozophora 42(82a): 744
  englemani 42(82a): 745
Pseudomenus 42(82a): 747
  veovatus 42(82a): 747
Praetorblissus
  obrieni 34(76b): 577
  wilcoxi 34(76b): 575

Rugomenus 46(84b): 685

TARGAREMINI 15(64b): 421

Xyonysius 12(63b): 702

THAUMASTICORIDAE

Discocoris
  drakei 3(59a): 25

UROSTYLIDAE

Ruckesona 26(70b): 633
  vitrella 26(70b): 634

Saileriola
  hyalina 26(70b): 631

BOOK REVIEWS

J. New York Entomol. Soc. 98(1):123–124, 1990

ISLAND FAUNAS

Zoologia Neocaledonica (New Series), Vol. 1. S. Tillier (ed.) 1988. Mém. Mus. nat. d'Histoire Nat. 142:1–158. Available through E. J. Brill, Leiden, the Netherlands. Subscription price not supplied.

Captain James Cook was the first non-Melanesian to know of its existence, in 1774. Sixty-nine years later, there was a French Catholic mission established on this large island, 800 miles east of Australia. Being insular, it still has one of the singularly unique biotas of the world. For one, it is ancient (Paleozoic, as well as Cenozoic formations are exposed); it has an extensive interior cordillera (with peaks up to 5,500 ft); the east coast has rich subtropical forests, the west savanna; relicts, such as *Araucaria,* reign dominant. It is a fascinating section of the Austral Region. The island is also extremely rich in mineral resources and, ever since France annexed the island in 1853, deforestation has been rampant because of the strip mining for nickel and other metals. New Caledonia is now a French overseas territory, its biota endangered and unique, and a concerted collecting and survey effort is now being made to learn of its animals.

This is the first volume in a projected series devoted to the faunal analysis of New Caledonia. Five of the 14 contributions concern Diptera, the order of my specialty, which is why the volume was passed to me. Three of these Diptera contributions are on the Mycetophilidae and Drosophilidae, families of my special interest and research. All 14 contributions are on Hexapoda. It is a serial publication that taxonomists will want to watch for, and probably request reprints from for their groups, but it is not the sort of periodical to personally subscribe to (larger natural history libraries should be subscribing to this series).

All the contributions are of course in French (some of which have an English version of the *résumé*), with all contributors except one being either at the Laboratoire d'Entomologie, of the CNRS (Centre National Recherche Scientifique) in the Paris Museum, and/or at the Laboratoire d'Ecologie général (in Brunoy at the Université Paul Sabatier). Chapter one is the most important one in the series and would be generally useful to anyone with a biogeographic interest in New Caledonia. It gives descriptions of the collecting localities and a map, as well as a list of the papers (by taxa) published in Sarasin and Roux's series, Nova Caledonia, which appeared sporadically from 1913–1929, entirely in German.

Five papers (chapters 2, 3, 4, 5, 6) are each on a separate family of Poduromorpha Collembola. None of these treats the entire family being dealt with for New Caledonia, although the first collembolan paper, on the Hypogastruridae, gives a list of the 21 species in 7 families formerly known to exist in New Caledonia. Basically, these papers are just species and genus descriptions; the systematics is hardly synthetic. Najt's paper, on a new species of *Dinaphorura* (Oxychiuridae) does give a world key to species of the genus (I don't care how nationalistically proud the French may be of their language, but if I were Chilean, I would be very offended at their spelling, used by Najt, of "Chili"). The contributions are well illustrated, which might save future taxonomists the need to rummage through the Paris Museum to examine types and verify identifications. Other contributions are on the Phasmatodea (which at least gives a key to species in New Caledonia), one on two species of cicadas, a new genus of eriococcid scales, two new species of *Dasyhelea* biting midges, 2 new species of *Mycetobia* wood gnats, the keroplatine mycetophilids, the ditomyiine mycetophilids, and the drosophilids in the subgenera *Sophophora* and *Drosophila.* At least two of the authors, of which I am aware, have published elsewhere on New Caledonia taxa, so one might have to do some sleuthing to track down all the French papers treating New Caledonia taxa in your group (e.g., Clastrier, 1987; Matile, 1986). The popularity of faunal works (vs. revisionary treatments) with the French is disconcerting: in many cases it simply generates excessive higher-level nomenclature for localized taxa, with little regard to phylogenetic relationships among the worldwide taxa. Unfortunately for the French method, the uniqueness of New Caledonia and its fauna cannot be realized simply by describing a new genus of this or that. Analytic methods in historical biogeography among the French have not progressed beyond Jeannel.

The paper on *Mycetobia* is very interesting, for this is the first Australasian record of what is certainly the most primitive genus of Anisopodidae (the authors indicate, and are probably correct, that *Mycetobia* should be in its own family, the Mycetobiidae). I would have liked to see illustrations of the wing venation of these two new species. As well, how do these two species relate to other, world species of *Mycetobia*? It's an intriguing question given the apparent disjunct distribution of the genus (1 North American species, 1 species each from Costa Rica, Dominica [Lesser Antilles], and Ethiopia, and a possible Chilean species—certainly there are species between these areas as yet undetected). By far the best paper is the one by Matile on the Keroplatidae, and this is not due only to the fact that I am interested in this group. The paper is the largest in the volume (47 pp.), treats all of the species for New Caledonia, and includes the descriptions of 3 new genera and 29 new species. It is very well illustrated, with life history notes on web-dwelling mycophile keroplatines. Matile even borrowed material from the Bishop Museum for study. Only two minor comments on this paper: figures 6–13 are poorly reproduced, with some of the fine wing veins having disappeared in the printing; the heading on pp. 133 and 135 should be Keroplatidae, not Ditomyiidae.

It will be interesting to see what will happen to the series. Will its production be as irregular and short lived as the Sarasin and Roux series? Either the French taxonomists will become generalists, or the series will end when the current specialists there have treated all the taxa that they can: I don't expect global participation in this project, which is unfortunate for a globally unique fauna.—*David Grimaldi, Department of Entomology, The American Museum of Natural History, New York, New York 10024.*

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Clastrier, J. 1987. Ceratopogonidae de Nouvelle-Calédonie. V. Genre *Atrichopogon* (Diptera, Nematocera). Cah. ORSTOM, sér. Ent. méd. et Parasitol. 25:193–216.

Matile, L. 1986. Diptéres Mycetophiloidea de Nouvelle-Calédonie. I. Lygistorrhinidae. Ann. Soc. Entomol. Fr. 22:286–288.

J. New York Entomol. Soc. 98(1):125–126, 1990

The Butterflies of Hispaniola.—Albert Schwartz. 1989. University of Florida Press, Gainesville, xiv + 580 pp., frontis [color], 8 pls., 200 figs. [B & W]. $32.50.

This is an excellent and much-needed book. With Hispaniola's fauna facing intensified habitat destruction, Schwartz's report on fifteen years' intensive collecting will probably remain the definitive work on the island's butterflies. Collectors and enthusiasts will be very disappointed that no photographs are offered for identification purposes. However, the book is designed to accompany existing field guides and a new one anticipated soon by D. Spencer Smith, L. D. Miller and J. Y. Miller. As Schwartz notes, though among the Greater Antilles Hispaniola is large and centrally located, its butterfly fauna has remained the least known.

The text is divided basically into four parts: (1) an introduction briefly treating geography and geology of the island, (2) taxonomic treatments, (3) in-depth discussion of distributions, ecology and conservation issues and (4) an English/Spanish "Key" to Hispaniolan butterflies. An addendum includes the description of a new Hispaniolan species of *Tmolus* (Lycaenidae). Plates are restricted to a decorative frontispiece, those of the addendum and a series of twenty-eight habitat photographs.

The major new information in Schwartz's book concerns some fifty new species added to the island's fauna in numerous recent papers. As a result, "the numbers" for Hispaniolan butterflies have changed dramatically. The last major Antillean field guide (Riley, 1975) reported 151 species of butterflies from Hispaniola of which 41 were considered endemic. Although Schwartz does not state a figure, one constructed from his text totals 197 species (198 if a transient/transplant is included and 200 if two new endemics in press are added) with 72 (74) appearing to be endemic. As Schwartz notes, this dramatic and biogeographically significant increase results from (1) collectors' recent penetration into remote areas of the island and (2) attention given previously ill-collected groups like Hesperiidae ("Skippers"), Satyridae ("Satyrs," particularly *Calisto*) and Lycaenidae ("Blues" and "Hairstreaks"). Because of this emphasis, most of the new discoveries (33 of 49) represent endemic species, a fact that is biogeographically important.

Interestingly, many of the new taxa are reported from very few specimens (some from only one) though their known habitats have been collected many times. Others are noted from disparate "early" and "recent" captures and others appear to have occurred in numbers and then disappeared. Obviously, Hispaniola is an island in great ecological flux. Some workers may caution that since 19 of the new endemic taxa reported from Hispaniola come from the single satyrid genus *Calisto,* this taxonomy may be excessively split. However, a recent examination of female genitalia in the genus (Johnson, Quinter and Matusik, 1987) showed little conflict with the species limits indicated by the more well-known males.

Intense recent field work on Hispaniola has been accomplished by a relatively small number of field workers (p. xiii). Because of this, Schwartz notes, one can assume further additions to the Hispaniolan fauna are inevitable. Most Hispaniolan field workers are aware of areas (and biomes) on the island still relatively unexplored. For biogeographers, new figures concerning endemism are important and it is indeed fortunate that workers have delved intensely into Hispaniola's butterfly fauna at the same time virgin habitats were being destroyed. Schwartz's detailed comments on this wanton destruction are timely and the situation appears to have worsened exponentially since his writing. Thus, many of the areas described by Schwartz as "excellent opportunities for further research" (p. 506) may soon be gone. One important example, mesic forest at Las Abejas in the Sierra de Baoruco (type locality of seven recently described butterflies, pp. 498–500) appears to have lost its entire upland canopy since 1988.

The taxonomic section of *The Butterflies of Hispaniola* is well designed. Clearly rendered distribution maps appear next to each taxonomic entry and the text focuses on the occurrence and habits of each species. For many species, such field notes constitute the first published accounts. A drawback in the distributional data presented is that it is limited to the collections of Schwartz, his immediate colleagues, and selected specimens at some museums. The "upside" of this is accuracy of data and related commentary. A "downside," however, is that large numbers of specimens collected by other workers are omitted and prejudice some distributional accounts. The black dots only represent specimens in Schwartz's personal collection (with supplementary open dots added only if these records are unique). Lepidopterists who have collected on Hispaniola may find these instances irksome. However, owing to the breadth of sampling by Schwartz and his field associates, distortion does not appear severe and one must respect the clear, first-hand field data.

To understand the importance of this book one has only to ask what the statistics on Hispaniola's butterfly fauna would be without the recent work of Schwartz and his colleagues. It is sad, however, that the book has appeared at a time when other interested entomologists may have to ask how much remains of the many exciting locales and habitats Schwartz describes. Entomologists with any serious interest in the Antillean fauna will want a copy of this book.—*Kurt Johnson, Department of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024; David Matusik, Department of Entomology, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, Illinois 60076.*

LITERATURE CITED

Johnson, K., E. Quinter and D. Matusik. 1986 (1987). A new species of *Calisto* from Hispaniola with a review of the female genitalia of Hispaniolan congeners (Satyridae). J. Res. Lepid. 25:73–82.

Riley, N. D. 1975. A field guide to the butterflies of the West Indies. New York Times Book Company, Garden City, 224 pp.

A NEW NATURAL HISTORY DICTIONARY

J. New York Entomol. Soc. 98(1):126–128, 1990

The Cambridge Illustrated Dictionary of Natural History.—R. J. Lincoln and G. A. Boxshall. 1987. Cambridge University Press, New Rochelle, New York. 413 pp. Price not supplied.

To produce a dictionary is a daunting task. For natural history, in particular, one must distill the most important aspects of ecology, behavior, and taxonomy of approximately 1.5 million organisms into a readable, concise, and affordable volume. In some respects, this book is a success, in other respects there are simply too many errors to take all the entries very seriously. Granted, it is difficult to be entirely accurate in such diverse subjects as comparative zoology and meteorology, which is why, when perusing this book, I had to concentrate on the subject I know best, the insects. But, if the insect entries are any indication, do not use this book as an ultimate reference (say, for spelling or the basic facts). It does appear useful as a handy desktop book for a quick, preliminary definition of some taxonomic group or structure with which one might not be at all familiar.

To begin, for a book entitled the *Illustrated* dictionary . . . one would think that some effort would have been put into the illustrations. The whitefly on pg. 11 is simply 2 wings, 2 pairs of legs, a head, and a pair of antennae. For almost all of the insect drawings, the wing veins are simply sketched in, with no regard to proper venation (e.g., the honey bee, biting midge, glossinid, skipper, ichneumon, scorpion fly, and housefly—the may fly is actually pretty good). The caterpillar (pg. 68) could just as well be a sawfly larva, and the looper (pg. 217) and praying mantis (pg. 225) are rather entertaining. On pg. 6, the "carabid beetle" that is figured is actually an elaterid (click beetle). Under the definition of "Insecta," there is the illustration of an ephemeropteran with the legend "caddis fly": this mistake is not a difference in British and American vernacular, for under the "caddisfly" entry it is defined as Trichoptera (the British vernacular does pop up several times, such as "daddylong-legs" [=Tipulidae to the British; the Opiliones to Americans]; "naiad" is defined under "Unionoida" [freshwater molluscs], but it is also the vernacular [to Americans] for some kinds of freshwater insect nymphs). My favorite "drawing" is the figure of the loris (a primate), their behavior being described as "often hang suspended beneath branch of tree." The figured one is upright, above the branch, looking as if it is at the top of a giant swing on the high bar. For someone looking for a well illustrated and attractive volume, you won't find it here.

Rather distressing is the abundance of errors. The entry for "biting midge" is misspelled as *Ceratopongonidae* [sic] (pg. 49), as well as on pg. 72 as the entry word, but it is spelled correctly (Ceratopogonidae) in the figure legend and on pg. 319 (as the definition of "punky"). On pg. 83, the index word "Cicindelidae" [sic] is misspelled, but spelled correctly in the figure legend. On pages 295–296, the definitions of "pimpernel," "Pimelodidae," and "Pinaceae" are repeated twice. I have never known anyone who places the phlebotomine Psychodidae (biting moth flies) in their own family, but they are here (Phlebotamidae, pg. 290). In many instances, there is an inflation of the approximate numbers of species for orders, such as the Diptera with 150,000 (pg. 118), the Hymenoptera with 130,000 (pg. 189), and the Ditrysia Lepidoptera with 136,000 (pg. 118). In other instances, the authors rounded out the figures way too low: the family Drosophilidae, pg. 121 (small fruit flies), does not have 1,500 species, but just about 3,000; and there are more like 50,000, not 25,000, Noctuidae. The Ichneumonidae, as perhaps the largest family of insects (in competition with the Curculionidae) certainly has many more than 15,000 species.

There is a disproportionate coverage in the various subjects. There is an entry for most of the fish families of the world (not all of the approximately 550, but close!), but only what I estimate as about one-quarter of the insect families. As it should be, the insect families or other higher taxa that are included are generally the larger families and/or ones with conspicuous members. It is understandable that, if all the insect families were to be included, the book would be about twice the size. But, for example, for the orders Mecoptera and the Trichoptera, there are no family entries. For the Hymenoptera, to my count, there are 19 family entries, all being among the most common or speciose taxa (but still missing the Tenthridinidae, Pteromalidae, Proctotrupidae, Tiphiidae, and Megachilidae). Why the discrepancy between insects and fishes? Why couldn't the common scorpion flies (family Panorpidae) be included if the Kyphosidae (30 spp. marine perciform fishes) and the like were included? I suspect it is because Boxshall specializes in crustacean fish parasites.

For someone unable to afford volume two of the Synopsis and Classification of Living Organisms (treating the insect families of the world), it might be better still to save the money otherwise spent on the Illustrated Dictionary towards investing in that volume.—*David Grimaldi, Department of Entomology, The American Museum of Natural History, New York, New York 10024.*

INSECTS IN AGRICULTURAL COMMUNITIES

J. New York Entomol. Soc. 98(1):128–132, 1990

The Entomology of Indigenous and Naturalized Systems in Agriculture.—Marvin K. Harris and Charlie E. Rogers (eds.). 1988. Westview Press, Boulder, Colorado, 238 pp. $35 paper.

Recent years have seen an increase in agricultural research into the philosophy and methods of traditional systems of crop production, with the aim of applying the lessons learned towards putting modern, large-scale agriculture on a more environmentally sound and sustainable footing (for a recent exposition, see M. A. Altieri's *Agroecology: The Scientific Basis of Alternative Agriculture,* Boulder, CO: Westview Press; 1987). *The Entomology of Indigenous and Naturalized Systems in Agriculture* is a collection of articles on research that continues in this vein. The book stems from the first two meetings of the Annual Robert H. Nelson Symposium on Crop Protection Entomology, sponsored by the Entomological Society of America. As outlined in the preface, its purpose is to highlight some agriculturally important plants and their associated arthropod communities from a biological, as well as an agricultural, perspective. The authors' task was to integrate the two perspectives as much as possible by emphasizing how the wild progenitors and relatives of present-day crop plants interacted with arthropods prior to, as well as after, plant domestication, and to suggest how this knowledge might be used in solving pest and other problems in agriculture and biology. The book thus serves to bring together the two approaches, one basic, the other applied, into a more or less unified whole, furthering efforts to place the study of agricultural systems more firmly within a proper ecological and evolutionary framework. While much attention has long been focused on exotic pests in agriculture (e.g., C. L. Wilson and C. L. Graham, eds. *Exotic Plant Pests* *and North American Agriculture,* New York: Academic Press; 1983), many of the crops discussed in this book are indigenous to their growing regions and associated with native pests.

The systems surveyed include a cross-section of field, vegetable, fruit, and seed and nut crops. In Chapter 1, Rogers reviews sunflower (*Helianthus* spp.) entomology. A concise history of sunflower cultivation, and, more recently, selective breeding, establishes its importance, mainly as an oilseed crop. Cultivated sunflower, *H. annuus,* is the only native plant of the United States to become a major world-wide food source, with 85–95% of the oilseed seed produced in the U.S. exported to western Europe. The crop also has potential as a fuel source and source of biomass energy. Sunflower has a well-developed insect fauna of long association; few species, however, are considered pests.

Ever since the pioneering work of D. Pimentel and R. B. Root, the study of cruciferous crops has provided insight into the organization of both natural and agricultural communities. Finch's comprehensive paper (Chapter 2) on the entomology of crucifers (e.g., *Brassica oleracea*) deals with diversification of the crop system in relation to pest population dynamics. The pest on which he focuses is the cabbage root fly, *Delia radicum.* An overview of crucifer ecology shows species to be typically "weedy" in nature, colonizers of disturbed habitats lacking soils of structure and high nutrient content. Land cultivation and removal of competitors by selective herbicides have allowed cruciferous weeds to invade brassica crops. Finch stresses the scarcity of crucifers as compared to other weeds in the vicinity of row crops, a factor that must be considered when determining the potential of wild crucifers to serve as reservoirs of pests. The numbers of wild hosts were inadequate to support *D. radicum* populations large enough to add significantly to the pest burden of the cultivated crucifer; in this case, the crop itself constituted a reservoir for its own pest. The conventional view that wild hosts can serve as refuges and resources for predators and parasitoids is also called into question, at least in this system. Higher levels of predation and parasitization were found within the crop than in the more diverse, surrounding vegetation. The potential role of wild hosts in the development of insecticide resistance in herbivores is discussed. Oligophagous insect populations that regularly develop on different wild hosts and move to cultivated crops with a capacity for dealing with a variety of natural defensive compounds may be preadapted to detoxify insecticides. Cultural practices may also have evolutionary consequences. Development of three annual generations of the fly from the original two presumably resulted from recent changes in agriculture, namely extension of the season for cultivated crops and selection of highly nutritious cultivars, which affected the number and duration of generations.

Three chapters on berry crops follow. A survey of grape culture and insects of native North American muscadine grapes is made by Dutcher, McGiffen, and All. Species of *Vitus* have been cultivated for some 6,000 years, and an extensive complex of insect associates is known. In the southeastern U.S. alone, more than 185 species feed on grapes; all parts (shoots, leaves, buds, fruit, flower, and roots) are attacked. Discussed are 24 of the more common pests of the muscadine grape, *V. rotundifolia,* most of which occur only in small populations. Tolerance of muscadine grape cultivars to insect attack has reduced the frequency of insecticidal treatments; as a result, insecticide-induced problems, such as pest resurgence or the development of resistance, have not arisen. The entomology of cultivated strawberry, *Fragaria × ananassa,* is outlined in a short paper by Shanks and Sjulin. Little is known of the arthropods associated with wild strawberry. Of the major pests listed, few are restricted to strawberry. The potential for wild strawberry to serve as a source of genetic resistance to pests of the cultivated crop is emphasized. Payne, Horton, and Amis survey the arthropod complex of rabbiteye blueberries, *Vaccinium ashei.* Both reports in the literature and the experience of researchers in the field have fostered a perception that this species is relatively free of pest problems, although this will probably change as cultivated area increases. The major potential pests of rabbiteye and other blueberries are identified. The authors stress the need to develop timely pest management strategies to delay or prevent the advent of pest problems. This chapter falls somewhat short of the volume's stated purpose; there is little consideration of the big picture to relate the cultivated crop with its wild relatives and arthropod associates. The authors may not have had much to work with; apparently little is known of the arthropod complex in native *Vaccinium.*

Two chapters have to do with sorghum. In Chapter 6, Teetes discusses the role of johnsongrass, *Sorghum halepense,* an exotic, in influencing the dynamics of the sorghum midge, *Contarinia sorghicola,* the most serious insect pest of cultivated grain sorghum, *S. bicolor.* Initial domestication of grain sorghum dates from 3,000–4,000 B.C. in Africa; it was introduced into the U.S. during the slave-trade era. Johnsongrass was also purposely introduced into the U.S. southeastern and gulf regions in the 1830's for forage production, soon thereafter extending its range and becoming a pest (it is classified as one of the 10 worst weeds of field crops). The weed serves as a reservoir for *C. sorghicola* for the first two generations after emergence from larval diapause, allowing populations to build. Once early-planted sorghum has begun to flower, most midges disperse to the crop, and economic densities may soon be reached. In a reversal of the crop-weed-pest relationship as often viewed, johnsongrass constitutes the preferred host for the midge, while sorghum is relegated to the status of alternate host. Cultural insect controls are not always feasible. Crop protection has depended chiefly on insecticidal treatment, which is also of limited value. Teetes suggests, however, that the establishment of johnsongrass in crop environs may offer some good along with the bad, such as promoting genetic stability in pest populations, thus reducing the chances of biotype development. For this reason, not to mention the fact that it seems to be here to stay anyway, the author advises a kind of peaceful coexistence with the weed. Gilstrap (Chapter 7) describes a broader relationship, that of the sorghum-corn-wheat-johnsongrass association with Banks grass mite, *Oligonychus pratensis,* to argue that annual crops may provide the environmental stability necessary for effective use of biological controls. The importance specifically of johnsongrass in maintaining the stability of the system is again brought out, although much of the paper is concerned with reviewing work on conservation and augmentation of natural enemies within the crop itself.

Loevinsohn, Litsinger, and Heinrich's chapter on rice pests opens with a comparison of traditional and modern rice culture, including methods of insect control, in tropical Asia. There follows discussion of the impact, both favorable and unfavorable, of modern production practices (e.g., introducing resistant cultivars, chemical fertilization, and increasing cropping intensity) on pest populations, and how these practices might be modified to reduce crop losses. Much of the discussion is based on original data, here published for the first time.

In a comprehensive review that offers the reader an excellent short course in the production and entomology of wheat (*Triticum* spp.), a grain of premier importance in the global economy, Way surveys the range of insect pests of wheat from the different growing regions, with closer inspection made of the ecology of selected species. Major wheat pests, notably species of Aphididae and of various families of Diptera, but including a few other groups (e.g., cephid sawflies and chrysomelid beetles), tend to be oligophagous, associated with wild grasses. While the pests in western Europe appear to be indigenous, those in North America are primarily introduced species. The aphids are given especial attention. About 10 species are considered direct pests of wheat, including the Russian wheat aphid, *Diuraphis noxia,* the distribution of which should be amended in the author's list now to include North America (see M. B. Stoetzel. *J. Econ. Entomol.* 80(3):696–704; 1987). In areas, such as North America, where relatively low yields render chemical controls uneconomical, cultural controls and host plant resistance are potentially powerful techniques for wheat pest control.

The final chapter, by Harris, concerns arthropods of pecan (*Carya illinoensis*), a tree crop native to North America, and one in which a high percentage of production stems from naturally growing, wild trees. Unlike many other crops, for which the newest production methods and most improved varieties tend to be adopted universally by growers, the peculiar nature of pecan culture, involving the long association of a native plant with a native complex of arthropods, permits a rare glimpse of how the process of plant domestication affects an associated fauna; a range of ecological situations, from essentially undisturbed to intensively managed orchards, is available for study. Pecan thus offers something of interest for both the basic and the applied scientist. Only two species of nut feeders, of a fairly extensive arthropod complex, are of consistent, economic concern: the pecan nut casebearer, *Acrobasis nuxvorella* (a pyralid) and the pecan weevil, *Curculio caryae.* The phenomenon of masting, the synchronized production of nuts on alternate years over a broad geographic region, has generally been a major factor limiting pest abundance in pecan. This trait, together with the genetic diversity within orchards supplied by wild trees, is given credit for the infrequency of pest outbreaks. However, new tree varieties that yield every year now are necessitating the increased use of insecticides.

A common thread running through the chapters of this book is the recognition of the importance of natural vegetation in the life-ways of agriculturally important arthropods. The wild relatives of crops may be detrimental (as reservoirs of pests and pathogens) or beneficial (as sources of resistant germplasm or refuges for natural enemies) in the larger ecosystem of which the crop is a part, and it is within this context that strategies for pest control are most rationally considered and implemented. The doubtful utility of insecticides as a viable means of control is stressed repeatedly. In sentiments voiced at his chapter's, and the book's, end, Harris expresses well the theme of this volume: that the defensive mechanisms we have inherited from nature can be of greater value in the profit-driven environment of commercial crop production if only we develop a better understanding of them and how they can be exploited.

The Entomology of Indigenous and Naturalized Systems in Agriculture is, on the whole, an excellent reference source. Most of the chapters include tabulated summaries of pests and crop information accompanied by discussions of the biology and economic importance of each major pest species. Many include an extensive reference list, allowing the reader entry into, or review of, the significant literature of a subject area. The papers by Rogers, Finch, and Way are particularly interesting and informative, and undoubtedly will be cited in future work in their areas. Author names are thoroughly indexed, but a rather brief subject index may reduce somewhat the reference value of the book. The book does suffer from the usual minor typographical errors, inaccuracies, and lapses: a proper noun uncapitalized here, a scientific name misspelled there, a technical term used inappropriately, and the occasional, inadvertent abuse of the Queen's English somewhere else. These flaws are largely attributable to the format in which the book was produced, with chapters in the form of camera-ready, original typescripts. Physically, the book is well wrought. It is printed on acid-free paper and bound in soft covers, and would seem able to withstand long, if careful, use. The $35 price is, one supposes, about par for the course for "paperbacks" published for a limited, professional readership. The book will be of particular interest to every ecologically minded agricultural entomologist. It is further recommended as a supplementary text for courses in agricultural science, economic entomology, and seminars in insect pest management.—*Thomas W. Culliney, USDA Forest Service, Northeastern Forest Experiment Station, Center for Biological Control, 51 Mill Pond Road, Hamden, Connecticut 06514.*

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NEOTROPICAL NABIDAE (HETEROPTERA), 3: SPECIES OF THE GENUS *ARACHNOCORIS* FROM COSTA RICA

I. M. Kerzhner

Zoological Institute, Academy of Sciences of the USSR,
Leningrad 199034, USSR

Abstract.—*A. panamensis* (Dist.), *A. eberhardi,* n. sp. and *A. setosus,* n. sp. are found in Costa Rica in the webs of pholcid spiders.

Species of the neotropical genus *Arachnocoris* live in spider webs. Nine species were known prior to this study.

In 1985 Dr. R. T. Schuh (American Museum of Natural History, New York) kindly sent me a tube with alcohol preserved specimens of the genus *Arachnocoris* labelled "Costa Rica, Heredia, La Selva—Ca. Pto Viejo, 100 m, in webs of pholcids, III.1983, W. Eberhard." The material contains 3 species, two of which are new and the third represents a new record for Costa Rica. Holotypes and paratypes of new species are in the American Museum of Natural History, one paratype of each species is retained in the Zoological Institute, Academy of Sciences of the USSR.

KEY TO COSTA RICAN SPECIES OF *ARACHNOCORIS*

1. Hemelytra with a transparent white band near the middle. Abdomen constricted at base, base of segment III white, ventral laterotergites II, IV and V with a small raised ivory area. Hind lobe of pronotum unicolorous. Apex of scutellum highly raised. Middle femora in male strongly thickened. Length 5.2–6.3 mm .... *panamensis* (Dist.)
– Hemelytra without white band near the middle. Abdomen not constricted, base of segment III not white, ventral laterotergites II–VII with a whitish or yellowish spot around the stigmae, but the area of the spot not raised. Hind lobe of pronotum with a more or less distinct medial yellowish stripe. Apex of scutellum feebly raised. Middle femora in male not thickened, about as thick as the fore femora.
2. Antennal segment I longer than width of head, without bristles. Frons near the clypeus with a long thin curved bristle at each side (often rubbed off). Vertex, pronotum and scutellum without bristles. Ostiolar canal directed obliquely cephalad, forming a tubercle at apex. Extreme apex of corium white. Length 3.9–4.3 mm ...... *eberhardi,* n. sp.
– Antennal segment I shorter than width of head, with a thick bristle at the inner side. Frons without bristles. Vertex with 2, fore lobe of pronotum with 6, scutellum with 6, long thick bristles, clearly differing from the short hair cover of pronotum. Ostiolar canal directed obliquely caudad, not forming a tubercle at apex. Corium uniformly black. Length 4.5–4.9 mm .... *setosus,* n. sp.

Larvae can be identified by imaginal characters: in *A. panamensis,* base of abdominal segment III white; in *A. eberhardi* antennal segment I long and hair cover of the body short; in *A. setosus* antennal segment I short and upper surface of body (including abdomen!) with long bristles.

Arachnocoris panamensis (Distant, 1893)

Figs. 1–4

Herdonius (?) *panamensis* Distant, 1893:419.
Arachnocoris panamensis Bergroth, 1914:117; Kerzhner, 1986:180.
Arachnocoris albomaculatus (not Scott, 1881): Bergroth, 1914:117; Myers, 1925:136–146; Harris, 1928:29.

Dr. W. Eberhard collected 2♂♂, 2♀♀ and 1 larva of this species, formerly known from Panama only. Costa Rican specimens are darker and larger than those from Panama (length 6.0–6.3 and 5.2–5.6 mm, respectively).

Arachnocoris eberhardi, new species

Figs. 5–7

Diagnosis. Related to *A. berytoides* (Uhler) (Grenada) from which it differs in smaller size (length 2.85 mm), coloring of antennae, pronotum and legs, as well in male genitalia. Apparently related also to *A. torquatus* Bergroth (Venezuela), but in the last the head is in greater part yellowish, distance between ocelli equal to distance between ocellus and eye, antennal segment I as long as head, and rostrum, trochanters, base and a subapical ring of femora, apex of tibiae, and tarsi black.

Description. Head black, its apical part (including bucculae, antennifers and most of the clypeus) reddish or yellow. Neck black. Eyes reddish, ocelli red. Frons at both sides from the base of clypeus with a long thin bristle, curved at apex to behind (sometimes bristles rubbed off). Dorsal side of head in the fore half covered by short hairs, in the hind half hairless. Head length (without neck) about 0.27–0.30, width 0.50–0.53, width of vertex 0.23–0.26 mm. Distance between ocelli more than two times distance between ocellus and eye. Antennae dark brown, base of segment I and extreme apex of segments II and IV whitish, length of segments (I–IV) 0.67–0.71, 0.95–1.05, 1.20–1.35, 0.95–1.00 mm, length of antennal segment I distinctly more than length or width of head, all segments covered by short hairs, segment I without bristles. Rostrum dirty yellow, reaching to hind coxae, segment I sometimes reddish, apex of segment II, base of segment III and most of segment IV slightly brownish, length of segments (I–IV) 0.20, 0.65, 0.57, 0.34 mm.

Pronotum shining, all three parts clearly separated by transverse furrows. Collar finely, hind lobe strongly punctured, both covered with short hairs. Fore lobe (calli) unpunctured, hairless, except a narrow stripe of short hairs along the middle. Furrow between fore and hind lobes with an impressed point in the middle. Collar yellow. Fore lobe black. Hind lobe blackish brown, more or less distinctly yellow along the middle and at humeri, hind margin white, concave. Length of pronotum along medial line measured from above (not perpendicularly to its surface) 0.79–0.85 mm, including collar 0.1, fore lobe 0.21–0.24, hind lobe 0.49–0.53 mm. Width of pronotum 0.86–0.96 mm. Scutellum of subequal length and width, base and adjacent part of lateral areas black, the remaining part white, apex only slightly raised. Hairs on scutellum thin, most of them longer than those on pronotum.

Corium and clavus shining, semitransparent (except apex of corium), grey or blackish, veins somewhat darker, lateral margin of corium and hypocostal lamina dirty yellowish, apex of corium purplish black, its extreme apex white. Veins of corium and clavus, lateral margin of corium, and its apex with thin hairs, most of them about twice as long as those on pronotum. Membrane dark grey, often lighter at base, at apex and on the outer corner.

Coxae brown or dark red, with base and apex yellow. Trochanters yellow. Femora brownish yellow, base and two indistinct rings yellow, apex broadly red. Fore and middle femora with 2 rows of short black bristles on ventral side. Tibiae brownish yellow to dirty yellow. Tarsi brown. Claws small, asymmetrical. Length of fore and middle femora and tibiae 1.5–1.6, of hind femora 2–2.3, of hind tibiae 2.6–2.8, of all tarsi 0.5 mm.

Ventral side of prothorax yellow, except a black continuation of the coloration of calli. Ventral side of mesothorax black, acetabulae and hind margin of mesepimeron dirty yellow. Ventral side of metathorax yellow or partly red, medial third black, ostiolar canal directed obliquely cephalad, forming a tubercle at apex. Abdomen not constricted at base, black or dirty red with black apex, ventral laterotergites II–VII with a whitish spot around the stigmae.

Paramere flat, subquadrangular, with an apical projection on the inner corner, yellowish, semitransparent in the middle, covered by short hairs on the basal half. Aedeagus with 2 separate dark spines, two groups each consisting of 4 dark spines and two groups formed by smaller yellowish spines.

Female without ovipositor.

Length ♂ 3.9, ♀ 4.2–4.3 mm.

Holotype. ♂, COSTA RICA, Heredia, La Selva—Ca Pto. Viejo, 100 m, in webs of pholcids, III.1983, W. Eberhard.

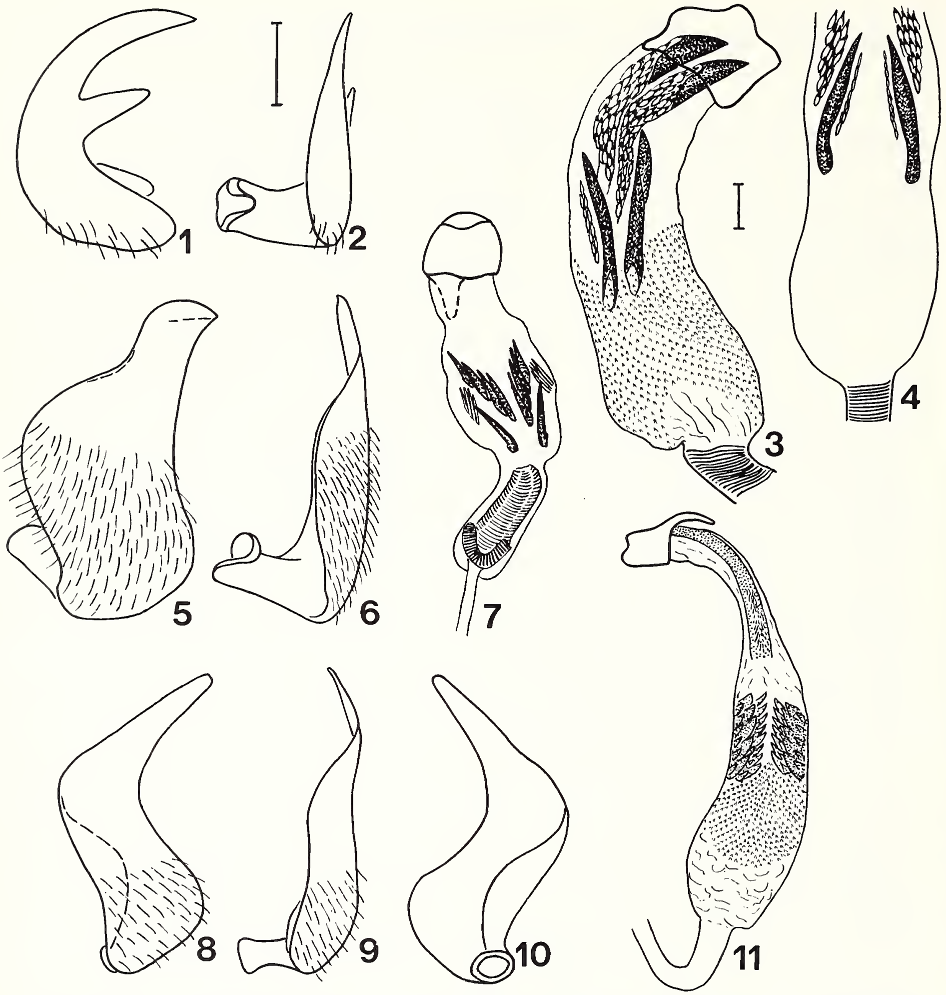
Paratypes. 3♀♀, 1 larva, same data as holotype.

Etymology. Named for W. Eberhard.

Arachnocoris setosus, new species
Figs. 8–11

Diagnosis. Differs from all known species in uniformly black corium and long stout bristles at vertex, pronotum and scutellum.

Description. Head black, its apex (including bucculae, antennifers, apical ⅔ to ¾ of clypeus) and ventral side yellow, inner margin of eyes, lateral areas behind eyes and vertex between eyes and ocelli brownish yellow. Neck black, its ventral side yellow. Eyes and ocelli red. Frons without bristles. Vertex with 2 long stout bristles near the eyes. Dorsum of head on the fore half covered by short hairs, in the hind half hairless. Head length (without neck) about 0.36–0.40, width 0.57–0.60, width of vertex 0.27–0.29 mm. Distance between ocelli less than diameter of an ocellus, about half the distance between ocellus and eye. Antennae dark brown to black, base of segment I, extreme base and apex of segment II, extreme base of segment III whitish yellow, a wide ring at segment IV occupying slightly less than a half of its length and placed nearer to base than to apex, length of segments (I–IV) 0.40–0.43, 0.79–0.83, 0.79–0.82, 0.86–0.90 mm, length of antennal segment I subequal to length of head and distinctly less than its width, all segments covered by short hairs, segment I with a stout bristle near the middle of the inner side. Rostrum brown, reaching the hind coxae, segment I and sometimes base of segment II yellowish, length of segments (I–IV) 0.30, 0.50, 0.60, 0.30 mm.



Figs. 1–11. *Arachnocoris,* male genitalia. 1–4. *A. panamensis,* Costa Rica. 1, 2. Paramere. 3, 4. Aedeagus and its basal part. 5–7. *A. eberhardi,* holotype. 5, 6. Paramere. 7. Aedeagus. 8–11. *A. setosus,* holotype. 8–10. Paramere. 11. Aedeagus. Scale lines equal 0.1 mm.

Pronotum shining, collar demarcated from fore lobe by a more or less distinct furrow, but the border between fore and hind lobes less pronounced, without furrow. Collar faintly, hind lobe strongly punctured, both covered by very short hairs. Fore lobe (calli) without longitudinal furrow, with a narrow stripe of short hairs along the midline and with stripes of very short hairs on slightly elevated areas on both sides of the midline, with 6 long stout bristles, 4 being placed near the fore outer corners and two at the hind margin. Collar brownish yellow to brown, fore lobe black, hind lobe brownish black, with a distinct longitudinal yellow stripe, also humeri narrowly yellow, hind margin concave, not differing in color or only slightly lighter than the remaining part of hind lobe. Length of pronotum along midline measured from above (not perpendicular to its surface) 0.93–1.07, including collar about 0.1, fore lobe 0.26–0.29, hind lobe 0.60–0.70 mm. Width of pronotum 1.07–1.13 mm. Scutellum broader (0.4 mm) than long (0.3 mm), dark brown, its elevated middle part or at least a medial stripe yellow, but the apex dark, not raised or only feebly raised. The surface of scutellum with 6 long bristles, similar to these on pronotum and vertex.

Hemelytra feebly shining, not transparent, corium and clavus black, hypocostal lamina dirty yellow, membrane black, with a semicircular spot behind the apex of corium and a similar spot at inner margin white. Veins of corium and clavus, lateral margin of corium and its apex with stout hairs, most of them several times longer than the hairs on pronotum.

Coxae dark brown or black. Trochanters brownish. Femora dark brown to black, the fore femora yellowish on the basal half except the extreme base, the middle femora on basal half yellow or with one or two yellow rings, the hind femora with a wide subbasal ring and a narrower ring on the apical half yellow. The apex of hind femora very narrowly red. Fore and middle femora with 2 rows of short black bristles at the ventral side. Tibiae brown, the hind ones narrowly yellow at base. Tarsi black, segment II yellowish. Claws small, asymmetrical. Length of fore and middle femora and tibiae about 1.25, of hind femora 1.5–1.6, of hind tibiae 1.85–2.0, of all tarsi 0.6 mm.

Ventral side of prothorax yellow, except a black continuation of the coloration of calli. Ventral side of mesothorax black, except acetabulae and hind margin of mesepimeron dirty yellow. Ventral side of metathorax yellow, medial third black, ostiolar canal directed obliquely caudad, not forming a tubercle at apex. Abdomen not constricted at base, dark brown to black, ventral laterotergites II–VII with a yellowish spot around the stigmae.

Paramere narrow, strongly bent, covered by short hairs on the basal half, dirty yellow. Aedeagus without hooks, with numerous small sclerotized formations lying on the basal half on both sides of midline, and on the apical half along the midline.

Female without ovipositor.

Length ♂ 4.5–4.7, ♀ 4.9 mm.

Holotype. ♂, COSTA RICA, Heredia, La Selva—Ca Pto. Viejo, 100 m, in webs of pholcids, III.1983, W. Eberhard.

Paratypes. 1♂, 1♀, 1 larva same data as holotype.

Etymology. Named for bristles on the dorsal surface, from the Latin *setosus,* covered by bristles.

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SEVEN NEW SPECIES OF *OZOPHORA* FROM THE WEST INDIES WITH NOTES ON SOME PREVIOUSLY DESCRIBED SPECIES (HEMIPTERA: LYGAEIDAE)

James A. Slater

Department of Ecology and Evolutionary Biology,
University of Connecticut, Storrs, Connecticut 06268

Abstract.—Seven new species of *Ozophora* are described from the West Indies: *hispaniola, testacea, caliginosa, darlingtoni* and *pusilla* from Hispaniola, *alayoi* from Cuba and *coleoptrata* from several islands in the Bahamas and from the Caicos Islands. A discussion of species living in montane habitats on Hispaniola and of a flightless species from low elevations in the Turks and Caicos and Bahamas is included. Dorsal view figures are given for *hispaniola* and *coleoptrata. Ozophora caroli* Slater and Baranowski is reported from the West Indies for the first time, from Grand Cayman and Hispaniola. *Ozophora cubensis* Barber is redescribed, corrections made in the labeling of the original type series, and variation and relationships discussed.

In my discussion of the zoogeography of the Lygaeidae of the West Indies (Slater, 1988) I included a checklist of species and used this checklist as the source for the numerical summaries in the paper. Several species of *Ozophora* were listed that had not been published. This paper treats these species and includes descriptions and comments on several previously described species.

Unfortunately several taxa are known from single specimens or from only one sex. In a number of cases I had recognized these taxa as distinct some years ago but withheld formal description in the hope of obtaining additional material. In the case of the species from the higher mountains of Hispaniola this has not occurred. The specimens from there were collected by the late P. J. Darlington half a century ago. Despite the literally thousands of specimens of *Ozophora* that I have examined from the islands not a single additional specimen has been obtained. Given the extensive deforestation of this island it is quite possible they are extinct, or if not, are confined to an extremely limited area. Since montane West Indian organisms often are of particular phylogenetic importance it seems especially appropriate that such taxa be formally recognized.

The genus *Ozophora* has radiated extensively in the West Indies. With the inclusion of the species described in this paper 35 species are now known from the islands out of a total fauna of 74 described species. This however is misleading as there remain a considerable number of undescribed species from Mexico, Central America and South America.

Although no formal cladistic analysis has been completed it is obvious that many West Indian endemics have their sister species on the mainland. Many species of *Ozophora* are vagile, fly readily and presumably are good colonizers. While it would be presumptuous to maintain that some speciation has not been due to island to island vicariance I see no evidence at this time that points in any way to island–mainland vicariance.

Ozophora hispaniola, new species
Fig. 1

Description. Body relatively broad, stout, robust. Coloration extremely variegated. Head nearly uniformly reddish brown with tylus pale, pronotal calli broad reddish brown becoming nearly black anteriorly and laterally. Explanate margins of anterior pronotal lobe testaceous yellow; anterior collar dark chocolate brown to black except for an elongate testaceous dash on either side of midline; posterior pronotal lobe mottled with testaceous and reddish brown, latter covering most of distal half except posteriorly on humeri, mesally testaceous but with a dark brown macula along posterior margin. Scutellum dark brown with a slightly lighter pale median stripe, apex pale and an irregular diverging testaceous vitta midway between meson and lateral margins. Hemelytra variegated with testaceous and dark chocolate brown, clavus with a conspicuous dark spot adjacent to apex of scutellum, corium with a large dark quadrate spot proximally at level of distal third of scutellum, a broad costal patch midway along corium reaching lateral margin, apex of corium with a large dark spot and extensively suffused with chocolate brown near inner angle around a pale patch. Membrane largely smoky brown with strongly contrasting pale yellow veins. First, second and third antennal segments pale testaceous with distal ends contrastingly dark brown; fourth segment with a white annulus on proximal half, distal half dark chocolate brown as is extreme proximal end. Ventral and pleural surfaces nearly uniformly dark red brown. Acetabula testaceous. Legs and labium pale yellow, a prominent dark brown annulus near distal end of middle and hind femora. Second and third tarsal segments dark brown. Thickly clothed above with numerous short semidecumbent silvery to testaceous hairs (examine in lateral view).

Head acuminate. Tylus strongly tapered reaching midway to distal end of first antennal segment. Vertex convex. Eyes sessile. Length head 0.80, width 0.90, interocular space 0.45. Pronotum broad, subquadrate, lateral margins strongly calloused appearing explanate, particularly on anterior lobe, transverse impression obsolete mesally, posterior margin straight, calli prominent, strongly convex, nearly confluent mesad. Length pronotum 1.02, width 1.55. Scutellum shallowly concave mesally on proximal half. Length scutellum 0.88, width 0.88. Hemelytra with lateral corial margins shallowly sinuate, strongly explanate but not reflexed. Length claval commissure 0.73, midline distance apex clavus–apex corium 1.05, midline distance apex corium–apex membrane 0.80. Metathoracic scent gland auricle conventional but tapered, not curved posteriorly. Middle and hind femora each armed below with two series of prominent sharp acute spines, each row consisting of seven to eight spines, hind femora also bearing two or three similar spines on dorsal surface distally. Middle and hind tibia with three to four rows of prominent sharp spur-like spines. Fore femora strongly incrassate, armed below with seven large sharp tuberculate spines extending from nearly proximal end to distal end. Labium elongate extending well between and slightly beyond metacoxae, first segment about attaining base of head. Length labial segments (from paratype) I 1.02, II 1.05, III 0.82, IV 0.25. Antennae slender, terete, third segment not conspicuously fusiform. Length antennal segments I 0.52, II 1.20, III 1.00, IV 1.20. Total body length 5.04.

Holotype. Male HAITI: Port au Prince, Thor. 10–12.X.1970 (J. D. Porter) (black light trap). In National Museum of Natural History (USNM).

Paratypes. HAITI: 1 female Diquini (W. M. Mann). DOMINICAN REPUBLIC:

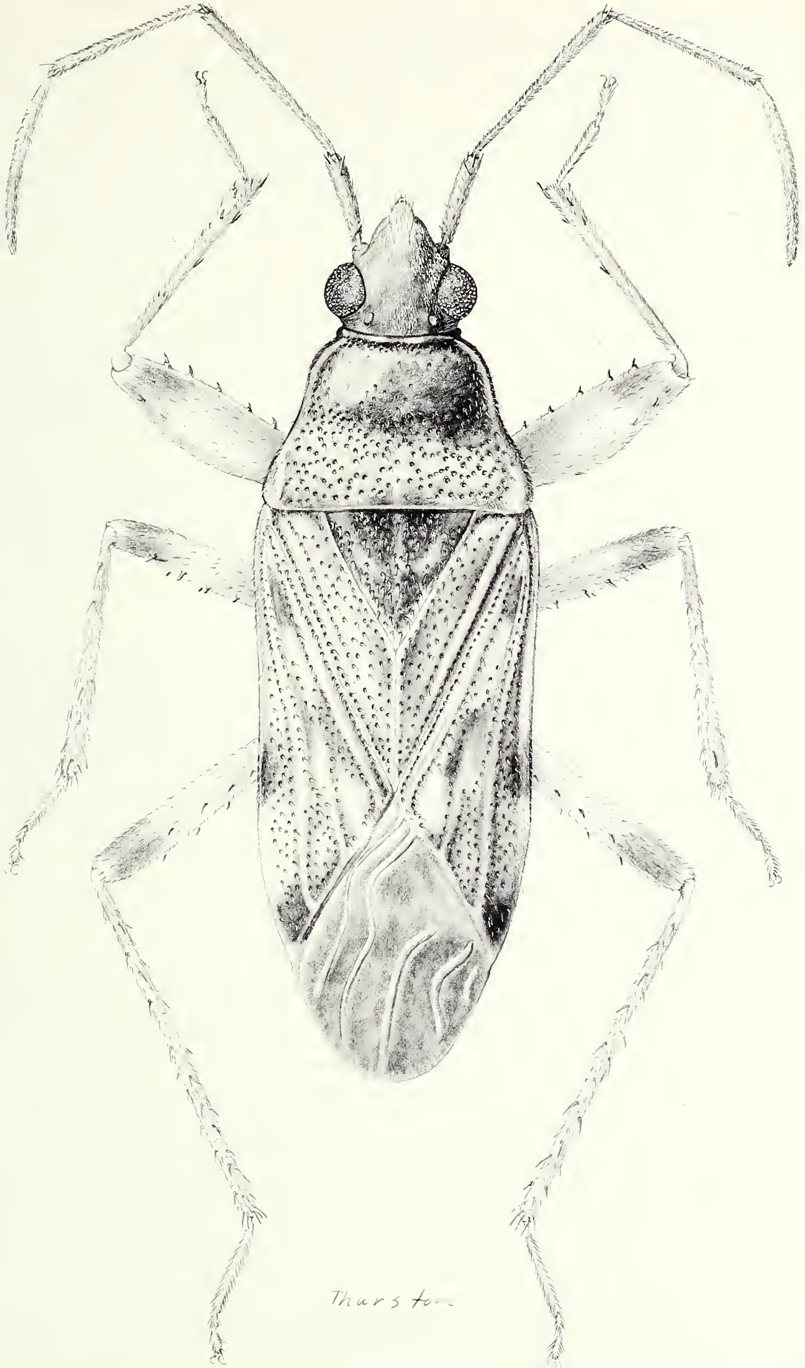

Fig. 1. *Ozophora hispaniola,* dorsal view.

1 male S. Domingo D.R. 9.X.1966 (L. H. Rolston). 1 male same 30.III.1966. 1 male St. Domingo S Francisco Mts. 14.IX.1905 (Aug. Busck). 1 male, 2 females St. Domingo 8.XI.1981 (H. Dominguez). 1 female same 27.XII.1981. 2 males, 3 females Altagracia, Nisibon 8.VI.1976 (R. E. Woodruff) (black light trap). 7 males, 1 female same locality 8–10.VI.1976 (R. E. Woodruff, E. E. Grissell) (malaise trap). 1 female San Jose Dolas Matas 1,000–2,000′ June ′38 (Darlington). 1 female San Lorenzo 24–26.VI.1915. 1 female Santo Domingo 12.VIII.1967 (J. C. Schaffner) (at black light). In National Museum of Natural History (USNM), American Museum of Natural History, Texas A&M University, Florida State Collection of Arthropods, Instituto Biologia UNAM Mexico, J. A. Slater and R. M. Baranowski collections.

Discussion. There is a great deal of color variation in the type series but almost no variation in structural details other than that some individuals have a slightly longer labium that extends well onto the abdomen. In older specimens the dark chocolate brown areas indicated in the description above usually are a reddish brown color, often ferrugineous. This may be the result of fading or these may have been paler specimens.

This is a very distinctive species because of the short but distinct hairs on the dorsal surface, the broad subquadrate pronotum and particularly by the unusual spines ventrally on the middle and hind femora. Despite its unique appearance *hispaniola* appears to be part of the *burmeisteri* complex.

Ozophora testacea, new species

Description. Body relatively short, robust. Head, anterior pronotal lobe, thoracic pleura and scutellum dark chocolate brown. Scutellum with a pair of diagonal pale yellow vittae present. Remainder of body including legs and antennae uniformly pale yellowish brown with darker punctures. No trace of proximal pale annulus present on antennal segment four. Pale anterior pronotal collar and lateral margins of anterior pronotal lobe contrasting strongly with chocolate brown coloration of remainder of anterior lobe and adjacent propleuron. Lacking upstanding dorsal hairs.

Head broad, short, tylus slightly declivent anteriorly, eyes only slightly removed from anterior margin of pronotum, vertex moderately convex, tylus at most extending anteriorly to middle of first antennal segment. Length head 0.92, width 1.04, interocular space 0.50. Lateral margins of pronotum strongly ridged; anterior pronotal lobe swollen, at least as elevated as posterior lobe; posterior margin straight. Length pronotum 1.0, width 1.40. Length scutellum (from paratype) 0.98, width 1.04. Hemelytra nearly parallel sided, very slightly sinuate. Length claval commissure 0.86. Midline distance apex clavus–apex corium 1.36. Midline distance apex corium–apex membrane 0.64. Metathoracic scent gland auricle straight or slightly bent posteriorly and truncated at distal end. Evaporative area occupying inner two-thirds of metapleuron. Fore femur moderately incrassate armed below distally with four large sharp spines, and two additional smaller spines, proximad of former. Labium elongate, slightly exceeding posterior margins of metacoxae. Length labial segments I 0.92, II 0.98, III 0.78, IV 0.42. Length antennal segments I 0.60, II 1.50, III 1.24, IV 1.50. Total body length 5.60.

Holotype. Male HAITI: Maneville, 18.II.1922, about 60 ft alt. F, 4636. In American Museum on Natural History.

Paratypes. HAITI: 1 male, 6 females same data as holotype. 2 females same data except 6–10.II.1922. 1 female Maneville (Mann). 1 male, 1 female Fond Parisien 11–18.II.192, "about 60 ft alt. F, 4632. L" DOMINICAN REPUBLIC: 1 male Barahona, IX.1938 (Darlington). In American Museum of Natural History and J. A. Slater collections.

Discussion. This is a very distinctive easily recognized species by virtue of the dark head and anterior pronotal lobe that contrast strikingly with the uniformly dull yellow coloration of the remainder of the body and the appendages. It does not appear to be closely related to any of the other species of *Ozophora* but perhaps *atropicta* may be its closest relative.

Ozophora caliginosa, new species

Description. Elongate, relatively slender nearly parallel sided. Head and anterior pronotal lobe dark chocolate to reddish brown. Pronotum with pale yellow markings as in *darlingtoni.* Scutellum reddish brown with a moderately elongate pale yellow vitta adjacent to each lateral margin. Clavus infuscated with brownish but not forming a distinct fascia. Corium strikingly alternated with dark reddish brown and almost white coloration. Dark brown markings as follows: a very broad complete transverse fascia across corium at level of distal end of claval commissure, extending along claval suture midway to base of corium, this fascia narrowing laterally but reaching lateral corial margins; a smaller dash present at level of apical third of scutellum lying immediately within corial groove, a small but distinct apical corial patch leaving apical corial margin exposed, latter brown on inner half and strikingly reddish on posterior half. Membrane dark brown with veins paler and a large white distal or apical end. Entire fore femora, distal third to half of middle and hind femora dark chocolate brown, remainder of legs pale yellow. First antennal segment also dark chocolate brown, concolorous with head and strikingly contrasting with pale yellow second segment. Dorsal surface without conspicuous upstanding hairs. Pronotal calli prominent, impunctate. Punctures on posterior pronotal lobe small and widely separated, those of corium and clavus typical of genus.

Head nondeclivent, tylus not attaining distal end of first antennal segment, vertex only moderately convex, eyes set well away from antero-lateral pronotal angles. Length head 0.96, width 1.06, interocular space 0.48. Pronotum with lateral margins deeply sinuate, prominently calloused; transverse impression deep and complete; a line of punctures present between calli; posterior lobe slightly elevated above anterior with posterior margin slightly sinuate or concave. Length pronotum 1.08, width 1.74. Length scutellum 1.14, width 0.96. Hemelytra nearly linear, lateral corial margins very slightly expanded evenly from base to near distal end. Length claval commissure 0.98. Midline distance apex clavus–apex corium 1.60, midline distance apex corium–apex membrane 1.20. Length labial segments I 0.90, II 0.98, III 0.78, IV 0.48. Length antennal segments I 0.78, II 1.68, III and IV missing. Total body length 6.80.

Holotype. Female HAITI: Furcy (Mann coll.). In American Museum of Natural History.

Discussion. This is another of the large elongate montane species from the Greater Antilles. It has the general overall appearance of *darlingtoni* but differs in a number of significant details. The first antennal segment is conspicuously black. The lateral margins of the pronotum are deeply sinuate. There is a complete dark fascia running across the corium and the fore femora are completely dark and the middle and hind femora darkened on the distal third to half rather than having strongly contrastingly banded femora as does *darlingtoni.* The holotype also has two distinct sharp spines ventrally on the distal portion of the hind femora. It is unfortunate that this striking species is known only from a single female.

In the American Museum of Natural History collections there is a female from the Dominican Republic labeled "Constanza 21 Aug.-38 3-4; 1000 ft. Darlington" which somewhat resembles this species. It agrees in having the dark first antennal segment and in the general overall coloration but is a much lighter species with a reddish brown rather than dark chocolate coloration, the corium does not have a complete fascia, the fore femora are not completely darkened and the middle and hind femora have only a distal banding. It does, however, closely resemble *caliginosa* in the shape of the apical dark macula on the corium and in having the apical corial margin red on the posterior half. This is also a female, and may well prove to be conspecific but is not included as a paratype at this time. This specimen does have all four antennal segments, the third segment is pale on the proximal three-fourths with a dark distal end, and the fourth segment has a conspicuous large white annulus occupying nearly all of the proximal half of the segment, the distal portion being chocolate brown.

Ozophora darlingtoni, new species

Description. Head dark chocolate brown, pronotum and scutellum chiefly bright reddish brown. Pronotum marked with yellow maculae as follows: an oblique spot on either side of midline on pronotal collar and a short dash midway between meson and lateral margin on posterior pronotal lobe beginning at transverse impression and extending to middle of lobe; four irregular spots along posterior margin, a lateral spot at humeri and one on either side of midline midway between meson and humeral angles. Scutellum becoming darker red brown on distal half with a pair of short oblique pale yellow maculae near lateral margins midway between base and apex. Hemelytra chiefly pale yellow, nearly white, marked with dark brown as follows: a large area adjacent to inner angle of corium extending anteriorly nearly to proximal end of claval commissure, a small oblique spot at level of distal third of scutellum immediately mesad of corial furrow, a small spot along lateral margin at level of apex of claval commissure and a large irregular apical corial maculae, latter not covering but slightly invading adjacent apical corial margin. Membrane dark brown with veins obscurely pale yellow, lacking a white vitta mesally at distal end. Legs pale yellow with distal third of each femur with a very conspicuous strongly contrasting dark brown annulus. First and second antennal segments pale yellow, proximal three-fourths of third segment pale shading to dark chocolate distally, fourth segment with a broad white annulus occupying nearly entire proximal half of segment, distal half of fourth segment dark chocolate brown. Dorsal surface lacking upstanding hairs but with a minute silvery decumbent hair arising from each puncture, the latter relatively small and obscure; claval and corial punctures typical for genus.

Head relatively small, tylus not attaining distal end of first antennal segment, vertex moderately convex, eyes set well away from anterior lateral pronotal angles. Length head 1.08, width head 1.52, interocular space 0.50. Pronotum strongly expanded from anterior to posterior margins, lateral margins obscurely but definitely calloused, transverse impression shallow, posterior margin nearly straight or very slightly concave, posterior lobe raised somewhat above anterior, calli with a few scattered punctures present. Length pronotum 1.30, width 2.14. Length scutellum 1.22, width 1.10. Length claval commissure 1.16. Corium rather evenly expanded from base to near distal end giving insect a broadened appearance from pronotum posteriorly. Midline distance apex clavus–apex corium 1.70, midline distance apex corium–apex membrane 1.40. Metathoracic scent gland auricle short, stout, not strongly curving posteriorly. Fore femora only moderately incrassate, each femur armed below on distal third with three sharp ventral spines. Labium extending well beyond mesocoxae almost, or reaching metacoxae. Length antennal segments I 0.74, II 1.84, III 1.44, IV 1.54. Length labial segment I 1.00. Total body length 7.76.

Holotype. Male HAITI: Lavisite & vic LaSelle Range 5–7,000 ft 16–23.IX.1934 (Darlington). In American Museum of Natural History.

Paratype. 1 female same data as holotype. In J. A. Slater collection.

Discussion. Paramere somewhat resembling that of *O. nitida* in that the inner tooth is large, blocky and strongly down-curved and the inner margin of the paramere is conspicuously concave at the base of the blade with the inner tooth convex along the dorsal margin and the outer projection rounded and not strongly produced.

This is a large strikingly colored species readily recognizable by the unusual shape of the pronotum and the somewhat expanded distally shaped hemelytra. The strongly banded femora are also conspicuous. It seems to be most closely related to *caliginosa* also known only from the mountains of Hispaniola.

As with a number of other species this striking insect is an example of the montane endemism present in the genus in the Greater Antillies.

This species is named in honor of the late Dr. Philip Darlington of the Museum of Comparative Zoology Harvard University who collected the type series and for his many important contributions to the systematics and biogeography of the West Indies.

Ozophora pusilla, new species

Description. Very small, slender, nearly parallel sided. Dark chocolate brown as follows: head; anterior pronotal lobe; a series of longitudinal stripes on posterior lobe that form three distinct "loops" by coalescence of the stripes posteriorly; scutellum with exception of a small yellow macula on either side of midline and white apex; a diffuse streak on clavus adjacent to claval commissure; a small spot on corium immediately within corial furrow at level of distal one-fourth of scutellum; a complete transverse corial macula that narrows markedly to lateral margin and extends as a narrow stripe along apical corial margin to join with large apical corial spot; membrane with exception of veins and a conspicuous pale ovoid apical spot; entire thoracic pleura and sterna with paler acetabula and with posterior margin of metapleuron white. Pronotal collar dark brown mesally with a pale spot on either side. Pale dorsal areas ranging from yellowish on pronotum, scutellum and anterior portion of corium to white macula posteriorly. Legs and labium nearly uniformly pale yellow, former with a trace of an annulus near distal end of each femur and distal two-thirds of tarsal segment three chocolate brown. Fourth labial segment darkened. First antennal segment bright red, segments two and three yellow becoming infuscated distally, segment four with proximal one-half white, distal one-half chocolate brown. Dorsal surface nearly glabrous, lacking upstanding hairs.

Head relatively large, non-declivent, tylus attaining middle of first antennal segment, eyes set far away from anterior margin of pronotum, vertex nearly flat. Length head 0.74, width 0.70, interocular space 0.34. Anterior pronotal lobe narrow, nearly parallel sided, posterior lobe conspicuously elevated above anterior lobe, evenly expanded to humeri; transverse impression complete, posterior margin straight. Length pronotum 0.82, width 1.12. Length scutellum 0.60, width 0.52. Length claval commissure 0.60. Midline distance apex clavus–apex corium 1.06. Midline distance apex corium–apex membrane 0.64. Middle of mesosternal shining plate with a conspicuous fringe of silvery hairs. Metathoracic scent gland auricle acute distally, slightly curved posteriorly. Fore femora slender, each femur with two small acute ventral spines distally placed. Labium almost attaining mesocoxae. Length labial segments I 0.50, II 0.48, III 0.34, IV 0.32. First antennal segment relatively very large and thickened, diameter as great as that of fore femur, segments two and three slender and terete, segment four narrowly fusiform. Length antennal segments I 0.58, II 1.50, III 1.20, IV 1.18. Total body length 4.48.

Holotype. Male, DOMINICAN REPUBLIC: Peravia, 16 km E San Jose da Ocoa, 8.VIII.1979 (L. & C. O'Brien). In American Museum of Natural History.

Discussion. Although this small species scarcely exceeds in length most members of both the *laticephala* and *pallescens* complexes it is not closely related to either but rather resembles such elongate slender boldly marked species as *versicolor* and several as yet undescribed species from Mexico.

The strikingly enlarged and red colored first antennal segment will readily separate it from any other species in the West Indies. Although described from a single specimen it undoubtedly is a distinct species.

Two females from Jamaica (Portland, Hardwar Gap, and Manchioneal) in rather poor condition are either conspecific or represent a very closely related species. One of these lacks antennae, the other has one first antennal segment present which is dark brown rather than red. The hemelytral coloration is as in the holotype of *pusilla* but the posterior pronotal lobes are heavily suffused with red brown so that the definite open "loops" of the holotype are not present.

Ozophora alayoi, new species

Description. Moderately robust. Head, anterior pronotal lobe, greater portion of posterior pronotal lobe and scutellum, a complete transverse hemelytral fascia, an apical corial macula and all but distal end of membrane bright red brown. Posterior pronotal lobe with a narrow pale yellow median line, two yellow spots on either side of midline immediately behind transverse furrow, and four spots along extreme posterior margin. Scutellum with two short diagonal streaks. Hemelytra other than as noted above chiefly pale yellow; large distal corial macula almost white as is apical end of membrane. Legs and antennae chiefly pale yellow. Hind femur with a diffuse subdistal brown annulus. First antennal segment reddish brown, fourth segment dark brown with a moderately contrasting pale subbasal annulus.

Dorsal surface shining, polished, lacking upstanding hairs.

Head rather acuminate, not declivent, tylus attaining middle of first antennal segment, length of head anterior to compound eye considerably greater than length of eye, latter slightly removed from anterior margin of pronotum. Vertex not strongly convex. Length head 0.86 width 0.86; interocular space 0.40. Calloused lateral margins of pronotum relatively weakly developed, especially on anterior lobe. Transverse impression complete but shallow. Calli smooth, impunctate, scarcely depressed across midline; posterior margin slightly sinuately concave before scutellum. Length pronotum 0.94, width 1.40. Length scutellum 0.80, width 0.74. Length claval commissure 0.70. Midline distance apex clavus–apex corium 1.20. Midline distance apex corium–apex membrane 0.90. Metathoracic scent gland auricle short, straight, subtruncate distally; evaporative area little differentiated from remainder of pleuron but apparently occupying most of the inner three-fourths of metapleuron. Fore femora moderately incrassate, armed distally below with three major spines, a minute spine distad of these and a hair spine proximad. Labium obscured but first segment attaining base of head. Length labial segment I 0.78. Length antennal segments I 0.50, II 1.30, III 1.10, IV 1.32. Total body length 5.28.

Holotype. Female, CUBA: Prov. Pinar del Rio, Vinales, 220 m, 23.VI.1966 (F. Gregor). In Brno Museum (Czechoslovakia).

Discussion. While I have some reluctance to describe a new species from a single female it seems obvious that this specimen does not represent any described species of *Ozophora* and does not in anyway appear to be abnormal.

O. alayoi appears to be most closely related to *O. floridana* Slater and Baranowski. It is readily distinguishable by the much longer head (head anterior to eye subequal to eye length in *floridana*), the thicker, darkened first antennal segment and the shining dorsal body surface. *O. alayoi* has a much darker posterior pronotal lobe than does *floridana* but this feature may prove to be variable when a series of the former is available for study.

It is a pleasure to dedicate this handsome new species to Dr. Alayo in recognition of his many important contributions to Cuban Hemipterology.

Ozophora coleoptrata, new species
Fig. 2

Description. Body surface chiefly dark chocolate brown. Contrasting pale yellow markings present as follows: pronotal collar on either side of dark meson, a longitudinal stripe on either side of midline of posterior pronotal lobe, a small spot laterad of this stripe immediately behind transverse impression and humeral angles; a pair of small diagonal scutellar dashes and apex of scutellum; raised cubital vein on clavus; corium laterad of furrow from base to level of distal end of claval commissure. Legs, antennae, fore and hind coxae and anterior half of mesocoxae also uniformly pale yellow. Dorsal surface with scattered but elongate upstanding hairs present.

Head large, slightly declivent anteriorly, tylus attaining middle of first antennal segment; eyes set only slightly away from anterior pronotal margin. Length head 0.74, width 0.82; interocular space 0.40. Lateral pronotal margins strongly sinuate, narrowly calloused. Calli swollen, almost contiguous across meson, more elevated than posterior pronotal lobe, latter with posterior margin concave. Transverse impression complete but shallow and coarsely punctate. Length pronotum 0.78, width 1.14. Length scutellum 0.66, width 0.58.

Clavus and corium fused but former recognizable and apparently not reduced. Corium slightly convex along lateral margin, attaining maximum width at approximately level of distal end of claval commissure, reaching posteriorly to anterior margin of abdominal tergum six. Membrane not extending caudad of apex of corium,

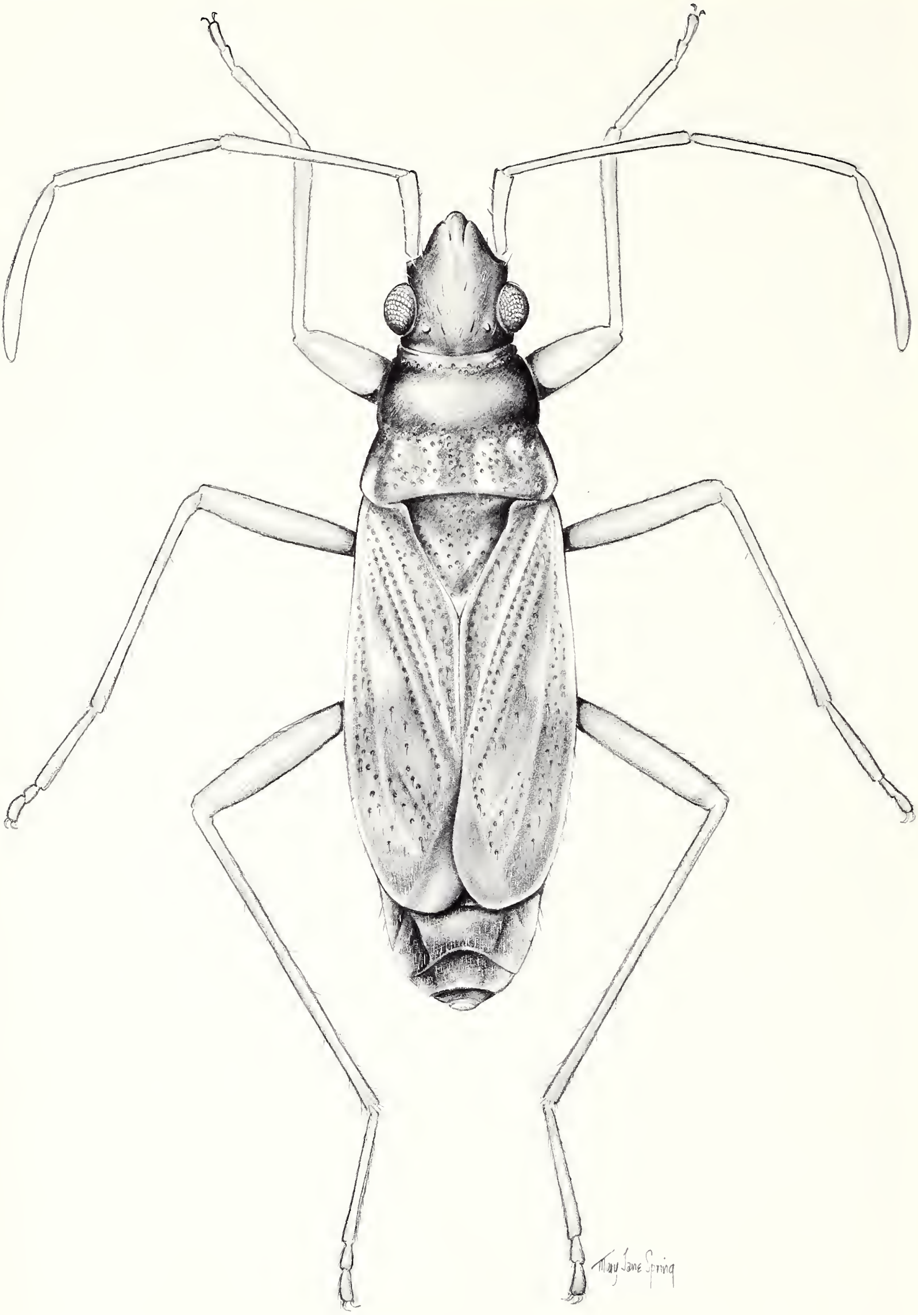

Fig. 2. *Ozophora coleoptrata,* dorsal view.

consisting of a broad "flap" along apical corial margin, the two membranes partially overlapping. Length claval commissure 0.80. Maximum length corium 2.36. Midline distance apex clavus–apex corium 0.82. Metathoracic scent gland auricle elongate, slender, "finger-like," slightly angled posteriorly. Evaporative area occupying entire inner two-thirds of metapleuron, its outer margin straight. Fore femur slightly incrassate armed below distally with three short blunt non-acute "spines" with a proximally located "hair spine" present. Labium attaining metacoxae. Length labial segments I 0.60, II 0.66, III 0.52, IV 0.38. Length antennal segments I 0.50, II 1.04, III 0.98, IV 1.18 (approx.). Total body length 4.48.

Holotype. Female BAHAMAS: *Inagua Island,* VII.1938 (McLean and Shreve). In American Museum of Natural History.

Paratypes. BAHAMAS: 1 female *N Bimini I,* Alicetown. 1 male *Great Inagua I,* Matthew Town, 31.I.1953 (E. B. Hayden and G. B. Rabb) (Van Voast–AMNH Bahama Isls. Exped.). 1 female *Turks* and *Caicos Isls.* Cays 3.5 m SW North Caicos Island 28.II.1953 (L. Giovannoli and G. B. Rabb) (Van Voast–AMNH Bahama Isls. Exped.).

Other material examined. MEXICO: 1 male *Puerto Morelos* (*Q.R.*), 7.VIII.1974 (night) (C. & L. O'Brien and Marshall). In American Museum of Natural History and J. A. Slater collections.

Discussion. There is considerable variability in the type series. Perhaps the most important difference is the condition of the fore femoral spines between the holotype and most of the paratypes. The paratype from Great Inagua has four acute spines nearly equidistantly spaced from one another on the left femur and occupying all but the proximal one-fourth of the femur and three on the right femur followed by a series of hairs. The Turks and Caicos paratype has two sharp spines on the left femur followed by a series of hair spines and those on the right with a hair spine series. The paratype from N Bimini has five small but sharp distinct spines on each femur. The Mexican specimen has four minute but acute spines on each femur. The spine pattern obviously varies. It resembles *burmeisteri* in that most specimens have a series of nearly equidistantly placed spines along a considerable portion of the ventral femoral surface rather than having the spines restricted to the distal fourth as in many species of *Ozophora.* It is important to note that all of these specimens have minute spines as compared with macropterus *burmeisteri.*

There is essentially no variation in the type or degree of coleoptery. There is, however, considerable variation in color. The holotype is considerably darker than the paratypes which show an almost graded series as follows: The lateral areas of the corium become pale yellow; the outer two-thirds of the clavus becomes yellow; the outer spot at the transverse pronotal furrow elongates to become a second longitudinal pale stripe; the dark areas of the hemelytra become restricted to the membrane and adjacent areas of the corium; the lateral margins of the posterior pronotal lobe become pale until finally in the Bimini paratype the hemelytra are completely pale yellow and the posterior pronotal lobe is conventionally so, only faint brown striping indicating the darkened areas of other specimens. Whether these color differences will prove to be of geographic significance must of course await adequate series. It should be noted that the two specimens from Inagua are much darker than any of the others.

For a number of years I have held this series of small coleopteroid female specimens from several islands of the Bahamas in the hope of obtaining a series, a male or some biological information. More recently the O'Briens have sent me the additional female from Mexico.

Originally I believed these specimens to represent coleopters of *O. burmeisteri* since they have upstanding hairs on the dorsal surface and were from the Bahamas where *burmeisteri* is a common species. This may still prove to be the case but there are several circumstances that suggest otherwise.

The reasons I am not willing to treat the coleopteroids listed below as representing *burmeisteri* are essentially these. 1.) All five of these coleopters have the fourth antennal segment uniformly pale yellow with no trace of a subbasal white annulus. This is true even of two specimens that have a largely dark chocolate brown dorsal surface. By contrast, of the several hundred macropterous specimens of *burmeisteri* examined all have a strongly contrasting white annulus basally on the fourth antennal segment. 2.) Although *burmeisteri* is widespread in the northern West Indian islands and occurs in Florida (it comes to lights readily) I have not seen a specimen from Mexico or Central America yet one of these coleopteroids is from Mexico. 3.) All of the specimens are considerably smaller than macropterous *burmeisteri* females. 4.) It is extremely rare in rhyparochromine Lygaeidae where a macropterous and a flightless stage occurs to have the macropter more common than the flightless form. Yet if these specimens are *burmeisteri* this would seem to be the case (many *burmeisteri* have been taken at lights, which, of course, biases the sample).

The occurrence of a coleopteroid *Ozophora* on low islands of the Bahamas is remarkable in itself. In *Ozophora* the only members of the genus to show any trace of wing reduction are from high elevations (none in the West Indies). Indeed, this is true for the entire tribe in the Western Hemisphere until one reaches temperate latitudes in southern South America and on the Juan Fernandez Islands.

Years ago Dr. P. D. Ashlock was perceptive enough to recognize that a new species was represented as attested by his label on one of the paratypes.

Ozophora caroli, Slater and Baranowski

Ozophora caroli Slater and Baranowski, 1983:422.

The type series of this recently described species was from southern Florida. Slater and Baranowski (1983), however, noted two probably conspecific specimens from Chiapas, Mexico. It appears to be a widespread although rare species as of the several thousand specimens of *Ozophora* examined I have seen only two additional females. One specimen is from Hispaniola, 21 km N Cabo Roso, Prov. Pedernales, 18.VI.1974 (R. E. Woodruff) (Florida Collection of Arthropods), the second from Cayman Islands: Grand Cayman W I. X.5.1980 (West Bay trap X) (M. E. Giglioli coll.) (Ashlock Collection).

Ozophora cubensis, Barber

Ozophora cubensis Barber, 1954:346.

Redescription of holotype. Body moderately elongate, nearly linear. Head and anterior pronotal lobe, including lateral margins, bright reddish brown; anterior collar also reddish brown but contrastingly pale yellow on either side of midline. Posterior pronotal lobe pale with obscure dark rays, these not reaching posterior margin, thus posterior portion of pronotum a strongly contrasting scalloped yellow stripe. Midline of posterior pronotal lobe pale. Scutellum dark red brown with a yellow macula on either side of midline obscurely produced into a diagonal streak; apex white. Hemelytra variegated, predominantly pale testaceous with an elongate dark brown stripe encircling pale macula at inner angle of corium and extending anteriorly to level of middle of claval commissure. Corium with small apical dark macula and a dark macula along corial margin at level of distal end of claval commissure that does not extend mesally to radius. Apical corial margin pale with posterior one-half to two-thirds crimson or red. Membrane pale fumose, veins in part pale yellow; apex of membrane mesally pale. Pleural and ventral surfaces bright reddish brown. Legs nearly uniformly pale testaceous, fore and mid femora without dark brown subdistal bands, hind femora with a somewhat obsolete dark subdistal annulus present. First, second and most of third antennal segment pale testaceous, third segment dark chocolate brown at distal fourth; fourth segment with a conspicuous white subbasal annulus, remainder of segment dark chocolate brown. Body lacking upstanding hairs on dorsal surface.

Head non-declivent. Tylus moderately acuminate, almost attaining middle of first antennal segment; vertex not strongly convex. Length head 0.84, width 0.94, interocular space 0.46. Pronotum with transverse impression complete, lateral margins sinuate; posterior pronotal lobe only moderately elevated above anterior lobe, posterior margin nearly straight. Length pronotum 1.08, width 1.64. Length scutellum 0.98, width 0.90. Hemelytra with lateral corial margins only very slightly concave or sinuate. Length claval commissure 0.84. Midline distance apex clavus–apex corium 1.46. Midline distance apex corium–apex membrane 1.04. Metathoracic scent gland auricle short, stout, obtusely rounded at distal end, not curving posteriorly. Fore femur moderately incrassate armed below with three long sharp spines with two hair-spines proximally and a short stout additional spine distally (on the left femur the most distal hair-spine is almost as large as the major spines). Labium extending posteriorly only between metacoxae. Length labial segments I 0.74, II 0.76, III 0.58, IV 0.28. Length antennal segments I 0.66, II 1.70, III 1.22, IV 1.32. Total body length 6.24.

Paramere with blade broad basally strongly tapered distally, inner major projection elongate finger-like, distal margin nearly evenly concave, tooth narrow ellipsoidal, basal flange strongly produced forward and upward. Sperm reservoir elliptical, wings strongly tapering and projecting posteriorly not markedly directed laterad.

O. cubensis was described from the mountains of Cuba, most of the type series being from the Sierra Maestra. The original type series consisted of 18 paratypes in addition to the holotype. I have examined the latter and 10 of the paratypes. They are all conspecific but Barber's listing of the data on the labels is somewhat misleading and to avoid future misunderstanding since the red labels say "Paratype" only with no indication of the species the following corrections and amplifications are included.

(1) The label on the holotype differs from Barber's listing in that the word, "J. Acuna" occurs after the year. The date is given as "May 16/48" rather than "May 16, 1948" as listed by Barber. After the elevation the label reads "feet" instead of "Ft. El."

Barber says that seven paratypes have the same data as the holotype but the paratypes before me have a number of label variations as follows:

1 male "Sierra Maestra Cuba May 18/48 Elev. 3500–4000 feet C. J. Ferras"
2 males "Palma Mocha Mt., S. Maestra Cuba May 16/48 Elev. 3900 FT. J. Ferras"
2 females "P. Mocha—Pico Joaquin, Sierra Maestra May 18/48 J. Acuna Elev. 3900–5300 feet"
1 female "Palma Mocha Mt., S. Maestra, Cuba May 16/48. J. Acuna 3900–4500 ft. elev."
1 female "Loma de Cala to P. Mocha, Sierra Maestra, Cuba V/16/48 3600–3900 feet." "J. Ferras Coll."
1 female as above but no collector label and "May" instead of "V"
1 male, 1 female as above except "J. Acuna" after "48"
The "J. A. Ferris" of Barber's listing apparently should be "J. Ferras."

The paratype series does not differ appreciably from the redescription of the holotype given above. In some specimens the pale scutellar vittae do not extend onto the anterior half of the scutellum; sometimes the distal end of the second antennal segment is infuscated and the crimson coloring along the apical corial margin, while always present, is sometimes confined to the outer one-fourth. Specimens from "P. Mocha-Pico" tend to be relatively pale, sometimes with the entire posterior pronotal lobe uniformly pale yellow and the apical dark corial macula reduced to a narrow "dash" along the lateral margin of the corium. The number of spines on the fore femur also varies from three to five, evidently due to the variability in the two most proximal spines. One paratype shows oligomery of the left antennae. Three segments are present, the second segment being much longer than the normal second segment and the terminal segment being considerably longer than the usual fourth segment and with a narrow white annulus present some distance from the base of the segment.

O. cubensis is closely related to *O. subimpicta* Barber but is much larger and more robust. It does have the distal portion of the apical corial margin red but this is never extended across the apex of the corium as a red macula as is frequently the case in *subimpicta.*

I have examined a single male in the American Museum of Natural History from Hispaniola, Loma Rucilla and Mts. N Dom. Rep. June '38, 5–8,000 ft (Darlington) which may represent a distinct species but is closely related to *cubensis* and is not described at this time. This specimen has considerably longer hemelytra relative to the length of the pronotum than is true of any of the type series of *cubensis.* The fourth antennal segment does not have a distinctly differentiated white subbasal annulus and the hemelytral membrane lacks an apical pale macula. I suggest this specimen will ultimately be shown to represent another montane endemic species on Hispaniola.

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WHAT IS *NEPA HOFFMANNI* (HETEROPTERA: NEPIDAE)? MALE GENITALIA HOLD THE ANSWER, AND DELIMIT SPECIES GROUPS

S. L. Keffer,[1] J. T. Polhemus,[2] and J. E. McPherson[1]

[1]Department of Zoology, Southern Illinois University,
Carbondale, Illinois, 62901
[2]University of Colorado Museum, 3115 S. York St.,
Englewood, Colorado 80110

Abstract.—*Nepa hoffmanni* Esaki is different somatically from its congeners; therefore, we here examine its generic assignment by comparing the male genitalia of *N. hoffmanni, N. cinerea* Linnaeus, *N. sardiniensis* Hungerford, and *N. apiculata* Uhler. Three diagnostic genitalic character states were found for the four taxa confirming *hoffmanni*'s membership in *Nepa*. In addition, internal genitalic structures clearly delimit two species groups within *Nepa*: an *apiculata* group composed of *N. apiculata* and *N. hoffmanni,* and a *cinerea* group composed of *N. cinerea* and *N. sardiniensis.* Finally, we hypothesize that internal genitalic characters can be used to delimit waterscorpion genera.

Esaki concluded his 1925 description of *Nepa hoffmanni* with four diagnostic characters for his new species. Compared to the two other species then in the genus *Nepa,* i.e., *N. cinerea* Linnaeus and *N. apiculata* Uhler, *N. hoffmanni* was much larger, had stouter legs (particularly the forelegs), a much shorter caudal respiratory siphon, and a relatively shorter abdomen (p. 314), characteristics that would seem to ally *hoffmanni* with *Telmatotrephes* Stål rather than *Nepa* (Lansbury, 1972a; Keffer et al., 1989). Currently, there are five species in *Nepa* (*N. apiculata,* eastern North America; *N. cinerea* with eight recognized subspecies, Europe, North Africa and northeast Asia; *N. hoffmanni,* northeast Asia; *N. remyi* Poisson, Morocco; *N. sardiniensis* Hungerford, Corsica and Sardinia) (Poisson, 1961; Tamanini, 1973) and *hoffmanni* differs somatically from all its congeners. Therefore, we here assess the generic assignment of *N. hoffmanni* by comparing its male genitalia with those of other *Nepa* species.

Ivor Lansbury, the preeminent taxonomist of the Nepidae over the last two decades, laid the groundwork for this study with his 1967 work on male Australian Nepidae. He later figured the male genitalia of other nepid genera in various revisionary works (1972a, b, 1973a, b, 1974a, b, 1978). Other workers who have figured male waterscorpion genitalia include Hamilton (1931), Larsen (1938), Kumar (1961) and De Carlo (1968).

MATERIALS AND METHODS

Specimens of *N. hoffmanni* from Japan; *N. cinerea* from Finland, Portugal and Morocco; *N. sardiniensis* from Sardinia; and *N. apiculata* from Illinois were dissected (*N. remyi* was not seen). The technique followed in the dissections was that of Lansbury (pers. comm.). Abdomens of relaxed specimens were immersed in dimethyl sulfoxide and then washed in alcohol. The outer margins of ventral laterotergites six and seven were cut with iridectomy scissors and then levered away, exposing the genital capsule. The apodemes attaching the capsule to the respiratory siphons were cut and the capsule then pulled free with spatulate forceps. After soaking in 10% KOH at room temperature for 24 hours the capsule was rinsed in glacial acetic acid and distilled water. The internal genitalic structures were exposed by cutting the capsule along one lateral margin and then severing the apodemes holding the internal structures to the inner capsule wall. In order to see the innermost structures it was then necessary to cut away one phallothecal plate and half of the anterior diverticulum of the internal genitalia (see below for description of terms). The genitalia were cleared in clove oil and drawings were prepared using a 10 × 10 ocular grid.

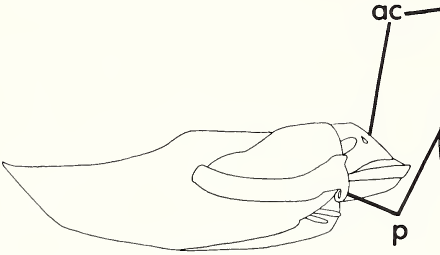
In the figures that accompany the text *N. cinerea, N. hoffmanni,* and *N. apiculata* are illustrated. *N. sardiniensis* is not figured because its male genitalia was found to be nearly identical with all the *N. cinerea* specimens.

RESULTS

Genital capsule. Lansbury has described waterscorpion genitalia as a "box within a box within a box" (pers. comm.). The outermost box is the genital capsule shown in lateral (Figs. 1–3), dorsal (Figs. 4–6), and ventral (Figs. 7–9) views. Two differences were found to occur between the four taxa. First, the anal cone (ac) of *N. hoffmanni* is constricted distally in dorsal view (Fig. 4), a condition not found in *N. sardiniensis, N. cinerea* (Fig. 5) or *N. apiculata* (Fig. 6). Second, the distal hook of the paramere (p) in *N. hoffmanni* (Fig. 7) and *N. apiculata* (Fig. 9) lies at a right angle to the long axis of the paramere and extends medially beneath the paramere's ventral edge while in *N. cinerea* (Fig. 8) and *N. sardiniensis* the hook lies mostly in the longitudinal plane of the paramere. *N. remyi,* the one *Nepa* species not seen in this study, also has the *cinerea* type paramere (Poisson, 1961, pp. 635–637).

Internal genitalia. Within the genital capsule is the second "box" which consists of a set of structures called by Lansbury the internal genitalia. All four taxa exhibit a high degree of uniformity in the arrangement of their internal genitalic structures (Figs. 10–12). An anterior diverticulum (ad) is short and heavily sclerotized. A median phallotheca (ph) is comprised laterally of heavily sclerotized phallothecal plates (pp). Dorsal to the phallotheca, paired basal plates (bp) are connected medially by a bridge (not shown in lateral view). Paired lateral arms of the basal plates (labp) curve around the anterior end of the phallotheca and posterior end of the anterior diverticulum and unite ventrally in a lamina ventralis (lv) which extends caudad. The lateral arms are clearly bipartite in all four taxa with the ventral and dorsal parts joined by membrane. Bipartite lateral arms have not been reported elsewhere in the Nepidae. This character state is thus diagnostic for these species. All four taxa have a large ejaculatory duct (ed) which passes beneath the anterior diverticulum and between the lateral arms and then into the phallotheca. Caudally, in all four taxa a membranous posterior diverticulum (pd) is framed laterally by sclerotized secondary struts (ss) which emanate from inside the phallotheca and extend to the distal margin of the posterior diverticulum. In no other species of the Nepidae thus far studied do secondary struts reach the distal margin of the posterior diverticulum. This character state constitutes a second diagnostic feature for these four *Nepa* species.

Two internal genitalic character state differences are evident. In *N. hoffmanni* (Fig.



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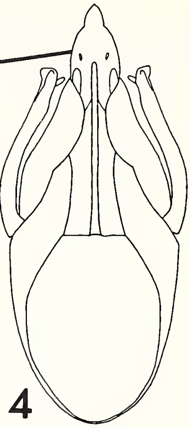

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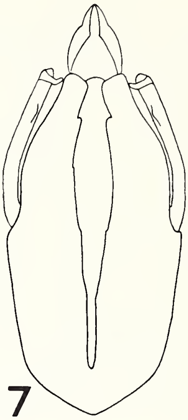

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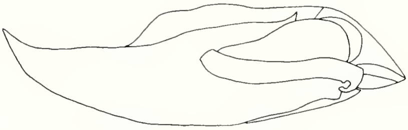

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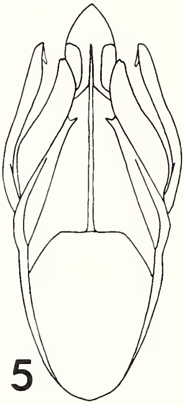

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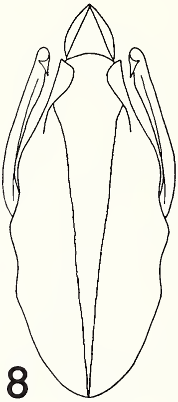

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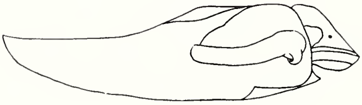

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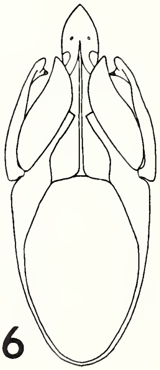

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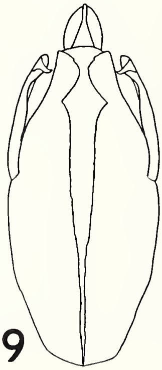

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Abbreviations used in the figures. ac, anal cone; ad, anterior diverticulum; bp, basal plates; bvr, break in the vesical rod; cs, central strut; e, endosoma; ed, ejaculatory duct; er, ejaculatory reservoir; labp, lateral arms of the basal plate; lv, lamina ventralis; p, paramere; pcs, process of the central strut; pd, posterior diverticulum; ph, phallotheca; pp, phallothecal plate; slr, sclerotized lever rods of the vesica; ss, secondary strut; v, vesica; vr, vesical rod.

10) and *N. apiculata* (Fig. 12) the dorsal margin of the posterior diverticulum is always shorter in lateral view than that of the anterior diverticulum while in *N. sardiniensis* and *N. cinerea* (Fig. 11) the dorsal margin of the posterior diverticulum is always longer. In *N. hoffmanni* and *N. apiculata* the posterior diverticulum ventrally descends well beneath the ventral margins of the exposed secondary struts. In contrast, the posterior diverticulum ventrally of *N. cinerea* and *N. sardiniensis* descends only partially beneath the ventral margins of the secondary struts.

Endosoma and ancillary structures. By removing the phallothecal plate and anterior diverticulum from one side of the internal genitalia, one reveals the innermost "box" of the male genitalia, a rather bewildering array of single and paired structures (Figs. 13–15) termed by Lansbury the endosoma and ancillary structures. In all four taxa a single median central strut (cs) is attached caudally to the lamina ventralis (lv) by membrane. Basally, the central strut is broadened into paired symmetrical processes (pcs). Above these processes are the paired secondary struts (ss). The cephalic end of the central strut is joined to the ejaculatory reservoir (er) which in all four taxa is broadly triangular. The vesica (v) is enclosed in an inverted U-shaped vesical rod (vr) which in all four species is bipartite. Bipartite vesical rods are not found elsewhere in the Nepidae and this is, therefore, a third diagnostic character state for the four *Nepa* species. Paired sclerotized lever rods of the vesica (slr) are attached anteriorly to the vesical rod, and from there descend into the phallotheca forming a deep (*hoffmanni* and *apiculata*) or shallow (*cinerea* and *sardiniensis*) concavity before ascending to the anterodorsal margin of the posterior diverticulum. The lever rods then descend to the dorsolateral margins of the posterior diverticulum and become thinner and very lightly sclerotized. They then extend posteriorly, meeting medially just distal and ventral to the upturned apex of the posterior diverticulum. The vesica and vesical rods are enclosed in a hyaline endosoma (e) which extends from the posterodorsal margin of the anterior diverticulum to the upturned apex of the posterior diverticulum and is attached variously to the central strut, the sclerotized lever rods, and the posterior diverticulum.

Differences between the four taxa occur in the shape and composition of the vesical rods. In *N. hoffmanni* (Fig. 13) and *N. apiculata* (Fig. 15) the break in the vesical rod (bvr) occurs in the posterior diverticulum, ventral to the secondary struts in *hoffmanni* and dorsal to the secondary struts in *apiculata*. The vesical rod anterior to the break is sinuate, descending into the phallotheca and then to the posterior diverticulum. Posterior to the break the rod ascends in, and then emerges from, the posterior diverticulum and ends simply. In *N. cinerea* (Fig. 14) and *N. sardiniensis* the break in the vesical rod occurs at the phallotheca/posterior diverticulum border. Anterior to the break the rod is straight, posteriorly it is shallowly concave, and distally the rod ends in a spear-shape. In all *Nepa* species examined the anterior section of the vesical rod is heavily sclerotized and rigid. Posteriorly, the vesical rods

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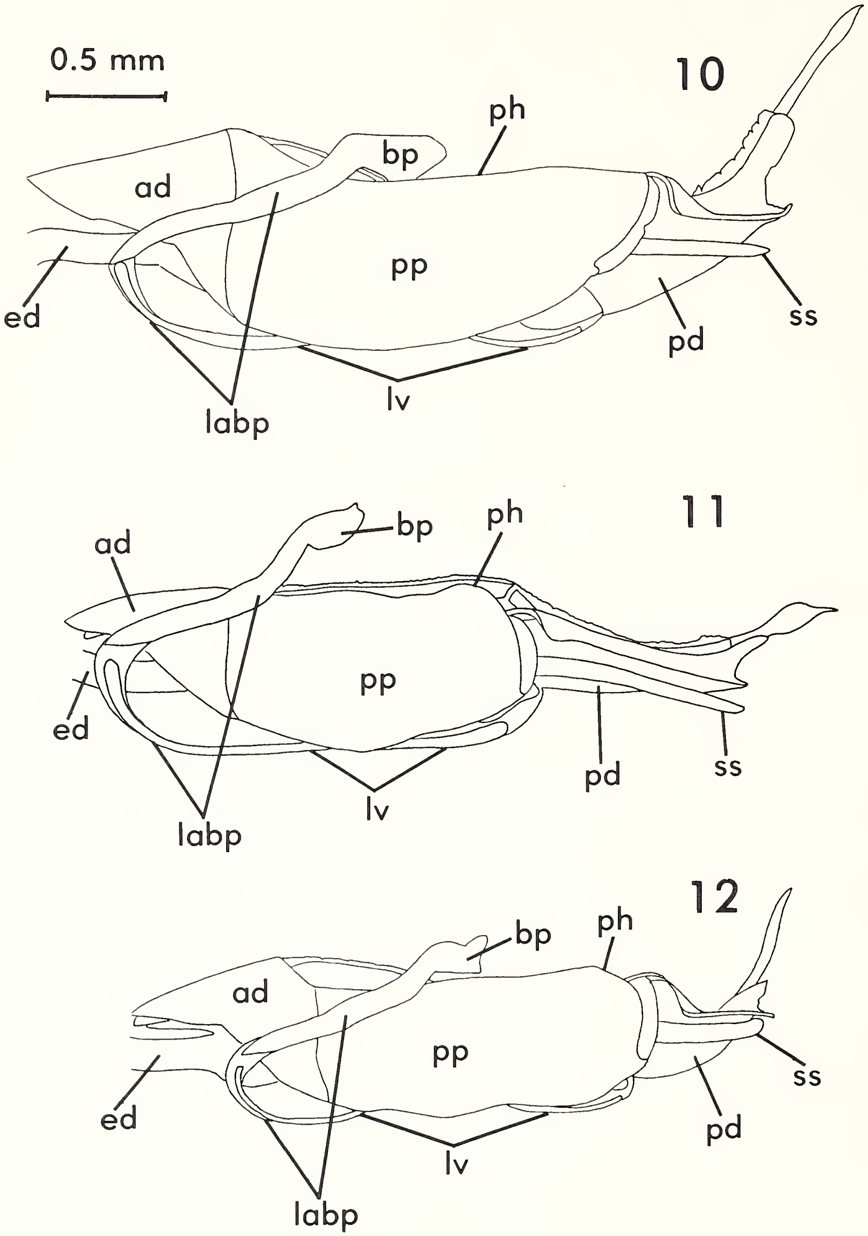
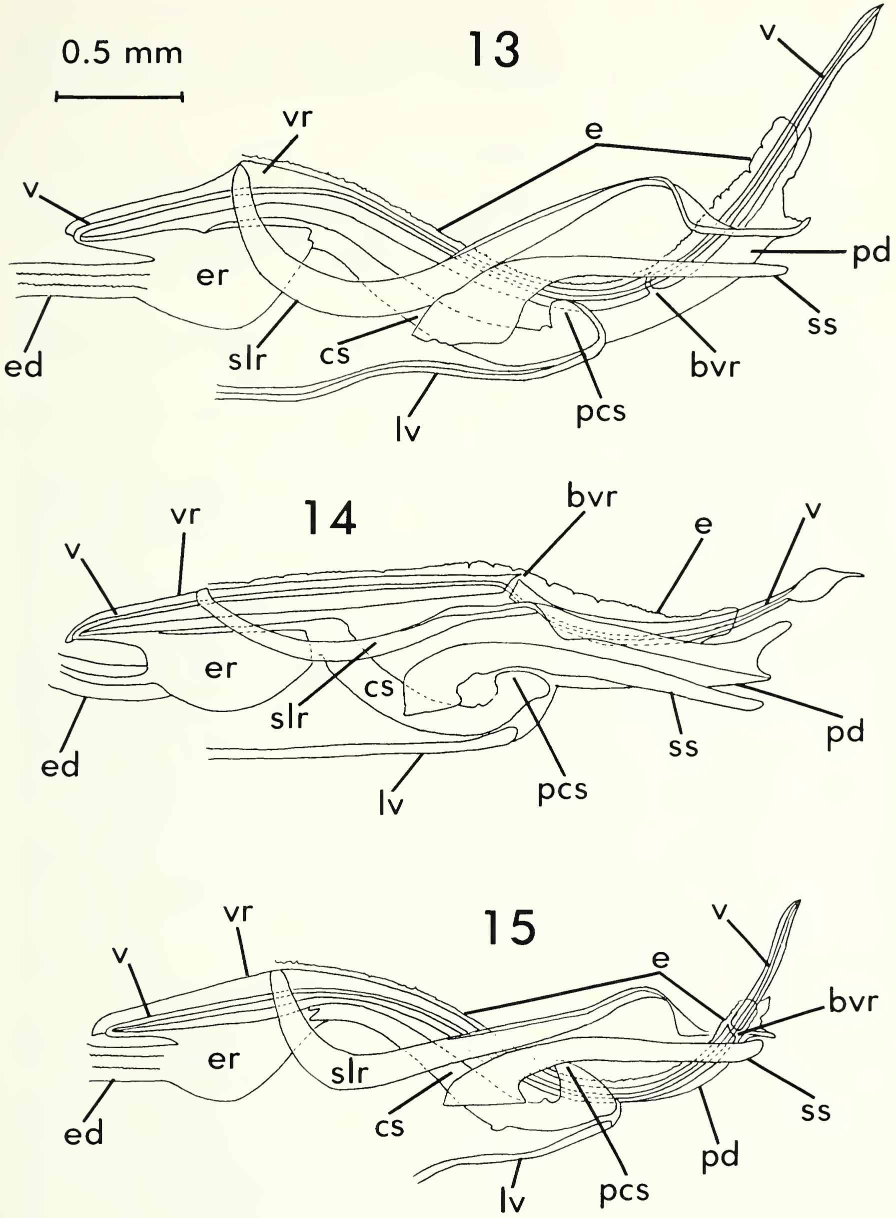
Figs. 1–9. Genital capsule. Lateral view: 1. *N. hoffmanni.* 2. *N. cinerea.* 3. *N. apiculata.* Dorsal view: 4. *N. hoffmanni.* 5. *N. cinerea.* 6. *N. apiculata.* Ventral view: 7. *N. hoffmanni.* 8. *N. cinerea.* 9. *N. apiculata.*



Figs. 10–12. Lateral view of internal genitalia. 10. *N. hoffmanni* 11. *N. cinerea.* 12. *N. apiculata.*



Figs. 13–15. Lateral view of endosoma and ancillary structures. 13. *N. hoffmanni.* 14. *N. cinerea.* 15. *N. apiculata.*

of *N. hoffmanni* and *N. apiculata* gradually become less sclerotized after the break and are flexible only distally. The vesical rods in *N. cinerea* and *N. sardiniensis* are dramatically less sclerotized immediately after the break in the rod and uniformly flexible throughout their length.

CONCLUSIONS

Amidst this mass of genitalic detail we have, of course, answered our primary question, namely, what is *Nepa hoffmanni*? These dissections reveal three character states that are diagnostic for species of *Nepa* including *N. hoffmanni*:

1) Bipartite lateral arms of the basal plate.
2) Secondary struts that extend to the distal margin of the posterior diverticulum.
3) Bipartite vesical rods.

We therefore conclude that *N. hoffmanni* should remain in the genus *Nepa* despite somatic differences with its congeners.

In addition to answering our central question, these dissections provide additional taxonomic information regarding species groups in *Nepa*. Six differences in genitalic structure clearly separate the species examined into two species groups (Table 1): an *apiculata* group composed of *N. hoffmanni* and *N. apiculata,* and a *cinerea* group composed of *N. cinerea* and *N. sardiniensis.* We can also tentatively assign *N. remyi* to the *cinerea* group because the shape of its paramere is *cinerea*-like (Poisson, 1961: 635–637). Poisson, in his 1961 review of *Nepa,* divided the genus into the same two species groups using differences in antennae (*N. apiculata* and *N. hoffmanni* lack lateral lobes on the penultimate segment while all other *Nepa* species are lobed except *N. cinerea dollfusi* Esaki which has the last two segments fused [p. 629]) and the same differences in paramere shape noted in our study (see above and Table 1). Subsequently, Tamanini, in a 1973 review of European *Nepa* spp., showed that the antennae of a given species are quite variable, subject to fusions, abnormalities, etc. Thus, antennae are of doubtful taxonomic value except when long series are available to establish a "normal" or most common form within populations. In short, only one of Poisson's species group characters, paramere shape, is currently thought to be valid. Thus, the five additional internal genitalic characters presented in this paper confirm and strengthen the species group concepts originally proposed for *Nepa* by Poisson.

The high degree of uniformity of internal genitalic structures observed in our study between the specimens of *N. cinerea* and *N. sardiniensis* suggests that taxonomic differences currently recognized in the *cinerea* group may be questionable. Various species and subspecies names have been proposed for *Nepa* populations closely allied to *cinerea,* all based on minor morphological variations or geographical separation. All of these except *N. cinerea orientalis* Esaki (northeast Asia) and *N. remyi* were reviewed by Tamanini (1973) who treated these European and North African taxa, with the exception of *sardiniensis,* as subspecies of *cinerea*; these include the nominate subspecies *cinerea* Linnaeus (northern Europe), *dollfusi* (Morocco), *major* Bergevin (Morocco), *meridionalis* Poisson (southeast Europe, Algeria, Tunisia), *minor* Puton (Mediterranean region), *poissoni* Tamanini (Pyrenees, southeastern Spain) and *seurati* Bergevin (southern Italy, Sicily, Tunisia, Tripolitania). Earlier Poisson (1961) provided analysis of roughly the same group of taxa; in this work he treated as species

Table 1. *Nepa* species groups.

apiculata group: *N. apiculata, N. hoffmanni*

1. Distal hook of paramere at right angle to longitudinal plane of paramere (Poisson, 1961, p. 629).
2. Posterior diverticulum ventrally descends significantly beneath ventral margins of secondary struts.
3. Posterior diverticulum with dorsal margin shorter than that of anterior diverticulum.
4. Vesical rod anteriorly sinuate, descends into phallotheca.
5. Vesical rod break occurs in posterior diverticulum.
6. Vesical rod posteriorly: gradually less sclerotized, flexible distally only, ends simply.

cinerea group: *N. cinerea, N. sardiniensis,* (*N. remyi*?)

1. Distal hook of paramere in longitudinal plane of paramere.
2. Posterior diverticulum descends partially beneath ventral margins of secondary struts.
3. Posterior diverticulum with dorsal margin longer than that of anterior diverticulum.
4. Vesical rod anteriorly straight, dorsal in phallotheca.
5. Vesical rod break at phallotheca/posterior diverticulum border.
6. Vesical rod posteriorly: abruptly less sclerotized, uniformly flexible throughout length, distal spear-shape.

many taxa that Tamanini later relegated to subspecies status. Nico Nieser, after studying several of these taxa from southeastern Europe, suggests (in litt.) that some of them may not warrant even subspecies status. It is possible that analysis of individual internal genitalic structures may help clarify the status of the *cinerea* group taxa. For example, Tamanini (1973) noted a difference in the posteroventral shape of the secondary struts between *N. c. cinerea* and *N. sardiniensis* (p. 259).

Differences in the vesical rod morphology of the two species groups suggests a possible vesical rod/spermathecal lock-and-key effect. Larsen, in his 1938 study of the genitalic morphology of *N. cinerea,* illustrated the conformation of the male and female genitalia during copulation. His figure 26 (p. 63) shows the break in the vesical rod correlating with a 180° switchback in the spermatheca (see also fig. 18, p. 56). We hypothesize, therefore, that the more distal vesical rod breaks in *N. apiculata* and *N. hoffmanni* will match correspondingly more distal switchbacks in their respective spermathecae.

Finally, we believe that our study has important implications for waterscorpion classification. The uniformity of the male genitalia across divergent external forms in *Nepa* suggests to us that internal genitalic characters may be useful in delimiting waterscorpion genera, notwithstanding Lansbury's (1967:647; 1974b:226) contention that the nepid male genitalia do not provide reliable subfamily or tribal characters in the genera he studied. We intend to test our hypothesis in forthcoming revisions of nepid genera.

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Dr. Ivor Lansbury's detailed descriptions and elegant drawings of waterscorpion genitalia were the source of inspiration for our work. Further, whatever success we have achieved with our study would not have been possible without the help of Dr. Lansbury who very generously shared his dissection protocol with the senior author.

Specimens examined were provided by the following: Southern Illinois University Entomological Collection (*N. apiculata*), Polhemus Collection (University of Colorado Museum at Englewood) (*N. hoffmanni, N. cinerea,* and *N. sardiniensis*), and Dr. Nico Nieser, Tiel, The Netherlands (*N. cinerea*). We also thank Dr. Nieser for sharing his assessment of certain European subspecies of *N. cinerea.*

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OBSERVATIONS ON THE TAXONOMY AND NATURAL HISTORY OF *OPHRAELLA* WILCOX (COLEOPTERA: CHRYSOMELIDAE), WITH A DESCRIPTION OF A NEW SPECIES

Douglas J. Futuyma

Department of Ecology and Evolution,
State University of New York at Stony Brook,
Stony Brook, New York 11794

Abstract.—Morphological evidence indicates that the North American galerucine genus *Ophraella* is a strictly monophyletic taxon, closely related to *Monoxia* LeConte and *Erynephala* Blake. Host associations for all species, including several hitherto lacking host records, are listed; all hosts are in the Asteraceae. Distinguishing morphological features of adults are described, and descriptions of immature stages of most of the species are provided. *O. macrovittata* LeSage is placed in synonymy with *O. sexvittata* (LeConte), and the possibility of conspecificity of *O. pilosa* LeSage and *O. americana* (Fabricius) is raised. A new species, *Ophraella artemisiae,* is described from Texas.

Several features of the life history are described. Phenological data indicate that northern populations and species are univoltine, whereas more southern populations are generally multivoltine. Cocoon formation differs from previous reports in that the cocoon material issues from the rectum. Several natural enemies were observed, including, in *O. communa* LeSage, a eulophid genus not previously recorded in North America. Geographically isolated populations of *O. communa* display partial sexual isolation, as do closely related sympatric species (*O. communa* and *O. notulata* [Fabricius]) which occupy different host plants. A difference in host affiliation is therefore not the only barrier to gene exchange.

Species of *Ophraella* Wilcox, a North American genus of leaf beetles (Chrysomelidae: Galerucinae, tribe Galerucini), are locally abundant throughout much of their range. Nevertheless, little is known of the biology of the genus, perhaps because the host plants have little economic importance. A few comments on host associations and other aspects of the biology of some species are provided by Blatchley (1910), Woods (1924), Wilcox (1965), Messina and Root (1980), and LeSage (1986); the life history of only one species has been described in any detail (Welch, 1978; Goeden and Ricker, 1985). The genus was revised by LeSage in 1986.

In the course of an ongoing analysis of the phylogeny and of the evolution and genetics of host association in the genus, I have made a variety of observations that increase the taxonomic and biological knowledge of *Ophraella*. Although some of these observations are not quantitative, investigators embarking on the study of little known taxa will find qualitative observations more helpful than none at all. In subsequent publications I shall treat the morphology of *Ophraella* and related genera, and the phylogeny and evolution of host associations within the genus, based on morphological and electrophoretic analyses. In another publication (Futuyma, in press), I have described feeding responses of many of the species to their congeners' host plants.

MONOPHYLY OF *OPHRAELLA*

Wilcox (1965) segregated *Ophraella* from *Galerucella,* and considered it most closely related to *Erynephala* Blake, *Monoxia* LeConte, *Ophraea* Jacoby, and several Neotropical genera. White (1979) referred the Neotropical *Trirhabda dilatipennis* Jacoby to *Ophraella,* but LeSage (1986) later placed this species in *Neolochmaea* Laboissiere. I have examined the morphology of this species, as well as species of *Erynephala, Monoxia,* and the holarctic taxon *Pyrrhalta* (subgenus *Tricholochmaea*) Laboissiere.

With reference to *Neolochmaea* and *Pyrrhalta,* the close relationship of *Ophraella* to *Monoxia* and *Erynephala* is supported by several synapomorphies not hitherto noted, including (1) spermathecal duct inserted subbasally (rather than extending rectilinearly from base); (2) sternum VIII of the female lacking the long anterior rod-like apodeme present in the other genera; (3) styli of the female (referred to as "accessory glands" by LeSage (1986)) reduced to flat setiferous discs (rather than elongate); (4) internal sac of male lacking ornamentation; (5) internal scuto-scutellar sclerites of larva each bearing laterally what appears to be a setaless socket (absent in the other genera). Brivio (1977) has noted that the above differences in female genitalia between *Ophraella* and *Pyrrhalta* also distinguish *Ophraella* from *Galerucella* (s.s.) and, for the most part, from *Xanthogaleruca. Ophraella* shares with *Monoxia,* its apparent sister group, the following synapomorphies: (1) pupation within a loosely woven cocoon rather than free; (2) sternum VIII of female with lateral extensions of the base (absent in the other genera); (3) apex of the male sternum deeply, conically invaginated (vs. shallowly or not at all); (4) aedeagus (median lobe) basally with a dorsal ring (vs. absent), this laterally confluent with the basal spurs. In addition to the features noted by LeSage (1986), the species of *Ophraella* share the following synapomorphic characters with respect to the condition in *Erynephala* and *Monoxia*: (1) mandible of adult with three rather than five teeth; (2) teeth IV and V of larval mandible only shallowly (rather than fully) separated, hence appearing fused basally; (3) larval cuticle lacking discrete aggregations of pigment ("melanophores"); (4) setae of dorsal sclerites of larva almost uniform in length (strongly variable in the other genera). Electrophoresis of 18 enzyme loci also supports the monophyly of *Ophraella* relative to *Monoxia* and *Erynephala* (Futuyma and McCafferty, in prep.).

TAXONOMY AND HOST AFFILIATION

LeSage (1986) recognized 13 species of *Ophraella,* of which he described five as new, renaming two others. He listed host records for 11 species. My records confirm LeSage's (1986) and Wilcox's (1965) supposition that all the hosts of *Ophraella* are Asteraceae (Compositae) (Table 1). Below I present an account of my present understanding of the taxonomic status and host affiliation of each of the species.

(1) *O. americana* (Fabricius) and *O. pilosa* LeSage. LeSage reported host records for *O. americana* as "*Solidago* spp.," and distinguished *O. pilosa* from *O. americana* on the basis of slight differences in genitalia, markings, average body size, the density of erect setae on the elytra, and association with *Aster.* Collections from *Aster* species (especially *A. urophyllus*) in central New York, Missouri (Dade Co.), Montana (Lake Co.), and Ontario (Leeds Co.) all conform morphologically to the description of *O. pilosa.* I have collected these forms on *Solidago* only in Ithaca, New York, where

Table 1. Known host plants of *Ophraella* species. Notations following host records: L, literature records (cf. LeSage, 1986; Goeden and Ricker, 1985); P, personal record; *, host not previously reported. Localities for host records are indicated in some instances. Attributions to other collectors are based on reliable personal communications.

Species	Known hosts
O. americana[1]	*Solidago* sp. (L)
O. pilosa[1]	*Aster macrophyllus* (L, P), *A. cordifolius* (L), *A. paniculatus* (L), *A. urophyllus* (P*, N.Y., Mo.), *A. laevis* (P*, Mt.), *A. lowrieanus* (P*, N.Y.), *A. novae-angliae* (H. Damman*, Ont.), *Solidago bicolor* (P*, N.Y.), *S. squarrosa* (R. Hamilton*, N.Y.)
O. notata	*Eupatorium perfoliatum* (L, P), *E. maculatum* (P*, N.Y.), *E. hyssopifolium* (P*, Va.), *E. capillifolium* (E. Hoebeke*, Fl.)
O. cribrata	*Solidago juncea* (L, P), *S. altissima* (L, P), *S. nemoralis* (L), *S. pinetorum* (P*, Va.), *S. bicolor* (P*, N.Y.)
O. conferta[1]	*Solidago altissima* (L, P), *S. gigantea* (P*, N.Y.), *S. juncea* (P*, N.Y.), *S. canadensis* (L), *S. rugosa* (L, P)
O. sexvittata (and *O. macrovittata*)[1]	*Solidago altissima* (P*), *S. leavenworthii* (P*), *S. gigantea* (J. Sullivan*, Mo.)
O. arctica	*Solidago multiradiata* (L, P)
O. bilineata	*Chrysopsis villosa* (L, P)
O. nuda	*Iva axillaris* (P*)
O. californiana	*Artemisia Douglasiana* (L)
O. artemisiae	*Artemisia Carruthii* (P*), *A. ludoviciana* (L)
O. notulata	*Iva frutescens* (L, P), *I. annua* (P*, La.)
O. communa	*Ambrosia artemisiifolia,* (L, P), *A. psilostachya* (L), *Iva axillaris* (R. Goeden*, P*, Ca.), *Xanthium strumarium* (L), *Helianthus ciliaris* (P*, Tx.), *Ratibida pinnata* (J. Sullivan*, Mo.)

[1] See text regarding taxonomic status.

larvae were taken on *Solidago bicolor, Aster macrophyllus,* and *A. Lowrieanus,* growing intermingled. These specimens, reared to adulthood, show no host-associated differences in the characters given by LeSage. Within *O. pilosa* taken from *Aster urophyllus* in New York, the range of intraspecific variation equals or exceeds the reported difference between *O. americana* and *O. pilosa* for the following characters held to distinguish these taxa: form of coronal marking (linear vs. triangular), form of spermathecal receptacle (ovoid vs. rounded), breadth/length of stalk of sternum VIII of female. (These characters are also intraspecifically variable in other species of *Ophraella.*)

Evidence of reproductive isolation between sympatric populations (the definition of biological species) can be provided not only by morphological differences, but also (and often more reliably) by substantial differences in allele frequencies at individual loci. In the limit, the absence of heterozygotes for pairs of alleles that are restricted to different populations provides conclusive evidence that the populations are different species. Loci identified by enzyme electrophoresis have proven useful in discriminating sibling species (e.g., Grassle and Grassle, 1976; Bush and Kitto, 1978). The electrophoretic data reported here and the methods used (Harris and Hopkinson, 1976) will be presented in full in a future paper (Futuyma and McCafferty, in prep.).

Allele frequencies in the syntopic collection of *O. americana*-like specimens from *Solidago bicolor* and *Aster* in Ithaca (combining samples from 1 June 1987 and 21 June 1988) did not differ at 11 fixed or 6 variable loci (N = up to 49 and 66 genes for *Solidago* and *Aster* samples respectively). At one locus (6PGD, E.C.1.1.1.44), allele frequencies differed significantly ($\chi^2 = 7.516$, df = 2, $P < 0.025$) between samples from *Solidago* (allele frequencies $p_1 = 0.07$, $p_2 = 0.62$, $p_3 = 0.31$; N = 30 genes) and *Aster* ($p_1 = 0.34$, $p_2 = 0.52$, $p_3 = 0.14$; N = 30 genes; p_3 = the summed frequency of four rarer alleles).

Larvae taken from *Solidago* and *Aster* at the Ithaca site on 21 June 1988 were reared to adulthood on *Solidago bicolor* and *Aster urophyllus* respectively, and tested individually for their feeding preference between these plants. Each beetle was placed in a 100-mm-diameter dish with moist filter paper and a leaf of each species, in a 14:10 L:D, 25°C/20°C incubator at 85% RH for two days; the foliage was replaced after 24 hr, and feeding in each 24-hr period was scored as the leaf area consumed (measured under a microscope with a rectangular ocular grid). Of 58 animals tested, 12 had been exposed to the rearing host between eclosion and testing; these did not differ in preference from the "naive" animals. Using total consumption of each plant, 13 of 23 *Aster*-derived beetles preferred *Aster* and 27 of 35 *Solidago*-derived animals preferred *Solidago,* a significant association ($\chi^2 = 6.803$, df = 1, $P < 0.01$). Considered separately, significantly more beetles from *Solidago* preferred *Solidago* ($\chi^2 = 10.314$, df = 1, $P < 0.005$), whereas those from *Aster* displayed no significant preference ($\chi^2 = 0.391$).

Only the allele frequency at one locus, and the apparent difference in breadth of host acceptability, suggest the possibility of a host-associated subdivision of this population into "host races" (Jaenike, 1981; Diehl and Bush, 1984; Futuyma and Peterson, 1985) or species. Whether or not *O. pilosa,* which according to LeSage (1986) is distributed primarily in northern United States and southern Canada, is specifically distinct from *O. americana* is uncertain at this time. In the collections I have examined, specimens most readily referred to *O. americana* by their high density of erect elytral setae are mostly from the southern U.S. Whether this represents geographic variation or the existence of two species cannot be determined until differentiation between sympatric populations is demonstrated.

Specimens of *O. americana/pilosa* can be distinguished from other species of *Ophraella* by the characters noted by LeSage, as well as by the greater number of setae on the penultimate segment of the labial palp (>2) and on the ligula (>4), extremely stout marginal setae on the ventral lobe of the lacinia, and by larval and pupal characters (see below).

(2) *O. notata* (Fabricius). A very distinct species (see LeSage, 1986), which resembles the "communa group" (see below) in size and elytral pattern, but is more similar to *O. cribrata* and *O. sexvittata* in several morphological respects (e.g., obsolescent gular sutures, strongly inflexed tooth I of mandible, deeply cleft lacinia, form of the spermatheca, and larval characters noted below). It is by far most abundant on *Eupatorium perfoliatum* in northeastern U.S., but I have found small numbers of adults and eggs on *E. maculatum* associated with *E. perfoliatum* (Ithaca, N.Y.) and have taken adults on *E. hyssopifolium* in Virginia (Mecklenburg Co.). Adults and larvae have been found on *E. capillifolium* in Hernando Co., Florida (Cornell University: E. R. Hoebeke).

(3) *O. cribrata* (LeConte). Morphologically similar to *O. conferta* except in those characters noted by LeSage (1986), the status of this species is not in doubt. I have collected it on *Solidago juncea* at many localities in the northeastern U.S., on *S. pinetorum* in Virginia (Mecklenburg Co.), and (as larvae) on *S. bicolor* in New York (Tompkins Co.). It has been recorded from *S. altissima* (LeSage, 1986) and will feed on it in the laboratory, but appears rarely associated with this plant in the field.

(4) *O. sexvittata* (LeConte), *O. conferta* (LeConte), and *O. macrovittata* LeSage. LeSage (1986) lists *Solidago altissima, S. canadensis,* and *S. rugosa* as hosts for *O. conferta* and *Solidago* sp. for *O. sexvittata*; he had no host information for *O. macrovittata,* which he distinguished from *O. sexvittata* (with which it is sympatric in southeastern U.S.) by the breadth of the elytral vittae, the size of elytral punctures, and genitalic characters. *O. conferta* and *O. sexvittata,* which have effectively parapatric distributions in the north and south respectively, differ chiefly in the density and size of elytral punctures and in the intensity of pigmentation of the vittae. LeSage (1986) suggested that these two forms may represent geographical variation within a single species.

I have collected *O. conferta* on *Solidago altissima* in many localities in the northeastern U.S., on the closely allied *S. gigantea* in Tompkins Co., New York, and have observed it feeding on *S. juncea* (N.Y.: Livingstone Co.) and on *S. rugosa* (N.Y.: Suffolk Co.); it is most commonly associated with the *S. altissima* complex. *O. sexvittata* was collected in abundance on *S. altissima* in several parishes in Louisiana and in North Carolina, as well as on a related goldenrod, *S. leavenworthii,* in Florida (Dade Co.). A large sample of *O. macrovittata,* which LeSage (1986) described from 12 specimens from six southern states, was taken on *S. altissima* at Zwolle, Sabine Parish, Louisiana (18 May 1986), and another large collection, together with approximately equal numbers of *O. sexvittata,* was taken from a stand of the same plant five miles west of Starks, Calcasieu Parish, Louisiana.

Electrophoretically, *O. conferta* (New York) and *O. sexvittata* (Florida and Louisiana) differ significantly in allele frequency at three of 18 loci (Table 2A). Because allele frequencies vary geographically in many species, these data do not bear on the conspecificity of these forms, but their common host association and close morphological similarity suggest that they are conspecific. In contrast, electrophoretic data on *O. sexvittata* and *O. macrovittata* from the same locality (Starks, La.) bear on their status. Four of 18 loci are sufficiently polymorphic to test for allele frequency differences, and none differs significantly between individuals classified by elytral color pattern (Table 2B).

The density of elytral punctures was estimated on five specimens with the color pattern of *O. sexvittata* and ten with that of *O. macrovittata* from Dade Co., Florida and Sabine Parish, Louisiana, respectively, by counting the number of punctures intercepted by a linear microscope reticle at 50×. One anterior–posterior transect of 30 reticle units was taken near the base of the discal vitta, and two, of 50 units, were taken in mid-disc between the discal and subsutural vittae. For *sexvittata* and *macrovittata,* respectively, the mean numbers of punctures were 6.4 and 6.5 along the shorter transect, and 11.7 (SE = 0.538) and 9.9 (SE = 0.833) along the longer transects; the difference between the latter means is not significant (t = 1.430, df = 2, $P >$ 0.10). Among other characters considered diagnostic by LeSage (1986), the breadth/length of the female sternum VIII did not differ (mean ± SE = 0.65 ± 0.029, 0.75

Table 2. Tests for allele frequency differences in *Ophraella conferta*, *O. sexvittata*, and *O. macrovittata*. Entries are number of genes scored.[1]

Locus	Taxon	Allele designation[2]			χ^2	df	*P*
A. *O. conferta* (N.Y.) and *O. sexvittata* (La. and Fl.)							
PGI		5	others				
	conferta	119	15		9.129	1	<0.005
	sexvittata	97	1				
PGM		3	7	others			
	conferta	107	15	8	131.293	2	<0.001
	sexvittata	1	65	12			
6PGD		2	13	others			
	conferta	1	209	8	72.558	2	<0.001
	sexvittata	32	73	13			
B. *O. sexvittata* (Starks, La.) and *O. macrovittata* (Starks, La.)							
PGM		7	9				
	sexvittata	50	8		0.263	1	>0.50
	macrovittata	58	7				
HK-1		3	others				
	sexvittata	48	9		0.018	1	>0.50
	macrovittata	60	12				
HK-2		6	others				
	sexvittata	51	7		0.969	1	>0.10
	macrovittata	71	11				
6PGD		13	others				
	sexvittata	35	21		0.039	1	>0.50
	macrovittata	47	26				

[1] E.C. designations of enzymes: PG1: 5.3.1.9; PGM: 2.7.5.1; 6PGD: 1.1.1.44; HK-1 and HK-2 (slow and fast loci, respectively): 2.7.1.1.

[2] Relative mobilities of electromorphs are as follows. The absolute position (in mm) on a typical gel is given in parentheses for the fastest of the designated electromorphs (relative mobility = 1.00). PGM *3* = 1.00 (30), *7* = 0.87, *9* = 0.73. 6PGD *2* = 1.00 (37), *13* = 0.95.

± 0.045 for *sexvittata* and *macrovittata*, respectively; $n_1 = n_2 = 3$; $t = 1.869$, $P > 0.10$); nor did the shape of the apical notch of this sclerite (highly variable), the form of the apex of the aedeagus, or the form of the spermathecal receptacle, which varies in *sexvittata* from rounded to "peanut-shaped" (LeSage, 1986), the form observed in all *macrovittata*.

Adult offspring were recovered from four female *O. macrovittata* and two *O. sexvittata* from Starks, Louisiana, that were enclosed individually in bags on *S. altissima* at Stony Brook, New York. The color pattern of the offspring of *sexvittata* (57 and 2 from the two females) conformed to that of *sexvittata*, but all four *macrovittata* segregated offspring of both patterns, as well as some that approached the *macrovittata* pattern but could not be readily classified. The proportions of *macrovit-*

tata + intermediate offspring were 0.86 (N = 30), 0.75 (N = 40), 0.64 (N = 14) and 0.57 (N = 7) in these broods. These data could be interpreted as reflecting a single locus with incomplete dominance, but provide no compelling evidence for this hypothesis, especially because females mate multiply (see below). The segregation, however, together with the foregoing observations, indicates that *macrovittata* and *sexvittata* represent a polymorphism for coloration, and that *Ophraella macrovittata* must be considered a junior synonym of *O. sexvittata.* Both LeSage (1986) and Balsbaugh and Hayes (1972), who referred *macrovittata*-like specimens to *O. conferta,* note that the elytral punctures are larger in "*macrovittata,*" and they impress me likewise. The coarseness of punctation may be a pleiotropic effect of genes governing pigmentation, because in *Ophraella* generally, the punctures included within the dark vittae tend to be larger than those not so included.

(5) *O. arctica* LeSage. This and the succeeding species appear very closely related, and constitute what I term the "communa group." Almost all the specimens on which LeSage based his description of *O. arctica* were collected on *Solidago multiradiata scopulorum* by W. J. Brown at Reindeer Depot, in the Mackenzie Delta north of Inuvik, Northwest Territories. I visited this region, 5–8 August 1987, and found neither the host plant nor beetles at Reindeer Depot, which has been abandoned and presumably has undergone succession since Brown's visit in 1948. I collected *O. arctica* in abundance on *S. multiradiata* at the southern edge of Inuvik, on a west-facing slope above the town dump; the hillside is recovering from a 1968 fire, and includes *Epilobium, Lupinus, Rosa, Salix,* and *Artemisia tilesii* among the dominant plants. During cold, wet weather, the beetles were collected from masses of litter taken from the base of the host plant.

O. arctica resembles *O. bilineata,* to which Brown referred at least some of his specimens (at University of California, Davis), but is smaller and darker, and differs in other characters noted by LeSage (1986). In addition, the elytral vittae of *O. bilineata* are more conspicuously free of punctures, and those bordering the vittae are more conspicuously enlarged; the border of tooth III of the mandible is finely serrate in *O. arctica* but does not appear so in *O. bilineata*; and *O. arctica* is fixed or nearly so ($p > 0.95$) at four electrophoretic loci (MPI, E.C.5.3.1.8; Aldolase, E.C.4.2.1.13; HK, E.C.2.7.1.1, faster of two loci; IDH, E.C.1.1.1.42, faster of two loci) for an allele found in *O. bilineata* and other members of the communa group at only a frequency of $p < 0.05$, if at all. Because *O. arctica* is apparently allopatric to all other species, its specific status cannot be determined with certainty at this time, but it is distinct enough to warrant specific status on a provisional basis.

(6) *O. bilineata* (Kirby). I have collected this form in abundance on *Chrysopsis villosa,* its only recorded host, at the following localities: Saskatchewan, 3 mi south of Chaplin; Alberta, southeast of Milk River, on Rte. 878 crossing the Milk River; Montana, 1 mi west of Cascade. Only those morphological characters noted by LeSage appear to distinguish *O. bilineata* from *O. communa.* At none of the 18 electrophoretic loci examined does *O. bilineata* carry a diagnostic allele with a frequency above 0.10, except at the fast IDH locus, at which an allele with high frequency (0.6) in *O. bilineata* was recovered at only low frequency in *O. communa* ($p = 0.08$ in New York) and in *O. notulata* ($p = 0.008$ in Florida). This same allele is fixed in the morphologically very distinctive *O. nuda.* Although LeSage lists records of *O. communa* from within the range of *O. bilineata,* I have not obtained *O. communa* in

that region and have no information on the possibility of gene flow between these closely related forms.

(7) *O. nuda* LeSage. This species was described from 26 specimens lacking host data. I found a dense population feeding and breeding on *Iva axillaris* on 17 July 1986 and 27 June 1987 on extensive dry mud flats at the southern edge of Pakowki Lake, 45 mi east of Milk River, Alberta, and smaller numbers on the same plant in the vicinity of Orion, 20 mi to the northeast. This species, reliably known only from southeastern Alberta, is very distinctive morphologically, differing from other members of the communa group by its sparse, short elytral pubescence, often yellowish elytral ground color, reduced subsutural vitta, rather uniformly sized elytral punctures, and depressed body form. Electrophoretically, it is fixed for an allele of PGM (E.C.2.7.5.1) and almost fixed ($p = 0.97$) for an allele of the fast HK locus, neither of which has been observed in any other species.

(8) *O. californiana* LeSage. This form is known almost entirely from the type series, collected from *Artemisia Douglasiana* at Drytown, California, 7 April 1974 by F. G. Andrews. I visited the type locality (F. G. Andrews, pers. comm.) on 9 July 1986 and 14 April 1987. The host plant is abundant both at this site and at several other California localities where collections were attempted, but no *Ophraella* were found, and no signs of feeding damage were evident. *Artemisia*-associated *Ophraella* appear to be very rare in this region.

Another form of *Ophraella* has been found feeding on a different species of *Artemisia,* in western Texas. It occurs also in Arizona. This form differs sufficiently from *O. californiana* to warrant description as a new species:

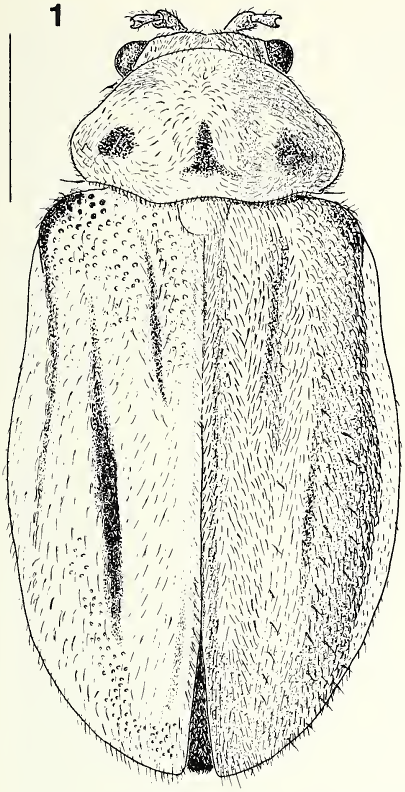
(9) **Ophraella artemisia**, new species

Diagnosis. This species resembles *Ophraella californiana, O. communa,* and *O. bilineata* in habitus and the pattern of elytral vittae, but is distinguished from all of these by the more deeply emarginate border of the labrum and the convexly arched upper rim (molar region) of the mandible. It differs from *O. californiana* and *O. communa,* further, by the denser, more adpressed elytral pubescence comprised of shorter setae, and by the form of the pronotum, which is more convexly arched in cross section. The elytral punctures are smaller than those of *O. bilineata,* and it differs from this species and from *O. communa* in its host plant, *Artemisia Carruthii.*

Description of Imago. SIZE: Linear measurements (mean and standard error, in mm, N = 5 pinned females and 8 males from type series; measured with ocular micrometer): Total length (front of head to apex of elytra, in dorsal view) of females, 4.22 ± 0.083, of males, 3.66 ± 0.053; length of elytra (base of humerus to apex) of females 3.27 ± 0.076, of males 2.88 ± 0.041; width of pronotum of females 1.48 ± 0.027, of males 1.31 ± 0.027; pronotum length (along midline)/width of females 0.59 ± 0.017, of males 0.61 ± 0.010.

COLORATION: Ground color yellowish brown (testaceous), dorsally obscured by pubescence lending a gray appearance under most lighting; each elytron with four narrow pale to dark brown vittae, tending to black where darkest. Submarginal (lateral) vitta darkest at humerus, generally meeting subsutural vitta before apex, subsutural vitta becoming evanescent half to one-third the distance from the base. Discal vitta darkest at about midpoint of elytron, becoming obscure basally and

1



2

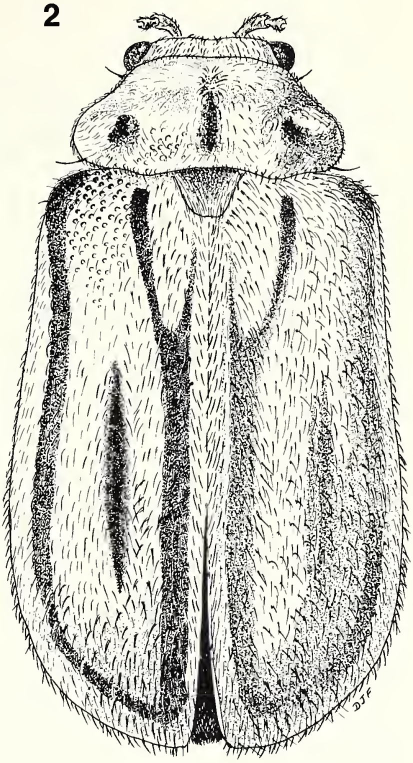


Fig. 1. *Ophraella artemisiae,* n. sp., female, paratype. Antennae and legs not fully portrayed.

Fig. 2. *Ophraella communa* LeSage, female. Canelo, Arizona, 11 Oct. 1955, G. D. Butler. Antennae and legs not fully portrayed.

apically. Supplementary vitta (LeSage 1986) originating and darkest near base, sometimes slightly carinate, oriented diagonally toward suture, sometimes joining subsutural vitta shortly distal to the latter's basal terminus, more often becoming evanescent before joining it (Fig. 1). Vittae in some specimens obsolescent, evident only in regions noted above as darkest. Pronotum with three small, dark brown maculae, obscure in some specimens; coronal suture of vertex, occiput, and in some specimens a broad dorsolateral extension from occiput toward margin of eye dark. Antennal segments dark brown, the bases of the six proximal segments testaceous. Clypeus pale; labrum with a dark brown transverse submarginal band, extended basad along sides and in midline; sclerites of mouthparts dark brown. Venter of mesothorax, metathorax, and abdominal sterna variably testaceous to piceous.

SETATION AND PUNCTATION: Body invested with pubescence, that of the elytra dense (at least three times as numerous as punctures) and moderately erect (at about 45° to surface); elytra with scattered, stouter, fully erect setae. Elytral punctures confused, dense, small, generally absent within darkest parts of vittae. Metepisternum densely invested with setae. Frontal tubercles not prominent, lacking setae.

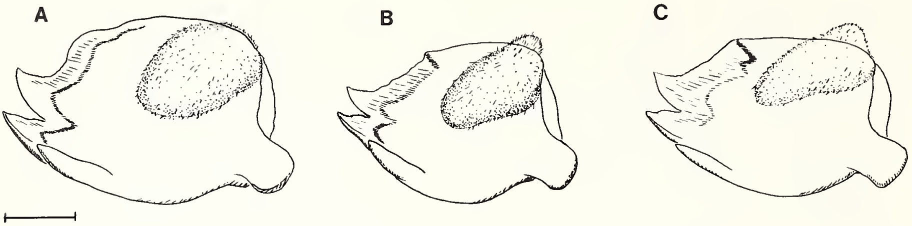


Fig. 3. Outline drawings of right mandible, in buccal view, of (A) *Ophraella artemisiae,* (B) *O. californiana,* (C) *O. communa,* all to same scale (bar = 0.1 mm). Drawn from female specimens. *O. artemisiae* and *O. californiana* were collected at their respective type localities; the specimen of *O. communa* was newly eclosed, reared from egg collected at Balmorhea, Texas. Length of elytron (for body size reference) of *O. artemisiae* 3.47 mm, of *O. californiana* 3.18 mm, of *O. communa* 3.94 mm.

OTHER STRUCTURAL FEATURES: Pronotum declining convexly from midline to lateral margin, surface almost even, eminence bearing lateral macula only slightly developed, rear margin only slightly concave. Anterior margin of labrum conspicuously, strongly concave; maxillary palpifer with three or four large setae; length of distigalea 1–1.5 times its width; upper margin (molar region) of mandible strongly convex, declining abruptly to the base of tooth III (Fig. 3); upper margin of tooth III generally but not always finely serrate; exterior surface of mandible bearing a small seta. Sternite VIII of female (LeSage, 1986) with moderately sclerotized lateral "wings," breadth across these slightly greater than length; breadth of its base 75% to 95% of its length. Spermatheca as in *O. californiana* and *O. communa,* apex simple or slightly produced. Genitalia of male, and of female except as noted, as in *O. californiana* and *O. communa.* Other characters as for the genus.

Type material. Holotype, female: Texas, Jeff Davis Co., 30°40′44″N, 104°01′41″W, on northwest slope of Mount Locke in the Davis Mountains at 1,870 meters (6,140 feet), on Texas route 118, 0.3 km (0.2 mi) south of road to Mount Locke peak and McDonald Observatory, Stefan P. Cover collector, 20 June 1987. Paratypes: Twelve specimens with data as for the holotype; 19 specimens from the type locality, D. J. Futuyma collector, 1 October 1988. Holotype (C. U. type number 6385) and 12 paratypes (collected 20 June 1987) deposited in the Cornell University Insect Collection, Ithaca, New York; 8 paratypes (collected 1 October 1988) in the Canadian National Collection, Ottawa, Ontario; 11 paratypes (same date) in the California State Collection of Arthropods, Sacramento; 6 paratypes (same date) in the American Museum of Natural History, New York.

Other material. Specimens in the collection of the Department of Entomology, University of Arizona, Tucson, as follows: "Ariz., Pima Co. Sta./Rita Mts., N end, Rose-/mont area, 31D48–53′N/110D42–47′W, 4400–/6175′ El., Anamax Mine/Inventory, 1975–1976/J. Busacca & C. Olson": 3 specimens, two bearing additional label "McCleary Cn./Sec. 30 5200′/9–23 1975 D-Vac," and one "Ridge Area/Sec 24 5600′/7–30 1975 D-Vac." "Catalina Mts./Ariz. 24 HkHy./July 18 1955/G. D. Butler," "Ceanothus fendleri" (1 specimen); "Blue Mts./Greenlee Co./VI-18-43 Ariz.," "M. puberula Blake?/F. H. Parker Collection" (1); "Hualpai Mtn. Pk./Mohave Co., ARIZ./

Aug. 9, 1962 6200′/F Werner, J Bequaert/Ceanothus fendleri" (1); "Walnut Ck, Sta Maria/Mts., Yavapai Co., AZ/4-IX-78 Hetz" (1); "Vic. Sunset Crater/Nat. Mon., Coconino/Co., ARIZ. VII-17-58/6500′. WL Nutting" (2). All these specimens have the distinctive pronotal form and emarginate labrum of *O. artemisiae,* and in all except the Greenlee Co. specimen, the elytral surface is obscured by dense, short, reflective pubescence. The vittae are rather faint to almost entirely obsolete in all. Dissection of one specimen from McCleary Cn., Sta. Rita Mts., Pima Co. and one from Sunset Crater Nat. Mon. revealed the diagnostic form of the mandible and the short distigalea in both. "*Ceanothus fendleri,*" noted on two specimens, is unlikely to be a host plant. See note added in proof for Minnesota records.

Host association. This species was abundant at the type locality on 1 October 1988, feeding and breeding on *Artemisia Carruthii* Wood (Asteraceae) (identification confirmed by B. L. Turner, University of Texas). Several larvae and old egg masses were observed. Upon return to the laboratory, on 5 and 6 October, feeding preferences of 21 wild-caught individuals were tested, after depriving them of food for 36 hr, by confining them individually with a fragment of each of three test plants (*Artemisia Carruthii, Ambrosia artemisiifolia, Helianthus ciliaris,* the latter somewhat desiccated). The beetles were observed for a total of seven hr over two days; on the first day, the first of two feeding attempts by each beetle was interrupted, so that a total of up to three feeding initiations was scored. All 21 beetles initiated feeding on *Artemisia,* 7 initiated at least one attempt on *Ambrosia,* and one consumed a slight amount of *Helianthus.* Of a total of 61 feeding attempts, 51 were on *Artemisia.* In contrast, of 18 *O. communa* collected from *Helianthus ciliaris* on the same date at Balmorhea, Texas (44 km NNE of the type locality of *O. artemisiae,* altitude 975 m) and similarly tested, none displayed any response to *Artemisia*; of 52 feeding initiations, 30 were on *Ambrosia* and 22 on *Helianthus.*

A trip to the type locality and environs on 14–15 July 1989 yielded few adults, one pupa (in a cocoon), several larvae, and eggs which may have been deposited in transit. The eggs were deposited singly in pits chewed into the plant surface, and so were partly enveloped by the plant's dense pubescence. The first eclosion of adults that developed from these eggs occurred on 15 August, the larvae having been reared on the host plant at 25°C, 15/9 L:D.

Diagnostic characters. O. artemisiae closely resembles *O. communa* LeSage (Fig. 2). LeSage (1986) refers to a "pale form" of *O. communa*; this may well include *O. artemisiae. O. artemisiae* differs from *O. communa* taken on *Helianthus ciliaris* at Balmorhea, Texas in the following respects: elytral vittae of *O. artemisiae* paler, the discal and supplementary vittae not extending as nearly to the base of the elytron, the supplementary vitta less often joining the subsutural; elytral pubescence somewhat shorter and denser, obscuring more of the elytral surface; pronotum more densely pubescent, more convex from side to side and with shallower impressions (the dorsal surface being more planar from side to side in *O. communa*); rear margin of pronotum generally less concave; anterior margin of labrum much more concave, labrum more intensely pigmented; distigalea shorter relative to width (at least twice its width in *O. communa*); upper margin of mandible convexly inflated (declining gradually to base of tooth III in *O. communa*: Fig. 3); margin of tooth III finely serrate in some *O. artemisiae,* not so in *O. communa*; seta evident on external surface of mandible, not so in *O. communa*; average size slightly less (elytral length of *O. communa* about

Table 3. Allele frequency differences between *Ophraella artemisiae* and a sample of *O. communa* taken on *Helianthus* at Balmorhea, Texas. Entries are numbers of genes scored.[1] All χ^2 values are significant at $P < 0.001$.

Species	Locus	Alleles[2]				χ^2 (df)
	MDH-1	1	2	5		
O. artemisiae		112	0	0		172.003 (2)
O. communa		0	14	46		
	IDH-1	1	7			
O. artemisiae		9	99			121.467 (1)
O. communa		57	3			
	IDH-2	1	2			
O. artemisiae		108	0			172.131 (1)
O. communa		0	64			
	LAP	5	6	others		
O. artemisiae		103	1	6		126.672 (1)
O. communa		5	53	0		
	6PGD	4	6	others		
O. artemisiae		27	72	0		32.193 (2)
O. communa		6	31	15		
	MPI	2	3	4 + 5	others	
O. artemisiae		0	17	83	12	71.440 (3)
O. communa		15	30	9	5	

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[1] E.C. designations of enzymes: MDH-1 (anodal locus): 1.1.1.37; IDH-1 and IDH-2 (slow and fast loci respectively): 1.1.1.42; 6PGD: 1.1.1.44; MPI: 5.3.1.8.

[2] Relative mobilities of electromorphs (see footnote, Table 2): MDH-1 *1* = 0.80, *2* = 0.90, *3* = 1.00 (30). IDH-1 *1* = 1.00 (13), *7* = 0.46. IDH-2 *1* = 1.00 (20), *2* = 0.95. LAP *5* = 1.00 (52), *6* = 0.92. 6PGD *4* = 1.00 (20), *6* = 0.75. MPI *2* = 1.00 (55), *3* = 0.91, *4* = 0.96, *5* = 0.75.

3.6 mm in females, 3.1 mm in males). (Size, however, varies substantially with nutrition and other factors in *Ophraella* and is not a reliable character.) No genitalic differences are apparent. The form of the labrum and of the pronotum are the most evident characters by which most specimens can be distinguished without dissection. Electrophoretic comparison of 56 specimens of *O. artemisiae* and of 30 specimens of *O. communa* from Balmorhea, Texas revealed significant differences in allele frequencies at six loci (Table 3); the anodal malate dehydrogenase (MDH) and the faster of two IDH loci appear entirely diagnostic. (The alleles for which *O. artemisiae* appears fixed at these loci, and which do not appear in the Balmorhea sample of *O. communa* are, however, present in Californian samples referred to *O. communa*; the latter, in fact appear fixed for allele 1 at IDH-2. Samples of *O. communa* from New York, California, and Louisiana, like the Balmorhea sample, differ from *O. artemisiae* in their high frequency of MDH-1 alleles 2 and/or 5 and of IDH-1 allele 1, and in their low frequency of LAP allele 5.)

Specimens from several localities in Arizona, in the University of Arizona collection, conform to *O. communa* and are readily distinguishable from *O. artemisiae* by the characters noted above. Five specimens from Holbrook, Arizona resemble *O. artemisiae* in that the vittae are pale to obsolete and the elytral pubescence is dense and reflective; structurally, however, these specimens conform to *O. communa.*

The specific status of *O. artemisiae* is considerably more ambiguous with respect to *O. californiana* LeSage, the only other *Ophraella* reported from a host in the genus *Artemisia.* Not only are the populations widely allopatric, so that differences could represent only intraspecific geographic variation, but no living material of *O. californiana* is available for electrophoresis or experimentation (e.g., on mating preferences). If geographically intervening populations are discovered, *O. artemisiae* might well prove to be a geographical variant of *O. californiana.* However, because the morphological differences between the two populations exceed those among several other taxa of *Ophraella* that are recognized as species (a criterion commonly applied to allopatric populations; Mayr, 1969), designation as a distinct species appears warranted at this time. The following comparison is based on close examination of four paratypes of *O. californiana,* and dissection of three of them, kindly provided for this purpose by F. D. Andrews (California State Collection of Arthropods, Sacramento). Based on LeSage's (1986) description and my own impression of the remainder of the specimens in C.S.C.A., Sacramento, these specimens are representative of the type series, at least in superficial characters.

O. californiae differs from *O. artemisiae* in the following respects: elytral punctures much larger, those between the discal and supplementary vittae more than 30% greater in diameter and about 70% greater in area than those of *O. artemisiae*; setae of elytral disc more procumbent (except for a few stouter, erect setae), sparser (only slightly more numerous than the punctures); dorsum of pronotum more coarsely and closely punctured; setae of metepisternum thicker and much sparser than in *O. artemisiae*; lateral wings of sternum VIII of female only slightly sclerotized, base of this sternum relatively narrower (up to 50% of length); anterior margin of labrum less concave; length of distigalea about twice its width; dorsal edge of mandible not convexly inflated, dropping gradually to base of tooth III (Fig. 3); upper edge of tooth III not serrate; no seta evident on exterior surface of mandible. Spermatheca, male genitalia, color pattern, and other features generally, as in *O. artemisiae.* The shape of the labrum and mandible (the latter requiring dissection), the size of the elytral punctures, and the density of the dorsal pubescence are the most diagnostic characters.

Larva. A small sample (3) of larvae of *O. artemisiae* is available at this time. I compare them here to larvae of *O. communa* from Long Island, New York (specimens from Texas or Arizona are not available for comparison), and of *O. bilineata.* The larvae of *O. artemisiae* and *O. communa* are indistinguishable with respect to the setation of the head capsule, the mouthparts, and the sclerites of the thorax and abdomen. The anterior margin of the labrum may be slightly more deeply emarginate in *O. artemisiae.* The only evident, slight, differences between the species are in pigmentation and in the shape of the mandible. The vittae of *O. artemisiae* are pale to obsolescent, those of *O. communa* being considerably darker. In *O. artemisiae,* the ventral border of tooth IV of the mandible (LeSage, 1986) is almost straight, and the apex of the tooth is blunt, almost truncate. The dorsal border of the mandible is slightly produced anteriorly, forming an acute angle with the base of tooth V, and is slightly sinuous anterior to the penicillus. In *O. communa,* tooth IV is acute and has a strongly convex lower margin; the dorsal rim rises convexly at an obtuse angle from the base of tooth V, and is convex or straight from the apex to the penicillus. The three larvae of *O. bilineata* that I have examined are likewise indistinguishable from those of *O. artemisiae* except by their darker vittae and the form of tooth IV and the dorsal border of the mandible, which conform to the condition in *O. communa*. In *O. bilineata,* the dorsal edges of teeth II and III of the mandible are finely serrate, but are less conspicuously so, or not at all, in *O. artemisiae* and *O. communa.* The ratio of the depth to the length of the mandible in *O. bilineata* (mean = 0.72) is probably greater than in *O. artemisiae* (0.65) or *O. communa* (0.63). Larger sample sizes would be required, however, to be sure that any of these differences are diagnostic.

(10) *O. notulata* (Fabricius). LeSage (1986) applied the name *notulata* to the species that had hitherto been designated *integra* LeConte. Prior to LeSage's work, the epithet *notulata* Fabricius was applied to the species that LeSage has named *communa.*

I have collected this species on the salt marsh shrub *Iva frutescens* (=*I. oraria*) on both the Atlantic and Gulf coasts, and on the herbaceous annual *I. annua* in Louisiana. *O. notulata* and *O. communa* taken from, respectively, *I. annua* and *A. artemisiifolia* in a mixed stand in Baton Rouge, Louisiana were both electrophoretically and morphologically distinct. I cannot be certain that neither species occupied each other's host at this site. When these beetles were presented with a choice of these two plants in the laboratory, none of 10 *O. communa* fed on *I. annua,* whereas 8 of 10 *O. notulata* greatly or exclusively preferred *I. annua.* Baton Rouge animals of both species, offered a choice of *I. frutescens* and *A. artemisiifolia,* accepted both plants, although a larger fraction of *O. communa* (24 of 28) than of *O. notulata* (17 of 29) preferred (i.e., ate more) *Ambrosia.* Feeding responses and larval survival of *O. notulata* and *O. communa* on each other's host in New York are described by Futuyma (in press).

O. notulata differs from *O. communa* in electromorph frequencies entirely or almost entirely at several loci (MDH [anodal locus], IDH-1 and IDH-2, 6PGD, AAT [E.C.2.6.1.1, cathodal locus], LAP [E.C.3.4.11.-]). Morphologically it is distinguished by the several features noted by LeSage (1986), as well as by the lower number of setae on the prementum (one rather than two per side) and cardo (1–2 rather than 5–6). The elytral setae are shorter, more procumbent, and more uniform in direction, presenting a more "groomed" appearance.

(11) *O. communa* LeSage. This form is denoted *O. notulata* in the literature (e.g., Welch, 1978; Goeden and Ricker, 1985) prior to LeSage's revision. Populations morphologically referable to this species are distributed throughout most of North America, from southern Canada into Mexico. Although regional differences in electromorph frequencies exist (unpubl. data), samples from New York, California, Georgia, and Louisiana share many of the same alleles, and display, in polymorphic condition, peculiar multi-banded phenotypes at the 6-phosphoglycerate dehydrogenase locus (6PGD); these are provisionally interpreted as evidence of a gene duplication, and have been observed only in this species.

Throughout eastern North America, *O. communa* appears to be associated exclusively with *Ambrosia artemisiifolia.* In California, it has been taken on *A. psilostachya, Iva axillaris,* and *Xanthium strumarium* (all in tribe Heliantheae, subtribe Ambrosiinae) (Goeden and Ricker, 1985; R. Goeden, pers. comm.). I found it breeding on *Helianthus ciliaris* at Balmorhea, Texas, and J. Sullivan (St. Ann, Mo.; pers. comm.)

observed a specimen feeding on *Ratibida pinnata* in Missouri (both plants in subtribe Helianthinae). Morphological and electrophoretic differences between *O. communa* and other species are noted above.

INTERSPECIFIC DIFFERENCES IN IMMATURE STAGES

Eggs. Eggs of *Ophraella* are pale yellow when deposited, deepening to orange as they age. They are generally deposited in clusters on the host plant; however, *O. notata* usually lays eggs singly. (*O. artemisiae* may also have this habit.) The external morphology is rather uniform, but a few differences are evident among the species (Fig. 4). Compared to *O. communa* (Fig. 4A), the elements of the outer reticulum of the chorion are narrow in *O. notata,* and the junctures are elevated into slight projections (Fig. 4B); those of the inner reticulum are broad and within each fenestrum of the outer chorion, the peripheral fenestra of the inner chorion are much larger than the central fenestra. In *O. nuda* and *O. bilineata* (Fig. 4C, D), the inner fenestra are more uniform in size than in *O. communa* and other species, and in *O. bilineata* the inner reticulum is only slightly elevated. The ridges of the outer reticulum appear broader and deeper in *O. cribrata* and *O. conferta* (Fig. 4E, F) than in other species.

Larvae. These descriptions supplement those of LeSage (1986). The structural terminology follows Böving (1929). Only characters that vary among species and are visible without dissection are noted. Modal numbers of setae are given. The following description of the fully grown third (ultimate) instar larva of *O. communa* from New York will serve for comparison with other species. Each side of pronotal shield with 14 setae, 10 of which lie anteriorly and medially and 2 in a posteromedial field; dorsal sclerites (interior prescutal, interior scuto-scutellar) of meso- and metathorax fused across midline (as also on abdomen), each with 2 setae; thoracic posthypopleural sclerites with 2 setae; abdominal segments 1–7 with 1 interior scuto-scutellar, 4 epipleural setae; ventrally with at least one very small "presternal" seta anterior to sternellar sclerite. Ground color cream, three longitudinal, irregular dark vittae as follows: dorsal (from near midline to lateral border of interior scuto-scutellar sclerite), dorsolateral (from upper border of parascutal to upper border of epipleural tubercle), ventrolateral (fainter, surrounding hypopleural tubercles).

The larvae of *O. arctica, O. bilineata, O. notulata,* and *O. nuda* are structurally similar to *O. communa* in all these respects (as is *O. artemisiae*; see description above). Their color pattern is also very similar, but the dorsal vitta of *O. arctica* appears less intense than in *O. communa*; in *O. bilineata* the ventrolateral vitta is absent or interrupted, and is restricted to the region dorsal to the hypopleural tubercles; in *O. nuda* the dorsolateral and ventrolateral vittae are effectively confluent, interrupted only by the sclerite-bearing tubercles and nonpigmented spots anterior to the epipleural tubercles; the ventrolateral vitta extends to the lateral border of the parasternal sclerites. In *O. notulata* (northeastern specimens examined), the several vittae are effectively fused, and there is little interruption of pigmentation between the midline and the parasternal region. Because of variation in the intensity and extent of pigmentation, it is far from certain that these several species can be reliably distinguished as larvae.

In *O. notata, O. cribrata,* and *O. conferta,* the thoracic posthypopleural sclerites typically bear one seta, and ventral setae are absent anterior to the sternellar sclerites.

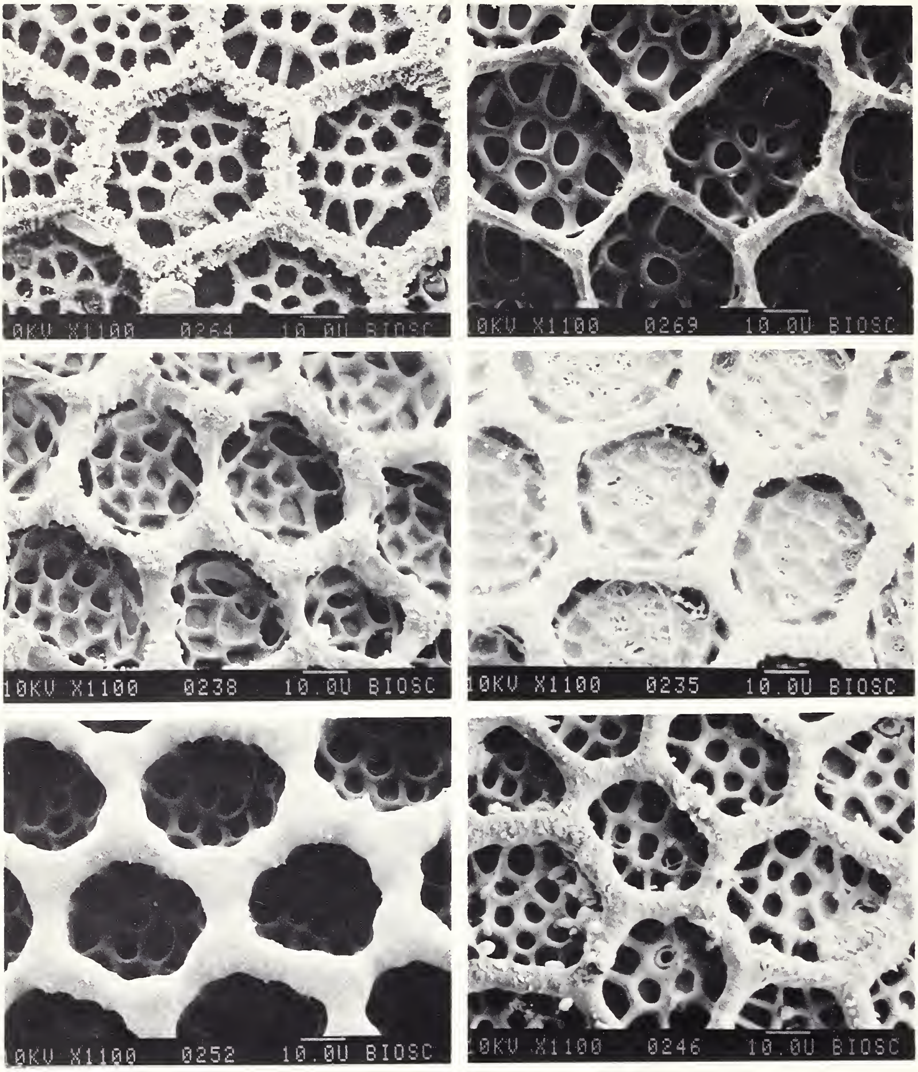

Fig. 4. Scanning electron micrographs of egg surface at 1,100×, taken normal to the surface approximately half way between micropyle and equator. Upper left to lower right: A. *Ophraella communa*. B. *O. notata*. C. *O. nuda*. D. *O. bilineata*. E. *O. conferta*. F. *O. pilosa*.

These species effectively lack pigmentation between the sclerites, which, especially in *O. notata* and *O. cribrata*, are paler than in the other species. The modal number of epipleural setae on the abdominal segments of *O. cribrata* is 5.

The larva of *O. pilosa* is most distinctive. The interior prescutal and interior scuto-scutellar sclerites are not, or hardly, fused at the midline, and setae are more numerous on the thoracic interior prescutal and interior scuto-scutellar sclerites (3 each), the abdominal interior scuto-scutellar (2), the abdominal epipleural (5, as in *O. cribrata*), and the pronotal shield, with (modally) 19 setae, 16 of which lie in the anterior and lateral regions and 3 in the posteromedial field. The dorsal vitta consists of interrupted infuscations before and behind the sclerites; the dorsolateral vitta extends from the lower edge of the exterior prescutal to the lower edge of the parascutal; the ventrolateral vitta is obsolete.

Pupae. The following descriptions of the modal condition are based on 3–5 specimens of each species examined. Even in these small samples, the number and exact location of setae in each setal field is variable, except for those of the mesonotum, metanotum, and abdominal nota, which appear invariant. The vertical setae are also almost invariant. Much of the variation consists of apparent absence of setae, usually in the form of fluctuating asymmetry.

Pupae of *O. sexvittata,* which may be taken as a standard for comparison, conform to LeSage's (1986) figure except that the head bears, in addition to vertical and supraorbital setae, a pair of setae on the lower frons and a lateral pair (and in some specimens a medial pair also) on the labrum. The posterior discal region of the pronotum bears on each side either 3 or 4 setae, arranged in pairs, in addition to the 6 anterior and lateral setae figured by LeSage; the latter are not arranged into evident pairs. *O. cribrata* and *O. notata* are identical to *O. sexvittata,* although lower frontal setae were observed in no *O. cribrata* and in only one *O. notata. O. communa* consistently had 2 pairs of posterior discal setae on the pronotum, and 8 anterior and marginal pronotal setae, these arranged in pairs. No lower frontal setae were observed. Whereas the setal apices are complex, tending to bifurcate, in the preceding species, those of *O. communa* are mostly simple (acute or blunted), although a few are truncate to incipiently bifurcate. *O. notulata* and *O. nuda* are indistinguishable from *O. communa. O. pilosa* is most distinctive: the pronotum bears 5 posterior discal setae (a lateral pair and a medial triplet) and 11–12 marginal setae, not arranged in pairs but including a posterior marginal group of 3, rather than 2 as in *O. communa.* Each of the other nota bears an extra paramedial seta on each side, thus 3 on the meso- and metanota and 5 on each abdominal notum (rather than 2 and 4, respectively, as in all other species). Postorbital setae, otherwise observed only in two specimens of *O. nuda* (and asymmetrically present in these), are present but lower frontal setae are absent. The majority of setal apices are simple, but a considerable number are truncate to slightly bifurcate.

LIFE HISTORY AND BEHAVIOR

In the northeastern U.S., all species are found as adults in early spring; undoubtedly the adult is the overwintering stage in all species of *Ophraella.* Sperm were present in the spermathecae of *O. communa* and *O. conferta* collected in late autumn; thus females appear to store sperm over winter, as also reported for *O. communa* by Welch (1978) and Goeden and Ricker (1985). Both sexes mate repeatedly, and mating occurs throughout the season of activity. Eggs are laid on host foliage, generally in clusters (except in *O. notata*). As in *O. communa* (Welch, 1978; Goeden and Ricker, 1985), females lay a clutch of eggs every 1–3 days for several weeks. The development time of larvae before cocoon formation appears in all species observed to be approximately that recorded for *O. communa* by Welch (1978) and Goeden and Ricker

(1985) (i.e., 12–14 days at 27°C), but I have not taken careful data on the several species I have reared (*O. communa, O. notulata, O. notata, O. cribrata, O. conferta, O. sexvittata, O. pilosa*; cf. note on *O. artemisiae,* above). Adults and especially larvae appear to prefer fully expanded young leaves over mature foliage or leaves that have not yet expanded. Young larvae skeletonize the leaf, but adults eat through the leaf blade, including minor veins; species that feed on thick, succulent leaves (e.g., of *Iva*) leave feeding pits, generally on the abaxial surface. Especially in hot or sunny weather, the larger larvae and adults exhibit diel vertical migration, coming to the crown of the host plant during dusk and darkness; this behavior is especially notable in *O. pilosa, O. conferta, O. sexvittata,* and *O. cribrata,* but appears much less pronounced in *O. communa, O. notulata, O. bilineata,* and *O. notata.* During the day, adults of *O. pilosa, O. conferta,* and *O. notata* have been found resting within curled dead leaves near the base of the host plant.

All species have been observed to pupate within a cocoon, generally attached to foliage of the host or neighboring plants. In *O. communa, O. bilineata,* and *O. notata,* the cocoon is often on exposed foliage or among the branches of the inflorescence, but in other species pupation occurs most often near the ground. Pupae of *O. notulata* have been found not on the host, but within fragments of dead *Spartina* stems in nearby litter. Larvae of *O. communa* observed making cocoons displayed the behavior described by Goeden and Ricker (1985), with the following important exception: the viscous liquid material issues not from between the prothoracic legs, but from the anus. The larva curls the abdomen ventrally and forward, everts the rectum slightly, and strokes the everted rectum against the medial setae of the mesothoracic legs; a drop of liquid is then ejaculated and held between the prothoracic coxae, and the abdomen resumes its normal orientation. As described by Goeden and Ricker (1985), the larva periodically dips its mouthparts into the pool between the legs to obtain material for weaving. Analysis of dry cocoons of *O. communa* in a CHN Elemental Analyzer (Perkin-Elmer Model 240) gave approximately 10% N, 43% C, and 7% H by weight, oxygen presumably constituting much of the remainder. This analysis suggests that the cocoon is largely proteinaceous.

Table 4 summarizes the seasonal distribution of life history stages as I have found them in the field. Probably univoltine populations include *O. arctica, O. bilineata,* and *O. nuda,* as well as *O. conferta* and *O. cribrata* in New York. *O. notata* and *O. pilosa* appear bivoltine in New York, and *O. notulata* in the same region is at least bivoltine. *O. communa* is at least trivoltine on Long Island. The limited information from southeastern U.S. suggests that all species are multivoltine in this region.

Populations of species that feed on perennial plants appear to persist year after year; I have sampled from the same localized populations of all species (except *O. arctica* and *O. californiana*) for at least two, and in most cases four, years. Because *Ambrosia artemisiifolia* is annual, local stands often do not persist for more than one year, so *O. communa* populations associated with this host frequently must disperse. On one occasion, moreover, a stand of *Ambrosia* that harbored an abundant second generation of *O. communa* was, despite the seemingly good condition of the plants, virtually devoid of animals a month later, when a third generation was abundant in other local sites. This may indicate mass dispersal from stands of the host.

With respect to natural enemies, I have found dipteran larvae in the abdominal cavity of adults of *O. conferta* (collected 28 Sept., Ithaca, N.Y.) and *O. communa*

Table 4. Seasonal distribution of life history stages of *Ophraella* observed in the field. A, adult, E, egg, L1, first and/or second instar larva, L3, third instar larva, P, pupa. (1), (2) after locality indicate one or two visits to locality.

Species, location	March 15–31	April 16–30	May 1–15	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	Aug. 1–15	Aug. 16–31	Sept. 1–15	Sept. 16–30	Oct. 1–15	Dec. 16–31
arctica (N.W.T.) (1)									A, L3, P					
bilineata (MT, Alta., Sask.) (2)						A, E, L3, P		A	A, L3	A, P				
nuda (Alta.) (2)						A, E, L1, L3		A						
sexvittata (LA) (1) (S. Fl) (2)	A, L3			A, L3										A, E
conferta (NY, PA)			A, E	A, E	A	A, E, L1, L3		A, L3	A	A	A	A		
cribrata (NY)		A, E	A, L1, L3	A, L1, L3	A	A		A		A	A	A		
pilosa (NY)					A, E, L1	A, L1, L3		A		A, L3, L1, P		A		
notata (NY)			A	A	A, E			A, E, L1, L3	A, L1, L3	A, L1, L3, P		A, L3		
notulata (NY)		A	A, E	A, E	A, E, L1, L3		A, E, L1, L3, P	A, E		A, E, L1, L3	A, E	A, L3		
artemisiae (TX) (2)						A, E							A, L3	
communa (NY)				A, E, L1, L3	A, E, L1, L3	A, L3, P		A, E, L1, L3, P	A, E, L1, L3, P	A, E, L1, L3, P	A, L3, P	A, L3, P	A, P	
communa (TX) (1)													A, E, L1, L3, P	

(27 Sept., Long Island, N.Y.). Each parasitized beetle had one larva, and in female beetles, the ovaries and spermatheca had been consumed; fragments of the spermatheca were observed in one specimen. Too few specimens were dissected to provide an estimate of the rate of parasitism. Several *O. notata* (29 August, Ithaca, N.Y.) yielded fly puparia. A tachinid species (see second end note) emerged from *O. notulata* collected as larvae on *Iva frutescens* at Bluffton, South Carolina, 20 April 1989; the fly pupates within the beetle prepupa after it has formed a cocoon. Adult flies had emerged by 3 May. Tachinids have been reported from *O. communa* (Goeden and Ricker, 1985) and *O. bilineata* (LeSage, 1986). On Long Island, pupae of *O. communa* yielded a gregarious eulophid (Hymenoptera), identified by M. E. Schauff (Systematic Entomology Laboratory, U.S.D.A.) as *Asecodes* sp., near the Palearctic species *A. mento* Walker, which is known to parasitize the galerucine *Lochmaea suturalis* Thomson. *Asecodes* has not previously been formally recorded in North America (M. E. Schauff, in litt.). These parasitoids emerged from 15% of 141 pupae collected on 19 August 1986 at Stony Brook, New York, and were casually noted in material collected at other times.

Adult coccinellids (species not determined) have been observed feeding on eggs and pupae of *O. communa.* Adults of several species of *Ophraella* have been observed carrying larvae of the mite genus *Leptus* (Erythraeidae; identification courtesy of Dr. W. C. Welbourn, Ohio State University); heavy loads of these mites have been observed on *O. pilosa* near Ithaca, New York, and on *O. notulata* on Long Island, New York, in the autumn. Similar, perhaps conspecific, mites were observed on other beetle species and on Homoptera in the same sweep samples. These mites were tightly attached to their hosts by their mouthparts, and are unlikely to have been transferred among insects during sweeping.

SEXUAL ISOLATION

Exploratory tests of mating preference were performed for two geographical populations referred to the same species (*O. communa*) and for sympatric populations of reproductively isolated species (*O. communa* and *O. notulata*). In the former test, virgin adults were reared on *Ambrosia artemisiifolia* from eggs laid by *O. communa* collected 10 June 1988 on *Iva axillaris* at Antelope Spring, near Westgard Pass in the Inyo Mountains, Inyo Co., California. Virgin adults of *O. communa* from Stony Brook, New York, were reared from pupae collected on *A. artemisiifolia.* Virgin adults of both populations were fed *ad libitum* on *A. artemisiifolia* until testing, at which time the post-eclosion age was 7–14 days for the California population and 5–9 days for the New York population. On 4 August, 25 females from each population were individually confined in petri dishes, without food, with a California male and a New York male, the latter marked on one elytron with a dot of enamel paint. The dishes were placed on a lab bench under fluorescent lighting at 24°C, 68% R.H. and observed every 15 minutes for 6.5 hr. On 6 August, an additional 20 California females were similarly tested for 6 hr. Many females mated repeatedly (up to five times). No interactions among males were observed.

Levene's isolation index [$I =$ (no. homogamic matings − no. heterogamic matings)/total no. matings], which has an expected value of 0 for random mating and 1 for fully assortative mating, quantifies the departure from randomness. It is given with

Table 5. Mating trials. In each cell, the number of first and of total matings are above and below the diagonal, respectively. (A) Choice test, both sexes of *O. communa* from both California and New York, August 4, 1988. (B) Choice test, Californian female *O. communa* with male *O. communa* from California and New York, August 6, 1988. (C) Choice test, *O. notulata* and *O. communa* from New York, August 1987. (D) No-choice test, *O. notulata* and *O. communa* from New York, June 1988.

A. *communa* female from	Mated with male from			
	CA		NY	
CA	14		9	
		22		18
NY	1		24	
		6		49

B. *communa* female from	Mated with male from			
	CA		NY	
CA	13		5	
		17		14

C. Female	Mated with male			
	notulata		*communa*	
notulata	7		2	
		10		4
communa	0		9	
		0		16

D. Female	Mated with male			
	notulata		*communa*	
notulata	5		7	
		5		14
communa	0		8	
		0		12

its standard error (see Wasserman and Koepfer, 1977). On 4 August (Table 5A), there was significant departure from randomness for both first matings ($\chi^2 = 18.019$, $P < 0.001$; $I = 0.583$, SE = 0.1172, $P < 0.05$) and for all matings ($\chi^2 = 21.655$, $P < 0.001$; $I = 0.495$, SE = 0.089, $P < 0.05$). This result was attributable chiefly to New York females, which mated almost exclusively with New York males. On 6 August (Table 5B), first matings by California females were marginally homogamous ($\chi^2 = 3.556$, $0.05 < P < 0.10$; $I = 0.440$, SE = 0.132, $P < 0.05$), but total matings were not ($\chi^2 = 0.290$, $P > 0.50$; $I = 0.97$, SE = 0.179, n.s.). Combining the results for all California females, first matings were marginally significantly homogamous ($\chi^2 = 4.124$, $P < 0.05$), but total matings, again, were not ($\chi^2 = 0.690$, $P > 0.50$). Two California females that had mated only with New York males laid eggs that subsequently hatched. All New York females that mated with California males also mated with New York males, so the fertility of this interpopulation cross was not estimated.

In August 1987, virgin adults were reared from larvae of *O. communa* (on *Ambrosia artemisiifolia*) and *O. notulata* (on *Iva frutescens*), both from Stony Brook, New York. Ten female *O. communa* and 15 female *O. notulata* were individually confined with a male of each species for two hours for each of three days over a week's span, and observed every 15 minutes. Both first matings ($I = 0.78$, SE = 0.148, $P < 0.05$) and total matings ($I = 0.73$, SE = 0.124, $P < 0.05$) were significantly nonrandom, and no matings between female *O. communa* and male *O. notulata* were observed (Table 5C). In 1988, these observations were extended with virgins of both species collected in Stony Brook, New York (*O. notulata* reared from field-collected larvae, *O. communa* collected as pupae). Their post-eclosion age was 7–14 days for *O. notulata* and 2–6 days for *O. communa.* Females were not offered a choice of males. Ten of each of the two heterospecific combinations and 8 of each of the homospecific combinations were set up on two days (29 and 30 June); the same individuals were used on both days, but mixed into different combinations on 30 June. Observations were made every 15 minutes for a total of 16 hr. Undoubtedly because of the small sample sizes, no significant departure from randomness was observed either for first matings ($I = 0.30$, SE = 0.213) or total matings ($I = 0.096$, SE = 0.179; Table 5D). However, as in 1987, no female of *O. communa* mated with male *O. notulata.* Female *O. notulata* engaged in, if anything, more heterospecific matings. It is possible that the males of *O. notulata* were less competent to mate than those of *O. communa.*

These experiments on allopatric, presumably conspecific, populations and on closely related species show that some elements of mating discrimination exist between taxa associated with different host plants. Therefore, whatever role divergence in host association may play in the speciation of specialized phytophagous insects (Bush, 1975; Diehl and Bush, 1984; Futuyma and Mayer, 1980; Futuyma and Peterson, 1985), mating on the host plant is not the only potential basis for reproductive isolation.

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NOTES ADDED IN PROOF:

1. S. Y. Strauss (1987, *Ecology* 68:1670–1678) described "*Ophraella* sp." as an abundant specialist on *Artemisia ludoviciana* Nutt. at the Cedar Creek Natural History Area, Bethel, Anoka County, Minnesota. Twelve specimens from the collection of the Cedar Creek Natural History Area, sent to me by J. Haarstad, conform to *Ophraella artemisiae* in all features, including the diagnostic features of the mouthparts. All are labelled "U.S.A., MINNESOTA/

Anoka County/Cedar Creek Natural/History Area," with dates 2 June–10 Sept., 1985–1989. Notations on the labels, "Artlu" and "AS," indicate specimens hand-picked and swept, respectively, from *Artemisia ludoviciana* (J. Haarstad, pers. comm.). Four specimens have been deposited in the Cornell University Insect Collection. *Artemisia ludoviciana* and *A. Carruthii,* the known hosts of *O. artemisiae,* are in the same section (Abrotanum). *A. ludoviciana* is native to prairies and dry soils from southern Ontario and Missouri to British Columbia and northern Mexico, and is naturalized on the east coast from Quebec to Virginia (M. L. Fernald, *Gray's Manual of Botany,* 1950). Thus *O. artemisiae* undoubtedly has a broader distribution than is known at present.

2. The tachinid reared from *Ophraella notulata* collected at Bluffton, S.C., 20 April 1989, has been identified as *Celatoria* sp. by D. Grimaldi (American Museum of Natural History). The two North American species of *Celatoria* are known to parasitize four other genera of Galerucinae (Arnaud 1978, U.S.D.A. Misc. Publ. 1319).

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REVISION OF THE ADERIDAE OF EASTERN NORTH AMERICA

Floyd G. Werner
Department of Entomology, The University of Arizona,
Tucson, Arizona 85721

Abstract.—The family now contains 37 species in this region, including *Aderus populneus* (Panzer), apparently introduced from Europe. One new genus, *Gymnoganascus* (type-species *G. stephani*) is described. New generic synonymy is *Aderus* Westwood (=*Phomalus* Casey), *Ariotus* Casey (=*Scanylus* Casey), and *Ganascus* Casey (=*Sandytes* Casey).

New species described are *Elonus hesperus* (Oklahoma, Missouri, Arizona), *Gymnoganascus stephani* (Oklahoma, Texas, Kentucky, Mexico, Cuba), *Vanonus balteatus* (Oklahoma, Texas, Kansas), *V. macrops* (Missouri), *V. musculus* (Oklahoma), *V. oklahomensis* (Oklahoma), *V. uniformis* (Florida to Arkansas), *V. valgus* (Oklahoma to Florida), *Zonantes floridanus* (Florida), *Z. mississippiensis* (Mississippi), *Z. ouachitanus* (Oklahoma), and *Z. pallidus* (Oklahoma to Florida and eastern Canada). New combinations are *Aderus brunnipennis* (LeConte), *A. saginatus* (Casey), *A. tantillus* (Champion), *Ariotus luteolus* (Casey), and *Ganascus ptinoides* (Schwarz). New specific synonymy is *Pseudariotus notatus* (LeConte) (=*Pseudariotus amicus* Casey), *Elonus basalis* (LeConte) (=*Elonus princeps* Casey), *Emelinus melsheimeri* (LeConte) (=*Emelinus ashmeadi* Casey), *Ganascus ventricosus* (LeConte) (=*Ganascus opimus* Casey, *G. palliatus* Casey), *Vanonus huronicus* Casey (=*Tanilotes densus* Casey), *Vanonus piceus* (LeConte) (=*Xilophilus tuberculifer* Hamilton, *Vanonus congener* Casey, *V. fusciceps* Casey), *Vanonus sagax* Casey (=*V. floridanus* Casey), *Zonantes fasciatus* (Melsheimer) (=*Z. tricuspis* Casey), and *Zonantes hubbardi* (Casey) (=*Z. schwarzi* Casey).

Type-species are designated for the Casey genera *Ariotus, Elonus, Emelinus, Ganascus, Phomalus, Pseudariotus, Tanilotes, Vanonus,* and *Zonantes.* Lectotypes are selected for *Axylophilus yuccae* Casey; *Euglenes signatus* Haldeman; *Ganascus palliatus* Casey; *Xilophilus tuberculifer* Hamilton; *Xylophilus brunnipennis* LeConte, *X. fasciatus* LeConte, *X. impressus* LeConte, *X. melsheimeri* LeConte, *X. nebulosus* LeConte, *X. piceus* LeConte, *X. ptinoides* Schwarz, *X. quercicola* Schwarz, *X. subfasciatus* LeConte, and *X. ventricosus* LeConte; and *Zonantes tricuspis* Casey.

The author has had an interest in the beetle family Aderidae for some years, but this study was started when Karl Stephan requested identification of the aderids that he had collected on his property and in surrounding areas in Latimer County, eastern Oklahoma. He had taken most of the species known from the eastern United States, and series with both sexes of a number of species known from single specimens. His findings on season of emergence, relative abundance and habitat preference, the result of two full seasons of intensive collecting, will be the subject of a separate joint paper. The present contribution is based on his collection and on specimens generously loaned by the curators of museums and the private collectors listed in the acknowledgments.

The region covered, North America east of the 100th Meridian, is essentially what has been treated by previous authors, most notably LeConte (1855) and Casey (1895, 1905). The few species described from the Southwest (Casey, 1895; Werner, 1956) and southern California (Casey, 1895; Fall, 1901) are part of a largely undescribed fauna that may serve as the subject of another study. There seems to be little overlap between the regions; only one species of *Emelinus,* one of *Elonus,* and the introduced *Aderus populneus* have been taken both east and west of the 100th Meridian.

The size of individual species is given as length of a representative specimen from front of head with head deflexed to tip of elytra, width across widest part, and length of elytra. The range of size is given in terms of variation in the length of the elytra, a more reliable measurement than total length, which is influenced by the position of head and prothorax.

CLASSIFICATION

The family is more familiar to American workers as Euglenidae, but Baguena (1948) has argued that it should be Aderidae, and Mroczowski and Slipinski (1987) have petitioned the International Commission on Zoological Nomenclature to use its plenary powers to place Aderidae on the Official List of Family-Group Names in Zoology (Case 2510) and place Euglenesidae (=Euglenidae Seidlitz) in synonymy.

Casey (1895) placed the Nearctic species in 13 genera, Champion's genus *Cnopus* (1893) and 12 that he described as new. He later (1905) synonymized one genus, *Tanilotes,* on finding that it was based on females that could be associated with males in his genus *Vanonus.* Champion (1890, 1893) had described 44 species in the Biologia Centrali-Americana, placing all but the one species of *Cnopus* in the genus *Xylophilus.* Maurice Pic (1905) reduced all of Casey's genera to subgenera of *Hylophilus,* and assigned additional species in Central and South America to some of them on the basis of Casey's descriptions.

By far the most detailed study of any aderid fauna is that of Baguena for tropical Africa, reported in two publications (1948, 1962). In the first paper Baguena attempted to build a classification to include all of the previously described genera, and placed some of Casey's genera into synonymy with others from other regions. His treatment of the Nearctic fauna suffered from a severe lack of specimens, so he could place most of Casey's genera only on the basis of the original descriptions. Two of the major divisions of Baguena's classification are based on the presence or absence of interstitial setae between the primary setae that arise from major punctures. Israelson (1971) has called attention to the fact that the interstitial setae can be present or absent within a single species of *Vanonus.*

The classification presented here is an attempt to regroup the Nearctic genera on the basis of characteristics of the male genitalia as well as the more easily observed external characters. It has been possible to examine the male genitalia of almost all the species. Two very distinct types are represented, one in which there is a pair of parameres on the sides of the tegmen, and another with no trace of such parameres. These two types are used here as the basis for recognition of two subfamilies. Since Baguena's classification of the family into subfamilies and tribes does not include consideration of male genitalia, this provisional classification cannot be correlated with his without further study and dissection of type-species.

The provisional reclassification is as follows:

Male genitalia with lateral parameres (Fig. 71) .... Subfamily I
[*Vanonus piceus* an exception]

Hind femora without a brush in either sex .... Tribe 1

[included genera *Ganascus* Casey, *Gymnoganascus* Werner]

Hind femora with a posterior brush at least several setae thick in both sexes ... Tribe 2

[included genus *Vanonus* Casey]

Male genitalia without lateral parameres .... Subfamily II

Last visible sternum of female without a median pit. Hind femora without a posterior brush or with a very reduced brush in both sexes .... Tribe 1

[included genera *Aderus* Westwood, *Ariotus* Casey, *Axylophilus* Casey, *Cnopus* Champion, *Emelinus* Casey, *Pseudariotus* Casey]

Last visible sternum of female with a median pit. Hind femora either without a brush or with a very extensive pad covering underside in male .... Tribe 2

[included genera *Elonus* Casey, *Zonantes* Casey]

Most of the Nearctic genera are probably limited to the Western Hemisphere, and some contain species in the Neotropical Region. Two genera, *Aderus* and *Vanonus,* contain Palaearctic species, and the former has additional species in other regions, including the Neotropics. The limits of Casey's genera have been broadened in several instances, making them less homogeneous but reducing the need to establish additional genera.

KEY TO NEARCTIC GENERA

1. Hind femora with a brush along at least ⅛ of hind margin, sometimes on a lobe or extending onto ventral surface 2

– Hind femora without a brush, at most with an inconspicuous, elongate, seta-filled pit (Fig. 15) 4

2(1). Underside of abdomen with a large elevated plate bordered by dense golden pubescence (Fig. 47). Most of underside of expanded hind femora covered by a dense brush .... male *Elonus*

– Underside of abdomen without an elevated plate. Brush of hind femora much less extensive, confined to posterior border in most species 3

3(2). Brush on hind femora at least several setae thick, sometimes on a lobe (Figs. 5–7, 56–58, 69) .... *Vanonus*

– Brush on hind femora one seta thick (Fig. 63), sometimes inconspicuous ... *Ariotus*

4(1). Antennal segment 3 subequal to segment 2, shorter than segment 4 (Fig. 65) *Aderus*

– Antennal segment 3 longer than segment 2, longer than or subequal to segment 4 (Figs. 64, 66) 5

5(4). Segment 1 of hind tarsi shorter than segments 2–4 combined .... *Cnopus*

– Segment 1 of hind tarsi longer than segments 2–4 combined 6

6(5). Basal abdominal sterna with lateral patches of dense golden pubescence and last exposed sternum with a small pit on midline (Fig. 70). Dorsal pubescence including dense, laterally directed interstitial setae .... female *Elonus*

– Basal abdominal sterna without lateral patches of dense golden pubescence. If pit present on midline of last abdominal sternum, interstitial setae lacking 7

7(6). Upperside with dense interstitial setae involved in a color pattern, either in patches or over whole surface (Figs. 1, 2) .... *Ganascus*

– Elytra without interstitial setae, or such setae present and not involved in a color pattern 8

8(7). Tiny, less than 1.1 mm long, rarely collected, heavy-bodied species (Figs. 48, 54) 9

– Larger, more than 1.1 mm long, species, not so heavy-bodied 10

9(8). Front of head bulging from level of eyes to frontoclypeal suture; eyes deeply emarginate (Fig. 49) .... *Axylophilus*
– Front of head normally convex; eyes not emarginate (Fig. 48) ..... *Gymnoganascus*
10(8). Hind femora with a long, seta-filled pit on underside of posterior edge (Fig. 15) .... *Pseudariotus*
– Hind femora without seta-filled pit 11
11(10). Last visible sternum of female with a small median pit (Fig. 59). Male with antennae simple, front trochanters usually bearing a small spine. Hind angles of prothorax without tuft of setae .... *Zonantes*
– Last visible sternum of female without pit. Male antennae flabellate (Fig. 64), front trochanters not spined. Hind angles of prothorax with tuft of setae (Fig. 18) .... *Emelinus*

SUBFAMILY I

Diagnosis. Male genitalia with lateral parameres in addition to a median tegmen (Fig. 71). Hind femora without a brush, or brush several setae wide present on posterior side in both sexes. Interstitial setae present or absent. [*Vanonus piceus* (LeConte) has a brush on the hind femora in both sexes, but the male genitalia lack lateral parameres. It is left in *Vanonus* because of its great external similarity to some other species, but may have to be reassigned.]

Subfamily I, Tribe 1

Diagnosis. Hind femora lacking a brush of any kind in either sex. Two Nearctic genera.

Ganascus Casey

Ganascus Casey 1895:803 (type-species: *Xylophilus ventricosus* LeConte, new designation). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:27.

Sandytes Casey 1895:806 (type-species: *Xylophilus ptinoides* Schwarz, by monotypy). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:28. **New synonymy.**

Discussion. Casey established this genus for three species, here treated as *G. ventricosus.* The genus is redefined to include the two Nearctic species in which the male genitalia have separate parameres, the hind femora lack any sort of brush in either sex, the prothorax is constricted laterally near the middle, and dense interstitial setae are involved in a color pattern. The two Nearctic species are very different from each other. Additional species seen from the West Indies and Central America; one from the West Indies is somewhat intermediate between the Nearctic species.

Key to Species

1. Whole surface with primary and interstitial setae involved in a brown and gray color pattern. Robust, of form similar to *Anthrenus* in the Dermestidae, the eyes not protruding and antennae not particularly slender .... *Ganascus ventricosus*
– Most of surface shiny and devoid of interstitial setae, but patches of dense gray interstitial setae forming isolated markings on pronotum and elytra. Form similar to *Ptinus* in the Ptinidae; elytra robust, prothorax narrow, only ca. ½ as wide as elytra; eyes protruding and antennae unusually slender .... *Ganascus ptinoides*

Ganascus ventricosus (LeConte)
Fig. 1

Xylophilus ventricosus LeConte 1875:176. [Described from "Southern States." Lectotype, new designation, sex?, in LeConte Coll., MCZC, labeled "orange disk / ventricosus type (in pencil) / ventricosus 2," examined.] Casey, 1895:804 (*Ganascus*).

Ganascus opimus Casey 1895:805. [Holotype, sex?, labeled "Tex with ink dot under e / Type USNM 36513 / opimus Csy" in Casey Coll., USNM, examined by D. S. Chandler.] **New synonymy.**

Ganascus palliatus Casey 1895:806. [Lectotype, new designation, sex?, labeled "Tampa, Fla. 27.4 / Type USNM 36514 / palliatus Csy" in Casey Coll., USNM, examined by D. S. Chandler.] **New synonymy.**

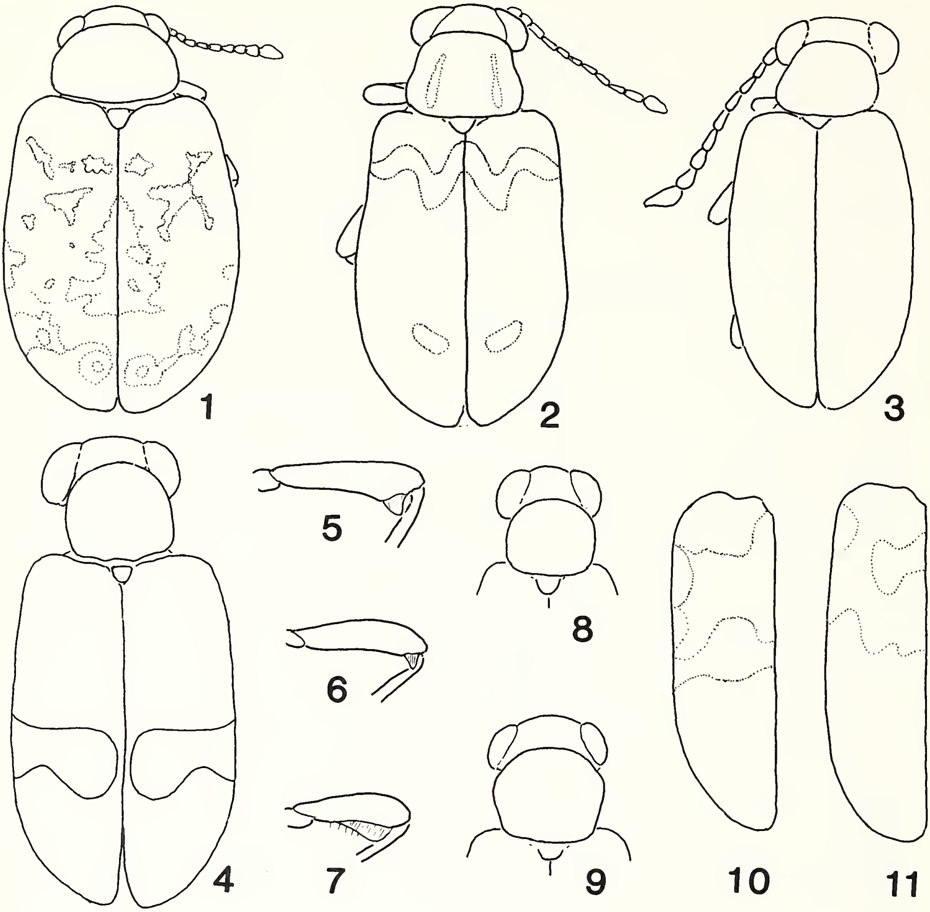
Diagnosis. Robust, prothorax subquadrate with sides slightly indented at middle. Brown but pale on all but middle of pronotum, scutellum, cuticle under pale pubescence, antennae, palpi, tarsi and parts of tibiae. Shiny, with evenly spaced dense punctures, surface partly concealed by dense, appressed interstitial setae. These and the primary setae form a brown and silvery gray color pattern dorsally, best described as variegated but basically bilaterally symmetrical. There is some variation in the denseness of the pubescence in different specimens, reflected in the synonymy. Separation of eyes 32%, length of antennae 132% of head width in male, 33% and 135% in female; sexing specimens almost impossible without dissection. Length 1.76, width 1.06 mm, elytra 1.41 (1.35–1.57) mm long.

Distribution. Coastal region from Georgia to Texas, with scattered records as far north as Indiana and possibly New Hampshire. Alabama: Mobile. Arkansas: Polk Co. Florida: Archer, Camp Mahachee, Crystal Beach, Daytona, Dunedin, Englewood, Enterprise, Everglades National Park, Ft. Ogden, Gainesville, Gulf Co., Highlands Hammock, Jackson Co., Key Largo, Lakeland, Lake Worth, Leon Co., Loggerhead Key (Dry Tortugas), Manatee Springs, Miami, Monroe Co., Myakka R. S., Tallahassee, Tall Timbers, Tampa (Casey, 1895, *palliatus*), Torreya State Park, Vero Beach, Welaka. Georgia: Athens, Tybee Island. Indiana: Harvey Lake. Louisiana: Baton Rouge. Maryland (state label). New Hampshire: Durham (mislabeled?). Oklahoma: Latimer Co. Tennessee (state label). Texas: Austin (Casey, 1895, *opimus*), Bandera Co., Bastrop, Cameron Co. (Sabal Palm Grove & Southmost), Hidalgo Co., Seabrook (CNCI, CUIC, DENH, EGRC, FMNH, FSCA, ICCM, KSTC, LSUC, MCTC, MCZC, OSUC, PSKC, SEMC, UAIC).

Ganascus ptinoides (Schwarz), **New Combination**
Fig. 2

Xylophilus ptinoides Schwarz 1878:371. [Lectotype, new designation, male, labeled "Enterprise, Fla, 16.6 / Coll. Hubbard & Schwarz / type! Schwarz / Type No. 4534 U.S.N.M." in USNM, examined by D. S. Chandler.] Casey, 1895:807 (*Sandytes*).

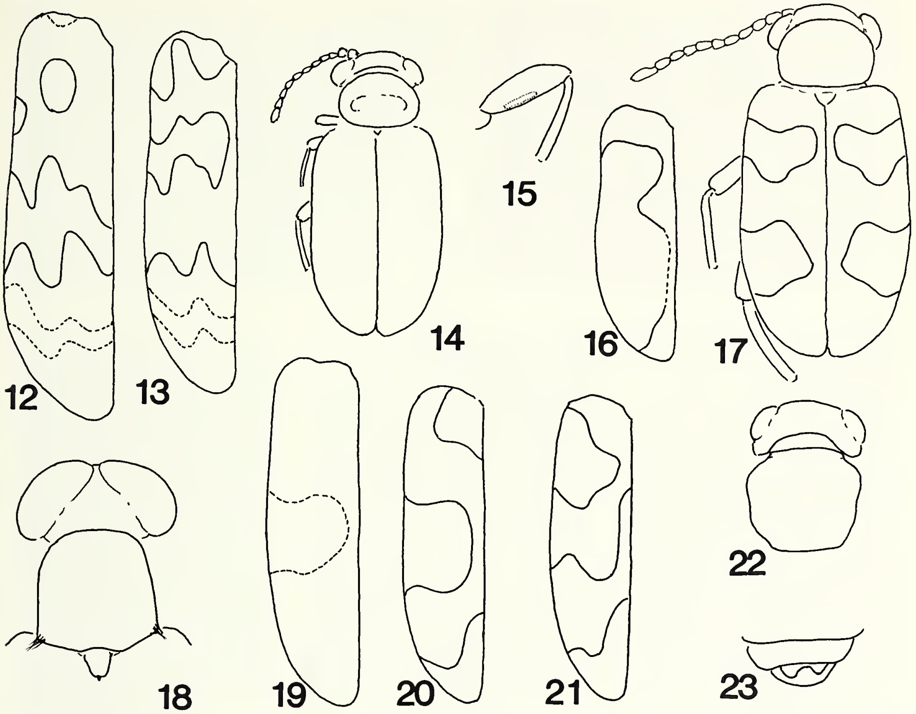
Diagnosis. Dark brown, paler under white markings, shiny, deeply punctured, rather robust but prothorax rather narrow and eyes protruding beyond its sides; head 108% as wide as prothorax in male. Antennae slender, long and threadlike in male, less so in female, yellowish with segment 11 thicker, brown. Tibiae, and sometimes



Figs. 1–11. Camera lucida sketches, 30×. 1–4 Habitus. 1. *Ganascus ventricosus.* 2. *Ganascus ptinoides.* 3. *Vanonus uniformis.* 4. *Vanonus balteatus.* 5–7. Hind femur, 40×. 5. *Vanonus wickhami* female. 6. *Vanonus vigilans* female. 7. *Vanonus oklahomensis* female. 8, 9. Forebody. 8. *Vanonus macrops.* 9. *Vanonus valgus.* 10, 11. Left elytron. 10. *Aderus brunnipennis.* 11. *Aderus populneus.*

most of legs, pale. Head and prothorax with some lateral appressed white pubescence, including interstitial setae, in sublateral lines on latter, and also in patches on elytra. When fully developed the elytral patches form a zig-zag pattern across the postbasal transverse impression, a more regular postmedian band and an incomplete band behind it. Separation of eyes 31%, length of antennae 182% of head width in male, 24% and 164% in female. Length 1.58, width 0.80 mm, elytra 1.24 (1.10–1.28) mm long.

Distribution. Florida and eastern Oklahoma. Florida: Dunedin, Enterprise (Schwarz, 1878), Gainesville, Haw Creek, Highlands Hammock, New Smyrna (Schwarz, 1878). Oklahoma: Latimer Co. (CNCI, CUIC, FSCA, ICCM, KSTC, MCTC, MCZC, UAIC).



Figs. 12–23. Camera lucida sketches, 30×. 12, 13. *Emelinus melsheimeri* elytra. 14. *Cnopus impressus* habitus. 15–17. *Pseudariotus notatus.* 15. Male hind femur. 16. Elytron. 17. Habitus. 18. *Emelinus melsheimeri* male forebody. 19–21. Elytra. 19. *Ariotus subtropicus.* 20, 21. *Ariotus quercicola.* 22. *Ariotus subtropicus* forebody. 23. *Ariotus quercicola* male apex of abdomen.

Gymnoganascus Werner, new genus

Diagnosis. Robust and thick-bodied, with inconspicuous pubescence not affecting color. Antennae stout in both sexes, the outer segments transverse. Legs not modified in male, but female with a fringe of longer setae on outer edge of hind tibiae. Separation of visible sterna 1 and 2 barely indicated. Male with no obvious modification of apex of abdomen.

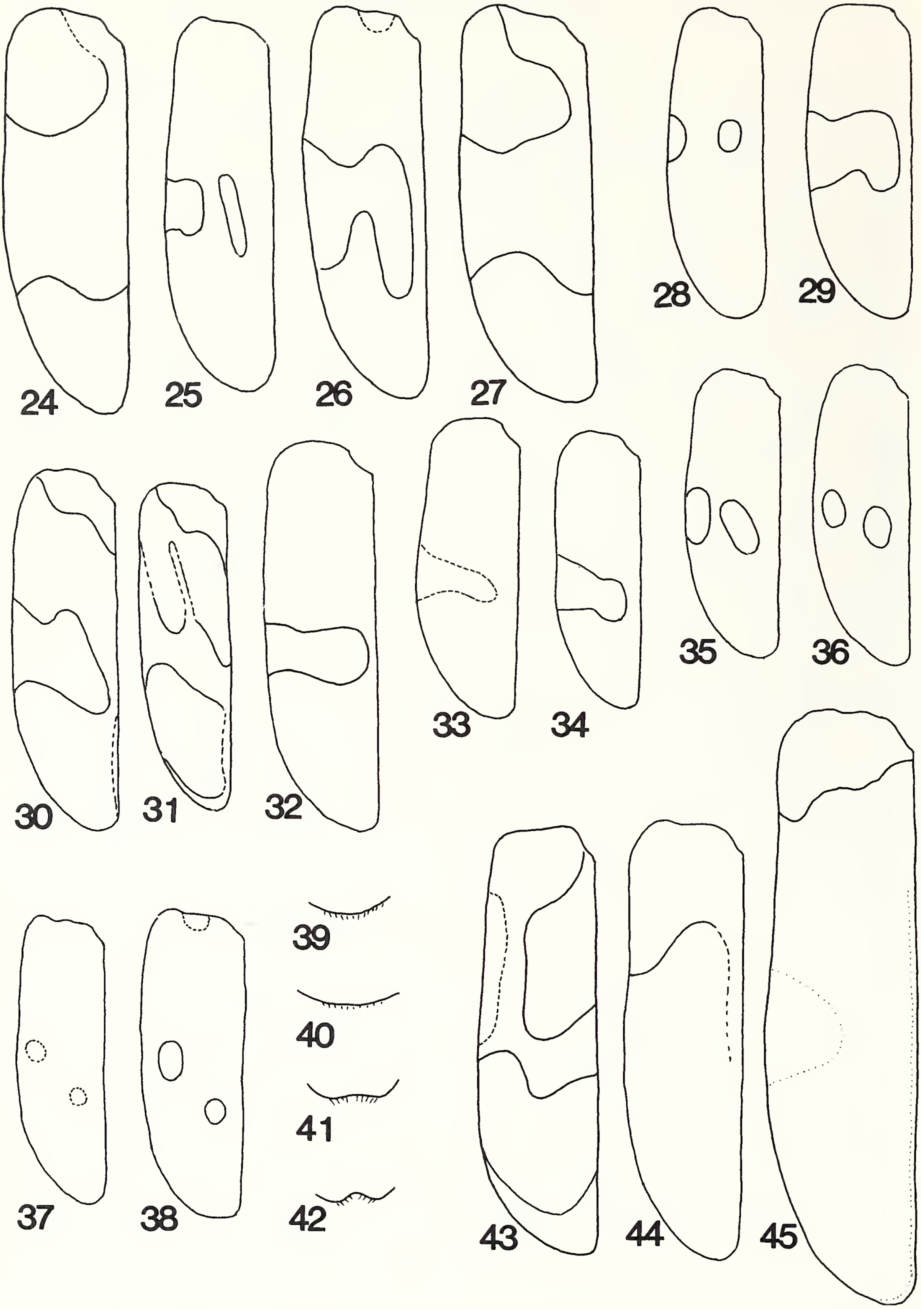
Type-species. Gymnoganascus stephani Werner.

Gymnoganascus stephani, new species

Fig. 48

Diagnosis. A tiny, convex species with inconspicuous pubescence, small eyes and short antennae. Separation of eyes 68%, length of antennae 154% of head width in male, 71% and 150% in female. Length 0.91, width 0.49 mm, elytra 0.69 (0.61–0.69; 0.76–0.81 in Queretaro specimens) mm long.

Description. Holotype: male, 0.91 mm long with head deflexed, pale reddish, shiny; elytra evenly convex, with distinct humeri, moderately deeply and densely punctured



Figs. 24–45. Camera lucida sketches, 30×. 24–42. *Zonantes* spp. 24–38. Elytra. 24. *Z. fasciatus.* 25–27. *Z. hubbardi.* 28, 29. *Z. subfasciatus.* 30, 31. *Z. nubifer.* 32. *Z. ouachitanus.* 33, 34. *Z. pallidus.* 35, 36. *Z. floridanus.* 37, 38. *Z. signatus.* 39–42. Apex of last visible tergum of female. 39. *Z. signatus.* 40. *Z. pallidus.* 41. *Z. subfasciatus.* 42. *Z. floridanus.* 43–45. *Elonus* spp. elytra. 43. *E. nebulosus.* 44. *E. hesperus.* 45. *E. basalis.*

Figs. 46–50. SEM photographs. 46. *Zonantes fasciatus* male, 21×. 47. *Elonus hesperus* male, 18×. 48. *Gymnoganascus stephani,* 42×. 49. *Axylophilus yuccae* head, 85×. 50. *Vanonus piceus* male head, 103×.

(ca. 0.02 mm separation), the punctures bearing slightly curved, almost appressed setae 0.06 mm long; head and pronotum separately convex, with very fine punctures and shorter appressed setae; underside with punctures slightly deeper. Head 0.22 mm long to strong frontoclypeal suture, 0.28 mm wide across eyes, portion behind eyes 0.25 wide, 0.06 long, the sides starting to curve at eyes, the base almost straight. Eyes small but prominent, 0.09 × 0.06 mm, their front margins almost straight and well separated from bases of antennae. A distinct ridge extends from the middle of each eye, slightly diagonally and then straight forward across bases of antennae, the 2 ridges 0.09 mm apart. Antennae 0.43 mm long, stout, segments 9–11 forming a club. Antennal segment 1 oval, 2 slightly narrower than 1 but stouter than 3, 4–9 of almost equal length, progressing from oval to broader than long; 9–11 abruptly wider, 8 0.04 mm wide, 9 0.06, 9 and 10 transverse, 11 broadest, obliquely truncate; 9–11 combined 0.13 mm long. Prothorax evenly convex, 0.24 mm long, widest anterior to middle, 0.27 mm, the sides just perceptibly convex from there to base, where 0.24 mm wide, narrowly curved anteriorly to short collar region 0.19 mm wide. Elytra convex, with a faint indication of a postbasal transverse impression and distinct humeri, which embrace the base of the prothorax; 0.69 mm long, widest, 0.49, at basal ⅓, 0.32 at points of humeri. Legs not obviously modified. Genitalia slender, with slender tegmen and parameres 0.06 mm long and less than 0.01 mm wide, bearing 3 long setae apically. Allotype: female, very similar to holotype, elytra 0.69 mm long. Head 0.28 mm wide across eyes. Hind tibiae with a fringe of long, decumbent setae on posterior side, stuck down in this specimen but decumbent and ca. 0.04 mm long in one from Queretaro.

Specimens examined. Known from four localities in the U.S.A. (eastern Oklahoma, eastern Texas and Kentucky), Queretaro in Mexico, and Cuba in the West Indies. Holotype: male, Oklahoma: Latimer Co., 4-IV-83, Karl Stephan/lowland forest, sifting litter. Allotype: female, same locality, XII-85/sifting forest litter. Holotype and allotype in USNM, paratypes in FSCA, FMNH. Paratypes (8): 4 males, 2 females same locality, 5 taken sifting litter and 1 in flight trap, V-83. 1 male, Oklahoma: Marshall Co., 1 mi SE Willis, 12.VII.1968/marsh floor near temp. pond, W. Suter. 1 male, Kentucky: Edmonson Co., Mammoth Cave N.P., Cabin Woods, Subt., 18 March 1972, W. Suter. Not designated as paratypes: 1 male, Texas: Bastrop Co., Buescher State Pk., VI.15–17.1973/leaf litter forest floor, A. Newton, MCZC. 1 male, 2 females, Mexico: Queretaro: 18 mi E Landa de Matamoros, 5,300 ft, VII-14-1969, S. & J. Peck/Ber. 169, pine-oak litter, FMNH, MCZC. 1 female, Cuba: Soledad (nr.) Cienfuegos, X-15-1926, Darlington, MCZC (FMNH, FSCA, KSTC, MCZC, UAIC, USNM).

Discussion. The seven specimens taken by sifting in Latimer Co., Oklahoma are very similar to each other and the one from Kentucky. The others differ in having sparse, fine interstitial setae on the elytra, and seem to have slightly shorter primary setae. The specimen from Cuba has longer tactile setae. Specimens from the U.S.A. are smaller; those from Queretaro may have slightly more slender legs. Named for Karl Stephan, who recognized the species as undescribed soon after he collected it.

Subfamily I, Tribe 2

Diagnosis. Hind femora with some kind of a brush several setae thick on posterior side in both sexes. Genus *Vanonus.*

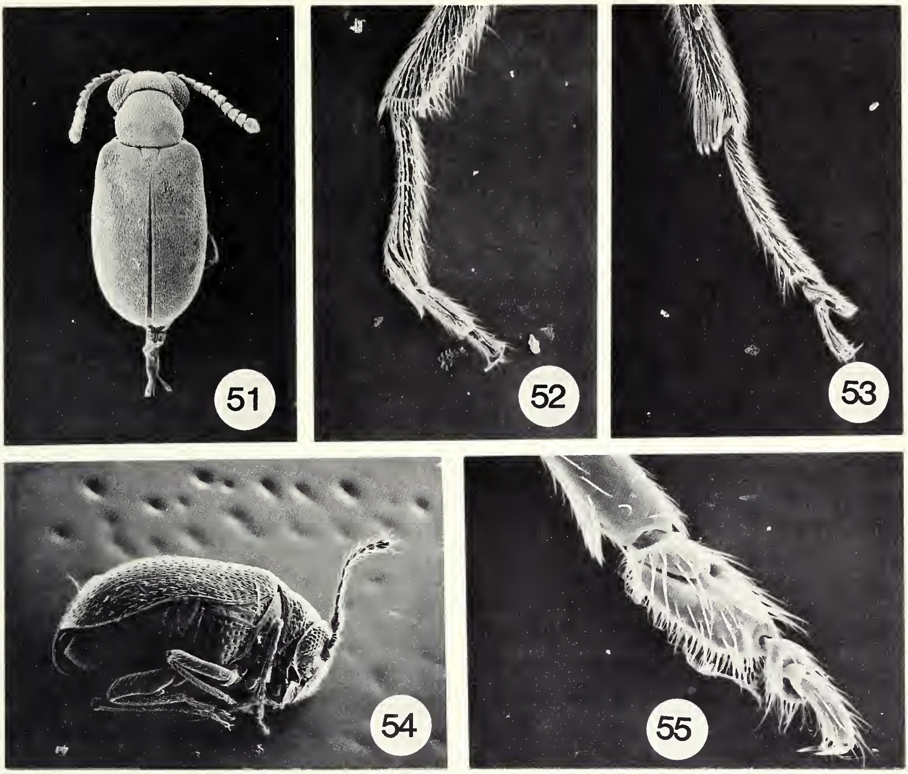
Genus *Vanonus* Casey

Vanonus Casey 1895:791 (type-species: *Vanonus wickhami* Casey, new designation); 1905:161. Pic, 1905:235 (subgenus of *Hylophilus*). Israelson, 1971:110.

Tanilotes Casey 1895:798 (type-species: *Tanilotes lacustris* Casey, new designation). Pic, 1905:235 (subgenus of *Hylophilus*).

Pseudanidorus: Baguena 1948:52, in part; not Pic, 1893:159 [from Baguena, 1948].

Discussion. Casey proposed this genus for a group of small, uniformly dark species with a posterior brush running the length of the hind femora, separating similar species in which the hind femora had a lobe or tooth in addition to a brush into the genus *Tanilotes.* He later (1905) decided that one species of *Tanilotes* was based on females and one of *Vanonus* on males of the same species, but was not aware that the female of one species has hind femora almost like those of males.



Figs. 51–55. SEM photographs. 51. *Vanonus musculus* male, 22×. 52. *Zonantes ater* female hind tibia, tarsus, 59×. 53. *Elonus nebulosus* female hind tibia, tarsus, 56×. 54. *Axylophilus yuccae,* 33×. 55. *Pseudariotus notatus* male front tarsus, 175×.

As here redefined, the genus *Vanonus* includes all Nearctic species in which the hind femora have a brush more than one seta thick on the hind margin, but with the brush not expanded into a large ventral pad as it is in the males of most species of *Elonus.* The genus is represented in the Palaearctic Region by at least a few species. In the males of most species the genitalia have slender parameres, each bearing three apical setae. *Vanonus piceus* does not, and may not belong in the genus. It is left here provisionally, but its proper placement is probably elsewhere. In all known species the brush on the hind femora of the male extends from near base to near apex and is of almost even width. The brush on the female hind femora varies from male-like to a broad lobe or tooth, and may not extend the whole length.

Key to Species

1. Pale, elytra with a brown band (Fig. 4) .... *Vanonus balteatus*
– Uniformly dark or head darker and/or appendages paler, elytra without a mid-band 2

2(1). Front of head strongly flattened (Fig. 50) 3

– Front of head normally convex 4

3(2). Head and elytra strongly microreticulate. Genitalia with separate parameres .... male *Vanonus calvescens*

– Surface not microreticulate. Genitalia lacking separate parameres .... male *Vanonus piceus*

4(2). Prothorax broadest anterior to middle (Fig. 9). Interstitial setae of elytra much denser than primary setae. Female hind femora strongly bowed at base, with a large posterior lobe in distal half, the lobe flat and covered with dense pubescence ventrally (Fig. 56) .... *Vanonus valgus*

– Prothorax broadest at or behind middle. Pubescence and hind femora variable 5

5(4). Hind femora with part of posterior brush expanded, or with a posterior tooth. Females 6

– Hind femora with brush of even width. Males, and female of one species. [Male of *oklahomensis* unknown.] 11

6(5). Brush of hind femora about equally distributed between proximal and distal halves of femur 7

– Brush of hind femora nearly or entirely confined to distal half of femur 8

7(6). Brush of hind femora abbreviated well before base and apex, and with a strong triangular expansion just basad of middle of femur (Fig. 69). Elytral interstitial setae much denser than primary setae .... female *Vanonus musculus*

– Brush of hind femora extending from near base to near apex, with a feeble expansion just basad of middle of femur. Elytral interstitial setae sparse and inconspicuous (Fig. 57) .... female *Vanonus piceus*

8(6). Hind femora with a large rounded posterior lobe, occupying distal half 9

– Hind femora with pointed brush or tooth, confined to distal fourth 10

9(8). Femoral lobe strongly downcurved (Fig. 58) .... female *Vanonus huronicus*

– Femoral lobe flat (Fig. 7) .... female *Vanonus oklahomensis*

10(8). Tooth of hind femora based on cuticle, with some setae extending beyond its apex, which lies distinctly before apex of femur (Fig. 5). Eyes moderately small, separated by ca. 60% of head width .... female *Vanonus wickhami*

– Tooth of hind femora consisting almost entirely of setae, which form a tooth that is gently sloped from base to point, then almost perpendicular to femur, dropping close to apex of femur (Fig. 6). Eyes not so small, separated by ca. 50% of head width .... female *Vanonus vigilans*

11(5). Antennal segments 7–10 distinctly thicker and longer than segments 4–6 .... female *Vanonus sagax*

– Antennal segments 4–10 subequal in length, gradually increasing in thickness except in *uniformis*. Males 12

12(11). Antebasal transverse depression of pronotum weak or absent, at least not distinct across midline. Interstitial setae of elytra either much more numerous, shorter and more appressed than primary setae, or completely absent 13

– Antebasal transverse depression of pronotum distinct across midline. Interstitial setae of elytra twice as numerous as primary setae or sparser, and difficult to distinguish from them 16

13(12). Elytra shiny, without interstitial setae. Dark, elytral humeri obscurely paler, and appendages paler .... male *Vanonus uniformis*

– Elytra with dense interstitial setae 14

14(13). Usually reddish brown with head darker and appendages pale 15

– Usually dark brown, antennae, palpi and tibiae paler .... male *Vanonus sagax*

15(14). Parameres more than twice as long as broad, in form of a truncate paddle (Fig. 71) .... male *Vanonus musculus*

– Parameres less than twice as long as broad. [female unknown] .... male *Vanonus macrops*

16(12). Eyes unusually small, separated by ca. 60% of head width male *Vanonus wickhami*

– Eyes separated by 50% of head width or less 17

17(16). Eyes larger, separated by ca. 35% of head width. Slightly larger, elytra 1.06–1.46 mm. Parameres more than 4 times as long as wide, sticklike .... male *Vanonus huronicus*

– Eyes smaller, separated by ca. 50% of head width. Smaller, elytra 1.04–1.20 mm. Parameres about 3 times as long as wide .... male *Vanonus vigilans*

Wickhami-Group

Diagnosis. Placed here are all of the species of *Vanonus* with symmetrical lateral plates on the internal sac of the male genitalia (Israelson, 1971, figs. 1, 2). None of the known species has any contrasting markings on the elytra; all are either uniformly dark or have the head darker and the prothorax paler than the rest of the upper surface. Males have antennae of almost uniform thickness, and hind femora bearing a brush of almost uniform width on the hind margin. None of the known species has the male head flattened in front. Females have the antennae thickened toward the apex, slightly clublike, and have the hind femora variously modified but always bearing a brush, from almost as in the male but with the brush slightly broader at the apex to strongly lobed with both setae and the femur itself involved.

Discussion. The group is largely Nearctic. Israelson (1971) has assigned *brevicornis* (Perris) from Europe and its subspecies *rotundaticollis* Israelson from the Canary Islands to *Vanonus.* Both *brevicornis* and *pentatomus* (Thomson) from Europe appear from Israelson's figures of genitalia (1970, 1971) to belong to the Wickhami-Group.

Vanonus vigilans and *V. wickhami* form one subgroup, *huronicus, oklahomensis* and *valgus* another; *sagax, macrops* and *musculus* seem to have no close relatives.

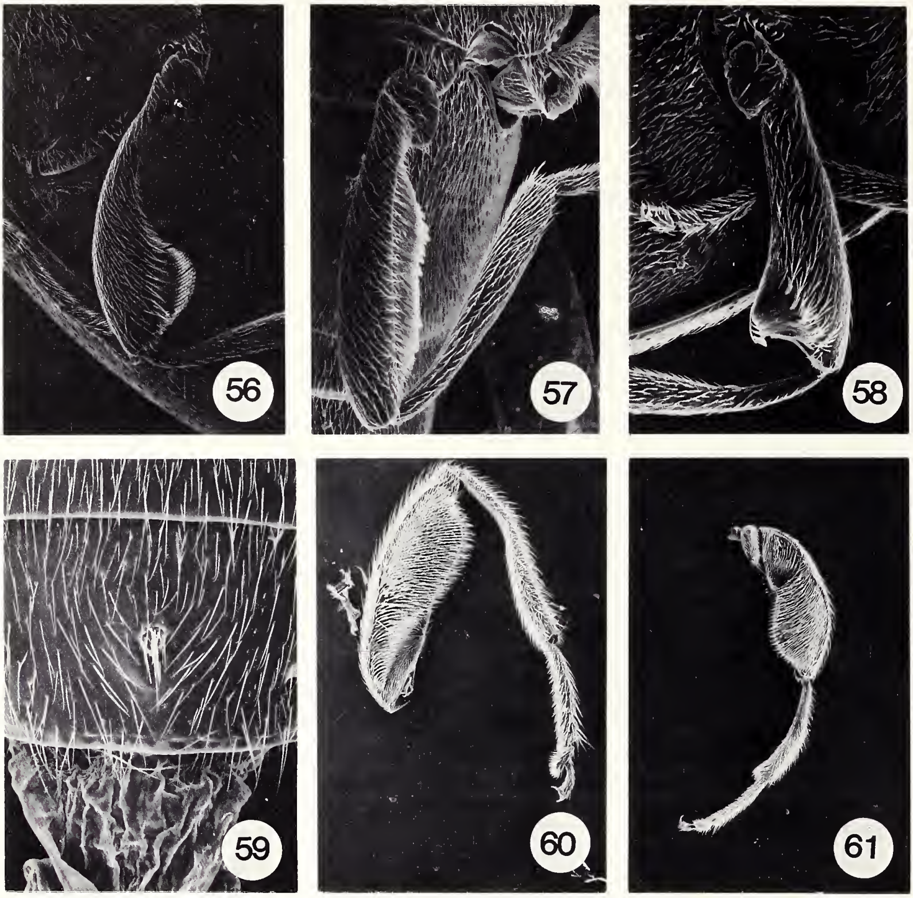
Vanonus huronicus Casey
Fig. 58

Vanonus huronicus Casey 1895:796. [Holotype, male, in Casey Coll., USNM, labeled "Mic. / Type USNM 36505 / huronicus Csy." Remounted on card by Israelson; genitalia placed in vial by Werner.] Israelson, 1971:110–111.

Tanilotes densus Casey 1895:799. [Described from "Pennsylvania (near Philadelphia)." Holotype, female, in Casey Coll., USNM, labeled "Penn, in red ink / Type USNM 36510 / densus Csy.," examined.] Casey, 1905:163 (*Vanonus*). **New synonymy.**

Diagnosis. Reddish tan, head darker, appendages reddish; moderately elongate, subparallel, pronotum with an almost complete antebasal transverse depression. Moderately densely, finely punctured and short appressed pubescent, the interstitial setae sparse in northern individuals, moderately dense in the single Oklahoma specimen. Separation of eyes 34%, length of antennae 152% of head width in male, 40% and 130% in female. Length 1.85, width 0.79 mm, elytra 1.44 (1.07–1.44) mm long.

Discussion. The Oklahoma specimen, a female, has the eyes relatively large, 0.26 × 0.20 mm. Hind femur (Fig. 58) 0.46 mm long, with a flat tooth from 0.26 to apex, ogival in profile and 0.07 mm high, its apex strongly and abruptly curved ventrad



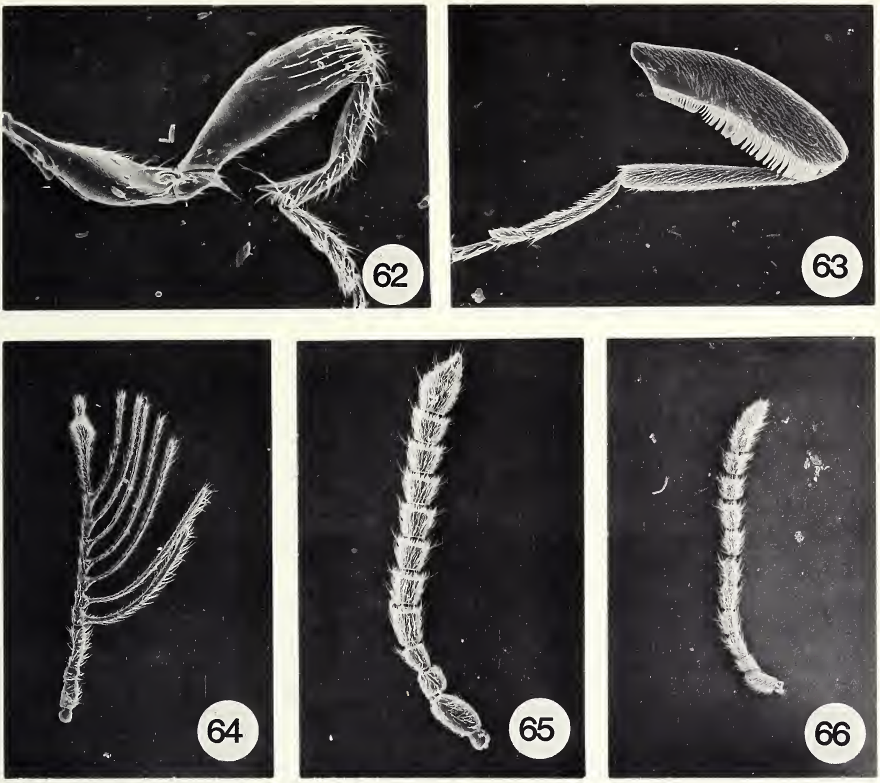
Figs. 56–61. SEM photographs. 56–58. *Vanonus* hind femora. 56. *V. valgus* female, 82×. 57. *V. piceus* female, 95×. 58. *V. huronicus* female, 84×. 59. *Zonantes fasciatus* female, last visible sternum, 110×. 60, 61. *Elonus* hind femora. 60. *E. basalis* male. 61. *E. nebulosus* male.

and more pointed; whole ventral surface of tooth with dense, appressed setae, its dorsal surface, including downbent portion, glabrous.

Distribution. Massachusetts to Wisconsin, south to eastern Oklahoma. Illinois: Ottawa (LaSalle Co.). Indiana: Indianapolis, Tippecanoe Co. Michigan: (Casey, 1895, *huronicus*). Oklahoma: Latimer Co. Pennsylvania: near Philadelphia (Casey, 1895, *densus*) (KSTC, MCZC, NMDC, UAIC, UMRM, USNM).

Vanonus macrops, new species
Fig. 8

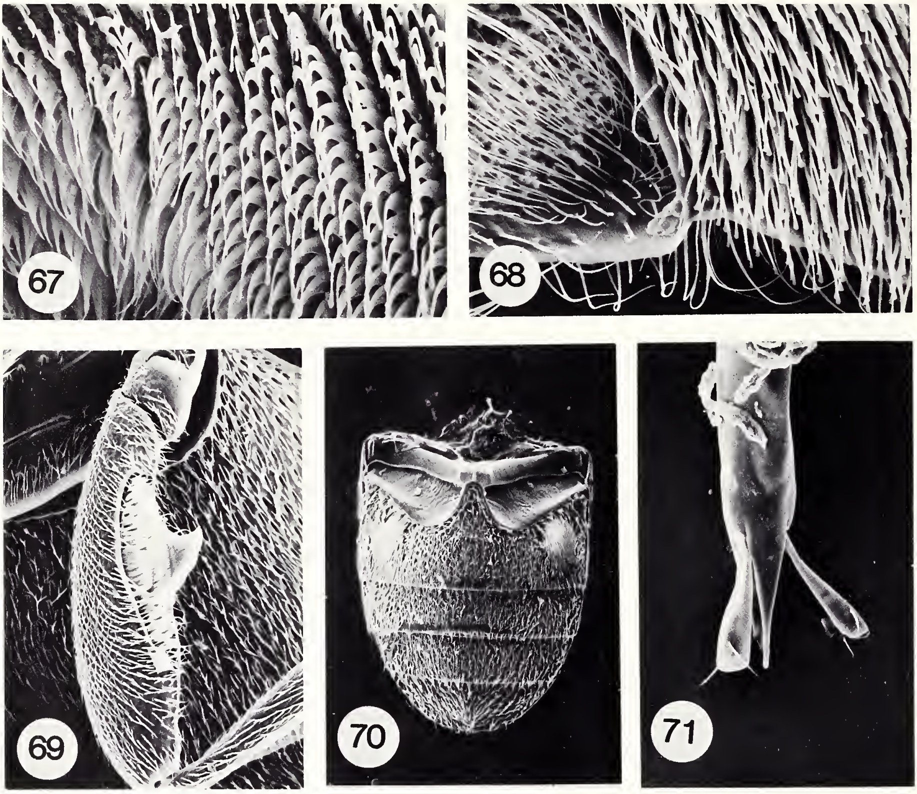
Diagnosis. Reddish brown with slightly paler appendages, black head, Interstitial setae of upperside denser than appressed primary setae, slightly finer and forming a



Figs. 62–66. SEM photographs. 62. *Zonantes hubbardi* male, front leg, 55×. 63. *Ariotus luteolus* male hind femur, 55×. 64. *Emelinus melsheimeri* male antenna, 21×. 65. *Aderus brunnipennis* male antenna, 55×. 66. *Elonus basalis* male antenna, 18×.

gray layer. Separation of eyes 30%, length of antennae 128% of head width in male; female unknown. Length 1.46, width 0.63 mm, elytra 1.09 mm long.

Description. Holotype, male: head 0.28 mm long to frontoclypeal suture, 0.46 wide across eyes, 0.25 behind. Eyes 0.23 × 0.19 mm, separated by 0.14, a line across their hind margins 0.02 from middle of slightly curved base, <0.01 mm from side margins of head. Antennae 0.59 mm long, gradually thicker to 0.07 wide at apex. Head punctures fine, sharply defined, ca. 0.02 mm center to center; interstitial setae present but not concealing dark color. Prothorax 0.31 mm long, 0.37 wide at base, 0.39 near middle, 0.26 at apex; antebasal transverse depression very feeble. Punctures slightly denser than on head and interstitial pubescence denser than on elytra. Elytra 1.09 mm long, 0.48 wide across humeri, 0.63 maximum, with feeble omoplates. Punctures ca. 0.02 mm apart, primary setae 0.02+ mm long, appressed, slightly curved, distinct from interstitial setae, which are dense to about middle of elytra, gradually sparser behind, finer and more appressed than primary setae. Underside more sparsely pubescent. Hind femora 0.41 mm long, with brush from 0.06 to 0.35. Parameres of aedeagus short and broad, ca. 0.07 × 0.05 mm, with 2 apical setae.



Figs. 67–71. SEM photographs. 67, 68. Details of *Elonus* hind femur. 67. *E. hesperus* male, 242×. 68. *E. nebulosus* male, 177×. 69. *Vanonus musculus* female hind leg, 120×. 70. *Elonus nebulosus* female abdomen, 26×. 71. *Vanonus musculus* male genitalia, 128×.

Specimens examined. Known only from northcentral Missouri. Holotype: male, "1 mi. E. Moberly, MO, Randolph Co., 25 Aug. 73, E. G. Riley." Deposited in USNM. No other specimens seen.

Vanonus musculus, new species
Figs. 51, 69, 71

Diagnosis. Reddish brown with brown head, paler appendages; sometimes darker. Elytra with short, appressed primary setae and much more numerous interstitial setae. Prothorax widest near middle and without antebasal transverse depression. Hind femora of female (Fig. 69) with a submedian triangle of setae projecting from a brush that extends along most of femur. Separation of eyes 31%, length of antennae 135% of head width in male, 42% and 127% in female. Length 1.69, width 0.73 mm, elytra 1.29 (1.15–1.31) mm long.

Description. Holotype, female: reddish brown with brown head, 1.69 mm long with head deflexed. Head 0.29 mm long to frontoclypeal suture, 0.49 wide across eyes, 0.35 just behind. Eyes large, 0.24 × 0.19, separated by 0.18, separated from base of head on sides by width of one facet. Antennae fairly short, 0.62 mm, segments 7–10 truncate at base and apex, transverse, 11 thickest, 0.07 mm. Prothorax 0.37 mm long, 0.38 wide at base, 0.44 maximum. Elytra 1.29 mm long, 0.73 wide, 0.53 at points of distinct humeri. Posterior femora 0.44 mm long, 0.13 wide at widest, with a brush from 0.05 to 0.27 mm from base, in a depression that is distinctly margined in front, the brush 0.05 mm wide maximum and containing a flat, triangular peak 0.04 mm high, 0.09 long, the proximal side nearly perpendicular and 0.17 mm from base, the distal side tapering to 0.26 mm, from an acute angle at the point; hind margin of femur with a slight bulge, ca. 0.02 mm, at level of peak. Allotype: male, head 0.28 mm long, prothorax 0.33, elytra 1.15. Eyes 0.23 × 0.19 mm, separated by 0.16, head 0.47 wide across them. Antennae slightly longer, 0.67 mm, with last segment comparable, 0.08 mm thick, middle segments nearly quadrate. Posterior femora 0.44 × 0.12 mm, with a brush 0.06 mm wide, 0.07 to 0.37 mm from base. Genitalia moderately slender with parameres short and truncate, with 3 apical setae. The name means little mouse, in reference to the dense pubescence.

Specimens examined. Eastern Oklahoma and Missouri. Holotype, female: Oklahoma: Latimer Co., VIII-1984, K. Stephan/beating up-land forest. Allotype, male, same data. Holotype and allotype in USNM. Paratypes: 10 males, 8 females, same locality. 1 male paratype, 2 specimens with legs missing, Missouri: Randolph Co., 1 mi E Moberly, Jul. & Sept., E. G. Riley (EGRC, FSCA, KSTC, UAIC, USNM).

Vanonus oklahomensis, new species
Fig. 7

Diagnosis. Brown, femora brownish, rest of appendages dull yellow, head black; elytral pubescence sparse, not concealing shiny surface. Female posterior femora with a rounded flat posterior lobe in distal half. Separation of eyes 36%, length of antennae 130% of head width in female; male unknown. Length 1.44, width 0.65 mm, elytra 1.09 mm long.

Description. Holotype, female: 1.44 mm long with head deflexed. Antennae short, 0.57 mm, segments 4–6 small, submoniliform, 7–11 forming a weak club, 10–11 0.08 mm thick, 7 quadrate, 8–10 broader than long. Pronotum with weak antebasal transverse depression. Elytral primary and sparse interstitial setae short, appressed and inconspicuous. Head 0.28 mm long to frontoclypeal suture, 0.44 wide across eyes, 0.28 behind; eyes 0.22 × 0.17 mm, separated by 0.16, a line across their hind margins 0.06 mm from middle of base, which is evenly curved. Head punctures small but distinct, ca. 0.02 mm apart, setae appressed, intervals shiny. Prothorax 0.27 mm long, 0.37 wide across base, 0.38 maximum slightly anterior to middle, 0.26 at apex. Punctures ca. ⅓ denser than on head, intervals subopaque. Elytra 1.09 mm long, 0.50 wide across points of humeri, 0.65 maximum, with weak omoplates; punctures ca. 0.02 mm apart, setae 0.03 mm long, appressed, slightly curved; primary and sparse interstitial setae barely distinguishable from each other, tactile setae suberect, 0.03 mm.

Hind femora 0.37 mm long, 0.06 wide at trochanter end, gradually wider to 0.11 at apical ¼, there augmented posteriorly to 0.16 mm by a row of stiff, straight setae, the brush starting at 0.13 mm from base, tapering slightly concavely to 0.19 mm from base, then forming a rounded lobe to 0.28 mm from base, there ending abruptly and leaving apical 0.06 mm of femur without a brush; narrow part of brush with 3 slender, erect setae 0.04 mm long. Last visible sternum with 6 slender erect setae 0.04 mm long, across apex. Separation between visible sterna 1 and 2 barely discernible.

Specimens examined. Holotype: female, labeled "Oklahoma: Latimer Co., X-1985, Karl Stephan / beating low-land forest." Deposited in the USNM. No other specimens seen.

Vanonus sagax Casey

Vanonus sagax Casey 1895:796. [Holotype, male, in Casey Coll., USNM, labeled "Haulover, March 10 Fla / Type USNM 38506 / sagax Csy," examined.] Casey, 1905:164.

Vanonus floridanus Casey 1895:797. [Holotype, female, in Casey Coll., USNM, labeled "Crescent City, Fla. / Type USNM 36507 / floridanus Csy.," examined.] Casey, 1905:163. **New synonymy.**

Diagnosis. Usually brown with yellowish appendages, sometimes with head perceptibly darker. Prothorax broadest at or behind middle. Elytral pubescence distinctly double, of numerous short, appressed interstitial setae and distinctly different, longer decumbent primary setae. Eyes very large, reaching almost to hind margin of head. Pronotum with a feeble antebasal depression. Female hind femur with brush almost as long as femur, without expansions, but slightly broader at apex than in male. Separation of eyes 32%, length of antennae 149% of head width in male, 43% and 126% in female. Length 1.39, width 0.56 mm, elytra 1.00 (0.91–1.15) mm long.

Distribution. Florida to North Carolina, west to eastern Oklahoma. Alabama: Mobile, Theodore (Mobile Co.). Florida: Crescent City (Casey 1895, *floridanus*), Enterprise, Ft. Ogden, Gainesville, Hilliard, Indian River (Casey 1895, *sagax*), Lynn, Rainbow Springs (Marion Co.), Steinhatchee (Taylor Co.), Torreya State Park (Liberty Co.), Welaka. Mississippi: Stone Co. North Carolina: Town Creek (Brunswick Co.). Oklahoma: Latimer Co. (CNCI, DENH, FMNH, KSTC, MCZC, PSKC, SEMC, UAIC, UMIS, USNM).

Vanonus valgus, new species
Figs. 9, 56

Diagnosis. Moderately slender, brown, appendages paler, head darker in pale individuals. Prothorax broadest ⅗ from base, the sides angling back to base in a nearly straight line and more abruptly forward to collar region; with a shallow antebasal depression, not interrupted at middle. Punctures and pubescence almost as in *musculus.* Separation of eyes 32%, length of antennae 139% of head width in male, 36% and 135% in female. Length 1.59, width 0.76 mm, elytra 1.37 (1.19–1.50) mm long.

Description. Holotype, female: brown, head darker, appendages paler, 1.59 mm long with head deflexed; head 0.31 mm long to frontoclypeal suture, 0.51 wide across eyes, 0.31 behind; eyes large, 0.32 × 0.22 mm, separated by 0.19. Antennae 0.70 mm long, segment 11 thickest, 0.09 mm. Prothorax 0.41 mm long, 0.37 wide at base, 0.46 maximum, 0.30 at collar region. Elytra 1.37 mm long, 0.59 wide across points of humeri, 0.76 maximum. Hind femora 0.47 mm long, 0.04 wide near base, bowed in basal portion, with a flat plate 0.24–0.43 mm from base, its apex rounded, to 0.07 mm wide and densely clothed with short, appressed setae ventrally. Dorsally, this plate consists of an expansion of the body of the femur, to ca. 0.14 mm, bordered by a narrow, shiny glabrous zone, ca. 0.02 mm wide and separated from body of femur by a ridge; packed setae apparently arising from underside and edge form a brush ca. 0.03 mm wide. Total width with brush 0.19 mm. Allotype: male, head 0.31 mm long, 0.51 wide across eyes, which are 0.28 × 0.22 mm and separated by 0.17. Antennae 0.72 mm long, segment 11 0.09 mm wide. Prothorax 0.41 mm long, 0.44 wide; elytra 1.67 long. Hind femora 0.48 mm long, 0.13 wide at widest, with an elongate brush 0.05 mm wide, 0.11 to 0.43 mm from base. Basal half not bowed. Genitalia with slender parameres, 0.17 × 0.03 mm, each bearing 3 terminal setae. The name refers to the bow-legged hind femora of females.

Specimens examined. Eastern Oklahoma to Florida. Holotype: female, Oklahoma: Latimer Co., VIII-85, K. Stephan/beating up-land forest. Allotype: male, same but May 1982. Holotype and allotype in USNM. Paratypes: Oklahoma: 2 males, 1 female, Latimer Co.; 1 female, Broken Bow, 13 June 1939, Kaiser-Neilon. Louisiana: 1 male, Catahoula Par., Sicily Island Hills W.M.A.; 1 female, Baton Rouge; 1 male, Feliciana Par., Tunica Hills W of Weyanoke. Florida: 1 male, Orange Co., Kelly Park Rock Springs; 1 male, Liberty Co., Torreya State Park; 1 female, Suwanee Co., 7 mi SE Branford (DENH, EGRC, FSCA, KSTC, LSUC, MCZC, UAIC, USNM).

Vanonus vigilans Casey
Fig. 6

Vanonus vigilans Casey 1895:795. [Described from "New York. Mr. H. H. Smith." Casey also (1905) gives it as "New York (Hudson Valley)." Holotype, male, in Casey Coll., USNM, labeled "N.Y. with an ink line under the N / Type USNM 36502 / vigilans Csy," examined.] Casey, 1905:162.

Diagnosis. Reddish brown to dark brown, head darker, usually dark brown, appendages paler, antennae with segment 2 paler than rest. Pronotum with a distinct broad antebasal transverse depression, weak across midline. Pubescence moderately sparse, elytral setae ca. 0.02 mm, decumbent, slightly curved and nearly touching surface at tip; interstitial setae just perceptibly shorter, from very sparse to almost as numerous as setae in different individuals. Separation of eyes 41%, length of antennae 164% of head width in male, 50% and 146% in female. Length 1.46, width 0.66 mm, elytra 1.11 (1.04–1.20) mm long.

Female (Tyngsboro, Massachusetts): eyes moderately broad, 0.22 × 0.18 mm, or 82% as wide as high, and protuberant (head 12% broader than prothorax). [In an associated male the eyes are slightly larger, 0.24 × 0.18 mm, 75% as wide as high, and the head is 28% broader than the prothorax.] Antennal segments 7–10 thickened. Hind femora 0.44 mm long with a pubescence-filled excavation on posterior side from 0.28 to 0.41, distinctly margined above and below, setae alone forming a flat triangle 0.05 mm high from 0.37 to 0.41, peaking at 0.41 (peak beyond apex of femur in some others), sloping at ca. 45 degrees to apex, the femur there ca. 0.16 mm wide, then dropping at close to 90 degrees.

Distribution. Quebec to Michigan and south to Alabama. Canada: Ontario: Hull.

Quebec: Berthierville, Parc Gatineau. U.S.A.: Alabama: Moody (St. Clair Co.). Arkansas: Waldron (Scott Co.). Connecticut: Cornwall. Maryland: Lloyds. Maine: Brewer, Paris. Massachusetts: Berkley, Dorchester, Fall River, Framingham, Lincoln, Natick, Sherborn, Tyngsboro. Michigan: Gladwin Co. New Hampshire: Wonalancet (Carroll Co.). New Jersey: Highlands. New York: Hudson Valley (Casey, 1895). Pennsylvania: (Nunenmacher Coll.). Virginia: Penington Gap (CNCI, CUIC, DENH, FMNH, FSCA, ICCM, MCZC, UAIC, USNM).

Vanonus wickhami Casey
Fig. 5

Vanonus wickhami Casey 1895:797. [Holotype, male, in Casey Coll., USNM, labeled "Bayfield, Wis., Wickham / Type USNM 36508 / wickhami Csy.," examined.] Casey, 1905:163. Israelson, 1971:110–112.

Tanilotes lacustris Casey 1895:799. [Holotype, female, in Casey Coll., USNM, labeled "Bayfield, Wis., Wickham / Type USNM 36509 / Tanilotes lacustris Csy.," examined.] Israelson, 1971:112 (*Vanonus*).

Diagnosis. Eyes unusually small, separated by ca. 60% of head width. The most notable differences from *vigilans* are the smaller eyes and the larger brush on the female hind femora. The eyes are narrower (0.22 × 0.14 mm or 64% as wide as high in female, against 82% as wide as high in *vigilans* female) and less protuberant (width across eyes 108% of width behind eyes against 112% in *vigilans* female; 106% against 122% in male). The difference in the eyes also shows up in width across eyes against width of prothorax (108% and 112% in females, 106% and 128% in males). Hind femora of female with posterior tooth in apical ¼, ending distinctly before apex of femur, and with some setae extending beyond apex of tooth. A female with hind femora 0.52 mm long has the brush from 0.37 to 0.46, with the peak at 0.44; femora 0.11 mm wide at base of brush, 0.17 at peak, including brush. Prothorax broadest at or behind middle. Separation of eyes 42%, length of antennae 158% of head width in male, 60% and 158% in female. Length 1.74, width 0.74 mm, elytra 1.39 (1.22–1.43) mm long.

Distribution. Southeastern Canada and adjacent States of the U.S.A. from Maine to Wisconsin. Canada: New Brunswick: Bathurst, Penobosquis. Nova Scotia: Cape Breton: Boisdale. Ontario: Arnprior, Carp, Trenton. Quebec: Ile de Montreal, Kazubazua, Laniel, Mt. Lyall—1,500′. U.S.A.: Maine: Dennistown, Mt. Katahdin. Michigan: Marquette. New Hampshire: Mt. Washington (Lake of the Clouds—5,000′). Wisconsin: Bayfield (Casey, 1895, *wickhami, lacustris*) (CNCI, MCZC, UAIC, USNM).

Calvescens-Group

Diagnosis. A single, relatively large, dark species, with sparse pubescence and distinctive strong microreticulation on head and elytra. Male with head strongly flattened on front, and with the separate parameres of the genitalia short and stout.

Vanonus calvescens Casey

Vanonus calvescens Casey 1895:793. [Described from "northeastern Wisconsin." Holotype: female, in Casey Coll., USNM, labeled "Wis. / Type USNM 36501 / calvescens Csy," examined.] Casey, 1905:162.

Diagnosis. Brown, head slightly darker, appendages paler. Head very strongly, elytra strongly microreticulate, pronotum smooth between distinct punctures; with moderately sparse short, appressed setae and no interstitial setae. Front of male head strongly flattened, even slightly concave, with thick vertex. Separation of eyes 42%, length of antennae 158% of head width in male, 53% and 156% in female. Length 2.31, width 0.96 mm, elytra 1.81 (1.50–1.81) mm long.

A female 2.31 mm long has head 0.39 long, 0.59 wide across eyes, 0.39 behind, the part behind eyes very short, 0.04 mm. Punctures 0.02 mm center to center; microreticulation lacking for a short distance on midline. Antennae moderately stout, 0.81 mm long, segment 10 0.07 × 0.07 mm; segments 1–5 distinctly microreticulate. Last segment of maxillary palpi an isosceles triangle, 0.19 mm across apex. Prothorax 0.48 mm long, 0.52 wide across base, 0.56 maximum, ca. 0.43 across apex, which lacks collar. Antebasal transverse depression weak. Elytra 0.70 mm wide at distinct humeri, 0.96 maximum; punctures 0.02 mm center to center, setae 0.04 mm, appressed, tactile setae suberect, 0.03.

Distribution. Quebec to Pennsylvania, west to Wisconsin. Canada: Quebec: Knowlton, Ste.-Foy. U.S.A. : Maine: Lincoln. New Hampshire: Carroll Co., The Bowl, 2.5 mi NW Monalancet; Mt. Washington. New York: Catskill Mts. Pennsylvania: Jeannette. Wisconsin: northeastern (Casey, 1895). Eight specimens seen, 3 males and 5 females, 5 taken in July, 1 in August (CCHC, CNCI, CUIC, DENH, ICCM, UAIC, USNM).

Piceus-Group

Diagnosis. Rather slender, sparsely pubescent dark beetles in which both sexes have an elongate brush of dense setae on the posterior side of the hind femora. Prothorax broadest in basal half, with a distinct antebasal transverse depression, its midpoint curved back into a blunt peak at middle of base. Very similar to Wickhami-Group but the male of the only known species differs in having the head strongly flattened on front; the female has a distinctive conformation of the femoral brush. The most striking difference, however, is that the male genitalia lack parameres. Assignment to *Vanonus* is therefore provisional.

Vanonus piceus (LeConte)

Figs. 50, 57

Xylophilus piceus LeConte 1855:276. [Described from "Middle and Southern States." Lectotype, new designation, female, in LeConte Coll., MCZC, labeled "pink disk / piceus 5." It is in a series headed by a female lacking hind legs and labeled "Louisian. / Type 4887 / X. piceus Lec." This designation restricts the type-locality to "Middle States."] ?Casey, 1895:794 (*Vanonus*).

Xilophilus [sic!] *tuberculifer* Hamilton 1893:279. [Lectotype, new designation, male, in Hamilton Coll., ICCM, labeled "Severn, Ont., tuberculifer / Carn. Mus. Acc. 519" and bearing my lectotype label, examined.] Casey, 1895:794, and 1905:162 (*Vanonus*), at least in part. **New synonymy.**

Vanonus fusciceps Casey 1905:163. [Holotype, female, in Casey Coll., USNM, labeled "N.Y., with an ink line under the Y / Type USNM 36504," examined.] **New synonymy.**

Vanonus congener Casey 1905:163. [Holotype, female, in Casey Coll., USNM, labeled "Bayfield, Wis., Wickham / Type USNM 36503," examined.] **New synonymy.**

Diagnosis. Brown, appendages tending toward reddish, head darker than body in paler individuals; shiny with sparse, fine appressed setae and interstitial setae on elytra, the latter about as numerous as the setae and equal in length; both kinds inconspicuous. Male with front of head almost completely flat from frontoclypeal suture to vertex, which is quite thin (Fig. 5). Front with evenly spaced, moderately dense, fine punctures and no obvious pubescence. Female head normal. Male antennae moderately slender. Separation of eyes 56%, length of antennae 181% of head width in male, 48% and 152% in female. Length 1.44, width 0.70 mm, elytra 1.07 (1.07–1.50) mm long.

Male hind femora with long brush as in males of the Wickhami-Group. Female hind femora with a similar brush of long setae from basal ⅕ to near apex, the setae gradually increasing in length from base to an obtuse peak at basal ⅓, gradually decreasing from there to apex (Fig. 57). Eyes slightly smaller and antennae heavier than in male.

Distribution. Ontario to Iowa, south to Florida and eastern Oklahoma. Canada: Ontario: Sparrow Lake (Hamilton, 1893, *tuberculifer*). U.S.A. : Alabama: Spades Mountain. Florida: Gainesville, Torreya State Park. Iowa: Keokuk. Maryland: College Park, Sparrows Point. Massachusetts: Framingham, Wayland. New Hampshire: 4 mi W Durham. New York: "near the city" (Casey, 1895, *fusciceps*). Oklahoma: Latimer Co. Pennsylvania: Allegheny, Jeannette, Pittsburg, St. Vincent. Virginia: Penington Gap. West Virginia: Guthrie. Wisconsin: Bayfield (Casey, 1895, *congener*) (DENH, FMNH, FSCA, ICCM, GHNC, MCZC, MCTC, PSKC, UAIC, USNM, WSCC, WVDA).

Uniformis-Group

Diagnosis. A single species in eastern North America, but additional undescribed species in the Southwest. Differs from other groups in having long and slender antennae, a shiny surface lacking interstitial setae, and pronotum lacking any indication of an antebasal transverse depression.

Vanonus uniformis, new species

Fig. 3

Diagnosis. Brown, elytral humeri obscurely paler, shiny, appendages light tan, middle and hind femora dusky. Separation of eyes 26%, length of antennae 200% of head width in male; female unknown. Length 1.63, width 0.78 mm, elytra 1.28 (1.13–1.28) mm long.

Description. Holotype, male: head 0.33 mm long, 0.50 wide across eyes, 0.31 just behind; eyes 0.28 × 0.22 mm, separated by 0.13 (26% of head width), overlapping hind margin of head. Front evenly convex, with distinct punctures and fine, appressed setae, the intervals smooth. Antennae long, all segments but second longer than wide. Last segment of labial palpi strongly transverse. Prothorax subquadrate, 0.35 mm long, 0.43 wide at base, sides nearly parallel to 0.28; moderately densely, distinctly punctured, without antebasal transverse depression. Elytra 0.59 mm wide across distinct humeri, 0.78 maximum. Surface very distinctly punctured, the punctures ca. 0.03 mm center to center in basal fourth, to ca. 0.02 mm and almost touching behind; intervals smooth and shiny; setae decumbent, ca. 0.04 mm, slightly curved and almost touching surface. Omoplates and postbasal transverse impression feeble. Hind femora 0.44 mm long, 0.06 wide at base to 0.12 maximum wide, with a brush 0.04 mm wide from apex of trochanter at 0.06 to 0.39. Female unknown.

Specimens examined. Florida to Arkansas. Holotype: male, Gainesville, Fla., VI-20-64, R. E. White, in FSCA. Paratypes: 1 male, Florida: Jackson Co., Florida Caverns St. Pk., 19-V-1983, E. G. Riley & D. A. Rider, Riley Coll. 1 male, Florida: Gainesville, R. E. Woodruff, 3-VIII-1971, at *Liquidambar styraciflua,* FSCA. 1 male, Alabama: Jefferson Co., Westview, VI-14-1974, T. King L. T., UMRM. 1 male, Arkansas: Newton Co., 9 mi W Jasper, 23.IX.1983, 1,000′, veg. nr. river, J. Pakaluk #204, SEMC (EGRC, FSCA, SEMC, USNM, WSCC).

Balteatus-Group

Diagnosis. A single species separated on the basis of contrasting markings on the elytra, in the moderately dense pubescence. Presence of the species at Brownsville, Texas may indicate a more tropical distribution than for the other groups.

Vanonus balteatus, new species

Fig. 4

Diagnosis. Bright tan with dark brown head and light brown midband on elytra, also sides of elytra from humeri to midband in one individual, in cuticle and moderately dense pubescence. Abdomen brownish in some. Hind femora with a strong, shiny black brush for most of the length. Separation of eyes 19%, length of antennae 168% of head width in male; female unknown. Length 1.93, width 0.85 mm, elytra 1.50 (1.35–1.70) mm long.

Description. Holotype, male: head 0.35 mm long, 0.57 wide across eyes, 0.31 just behind; eyes large, 0.31 × 0.23 mm, separated by 0.11, eyes to base of head 0.02 mm. Setae on eyes short and inconspicuous. Antennae 0.96 mm long, segment 11 0.09 thick. Prothorax 0.44 mm long, 0.47 wide, the sides subparallel but slightly sinuous, both front and hind angles nearly quadrate. Elytra 0.61 wide at points of humeri, 0.85 maximum, with brown band 0.59–0.93 mm from base behind humeri, 0.68–0.87 in middle, 0.70–1.02 near suture. Setae 0.05 mm, decumbent, interstitial setae almost equal, 0.04 mm, tactile setae erect, inconspicuous, 0.03 mm. Hind femur 0.52 mm long, with brush from 0.09 to 0.44, 0.06 mm wide, but with some pale setae on femur next to it that may also be part of brush. Last fully visible tergum and sternum with apex evenly rounded, not evenly beaded, pygidium small.

Specimens examined. Isolated localities from southern Texas to eastern Kansas. Holotype: male, Oklahoma: Marshall Co.: UOBS, Lake Texoma (Willis), 7.VII.1968, leg. W. Suter, at light, in FMNH. Paratypes: 1 male, same data but 3.VII.1968. 1 male, Brownsville, Texas, 12/10.1911, E. G. Smyth coll., Ser. No. 177. 1 sex?, Ft. Sam Houston, San Antonio, Texas, V-14-16-1945, light trap, D. E. Hardy. 1 male, Kansas: Douglas Co., Breidenthal Res., 2 mi N Baldwin, 2.IX.1983, UV light, J. Pakaluk (FMNH, SEMC, WSCC).

SUBFAMILY II

Diagnosis. Male genitalia without separate parameres. Interstitial setae present or absent. Hind femora either without a brush in either sex, with a very reduced posterior brush in both sexes, or with an extensive pad of modified "setae" in male only.

Subfamily II, Tribe 1

Diagnosis. Last visible sternum of female without a median pit. Hind femora either without a brush or with a very reduced brush in both sexes.

Aderus Westwood

Aderus Westwood 1830:58 (type-species: *Lytta Boleti* Marsham, =*Notoxus populneus* Panzer, by monotypy and original designation).

Phomalus Casey 1895:785 (type-species: *Xylophilus brunnipennis* LeConte, new designation). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:28. **New synonymy.**

Diagnosis. Unique in the Nearctic fauna in that antennal segment 3 is much shorter than segment 4, subequal to segment 2. Pubescence dense, the interstitial setae longitudinal. Hind femora without a brush in either sex. Widespread in the Palaearctic Region and other areas, including a few species in South America.

Discussion. Two species seen from south Texas are not included in the key. Both have dark heads and hind femora. One, a male from San Antonio, Bexar Co. (V-20-58, J. F. Lawrence, MCZC) is probably *Aderus saginatus* (Casey) [1895:787]—NEW COMBINATION—an abundant species in southwestern U.S.A. This species has the elytra entirely pale and the male antennae longer and heavier than in the female. The San Antonio specimen has antennae 220% as long as head width, comparable to males from Arizona.

The other species has a brown midband on the elytra. I am assigning it provisionally to *Aderus tantillus* (Champion)—[1890:190, pl. 8, fig. 28]—NEW COMBINATION. This species was described from a single male 1.5 mm long, from San Geronimo, Guatemala. The figure shows the same kind of brown band on the elytra, but both figure and description indicate pale hind femora. One Texas specimen, a male from Cameron Co. (Sabal Palm Grove Sanct., near Southmost, V-18-79, E. G. Riley, EGRC), is 1.55 mm long. The other, a female from San Patricio Co. (Weller Wildlife Ref., 8 mi NE of Sinton, 15 May 1985, Paul K. Lago, UMIS), is larger, 2.01 mm.

Key to Species

1. Hind femora contrastingly darker than others, darker than hind tibiae and often hind trochanters; other femora concolorous with rest of body or paler. Head dark. Strongly marked individuals with a brownish posthumeral zone on elytra, and a more extensive but paler zone in basal half that encloses oval pale lateral marks and less distinct pale marks on omoplates .... *Aderus brunnipennis*

– Hind femora pale, not darker than others or hind tibiae or trochanters. Head pale, brownish in the darkest individuals. Elytra of strongly marked individuals with pale brown pubescence in a W-shaped marking behind omoplates, in a broad postmedian band, and at apex, these markings inconspicuous at best .... *Aderus populneus*

Aderus brunnipennis (LeConte), **New Combination**

Figs. 10, 65

Xylophilus brunnipennis LeConte 1875:176. [Described from "S. Carolina, (Zimmermann); Illinois, (Walsh); Texas, (Belfrage)." Lectotype, new designation, in LeConte Coll., MCZC, labeled "S.C. / X. brunnipennis Zimm." LeConte apparently used a Zimmermann manuscript name and underlined Zimm. to indicate that he had used the specimen in his description.] Casey, 1895:786 (*Phomalus*). Not Hatch, 1965:129 (*Phomalus*).

Diagnosis. Tan to brown, head and hind femora very dark, sometimes almost black, prothorax nearly as dark, antennae and rest of legs pale. Pubescence dense, appressed, pale tan, with a gray and tan pattern on elytra, there tan to dark tan in postbasal transverse impression and along suture to base, often leaving an ill-defined pale spot on each omoplate and another longitudinally oval spot on side at basal ⅖. These are most noticeable in clean, dark specimens, lighted from front. Separation of eyes 26%, length of antennae 189% of head width in male, 38% and 190% in female. Length 1.87, width 0.84 mm, elytra 1.46 (1.24–1.54) mm long.

Distribution. Florida to eastern Texas, north to Pennsylvania and Kansas; Cuba in the West Indies. Alabama: Birmingham. Arkansas: Fulton Co., Jackson Co. District of Columbia: Washington. Florida: Archbold Biological Station, Collier Co., Dade Co., Daytona, Highlands Hammock, Indian River Co., Marion Co., Suwanee Co. Illinois: Fayette Co. Indiana: Bear Wallow, Evansville, Grantsburg, Indianapolis, Tippecanoe Co. Kansas: Lawrence. Kentucky: Perryville. Louisiana: Clinton, Sabine Parish. Maryland: Colesville, College Park. Missouri: Columbia, Creve Coeur Lake, Moberly, Raytown, Reynolds Co., St. Charles, St. Louis. North Carolina: Chapel Hill, Duke Forest. Ohio: Cincinnati. Oklahoma: Latimer Co., Pearson. Pennsylvania: Allegheny Co., Jeannette. Texas: Brownsville, Gonzales Co. (Palmetto State Park), Jefferson. West Virginia: Charleston, Guthrie. West Indies: Cuba: Guantanamo Bay (U.S. Naval Station), Soledad (near Cienfuegos) (CDAE, CNCI, CUIC, DENH, FMNH, FSCA, GHNC, ICCM, KSTC, LSUC, MCTC, MCZC, MUIC, SEMC, UAIC, UMRM, USNM, WSCC, WVDA).

Aderus populneus (Panzer)

Fig. 11

Notoxus populneus Panzer 1796:vol. 35, no. 4. [Described from Europe. Location of Panzer specimens unknown to author.] Baguena, 1948:277 (*Aderus*). Baguena and some other authors attribute the species to "Creutzer in Panzer."

Phomalus brunnipennis: Hatch 1965:129 (misidentification).

Diagnosis. Tan, head and abdomen slightly darker, palpi and legs paler. Pubescence dense, appressed, pale with obscure brownish pattern in elytral setae but not cuticle: a rough V-mark behind each omoplate, from 0.19 mm from base at sides, 0.20 near suture, 0.28 between, and back to 0.46; a band starting at 0.56 mm at sides, nearly transverse to middle, then offset backward to 0.70 from there to suture, its hind margin diagonal and extending back to 0.98; and a terminal zone from 1.39 mm to apex at 1.48. Separation of eyes 26%, length of antennae 259% of head width in male, 36% and 197% in female. Length 1.91, width 0.83 mm, elytra 1.48 (1.48–1.83) mm long.

Distribution. Quebec to British Columbia, south to Indiana and Iowa in East, northern Utah, and California on the Pacific Coast. Canada: British Columbia: Creston, Royal Oak (both from Hatch, 1965). Ontario: Ottawa, Pelee Island, Prince Edward Co. Quebec: West Brome. U.S.A. : California: Sacramento. Idaho: Nez Perce Co. (Juliaetta Falls). Illinois: Cornell. Indiana: Grantsburg, Tippecanoe Co., Vera. Iowa: Ames, Iowa City. New Hampshire: Lee. Ohio: Holgate. Oregon: Jackson Co. (Siskiyou Mts.), Lane Co., McMinnville (from Hatch, 1965). Utah: Logan. Washington: Whitman Co. Wisconsin: Milwaukee. The earliest North American records seen are Iowa City, Iowa (1934), Pelee Island, Ontario (1940), and Holgate, Ohio (1941) (CDAE, CNCI, DENH, FMNH, FSCA, MCZC, NMDC, UAIC, WSCC).

Emelinus Casey

Emelinus Casey, 1895:777 (type-species: *Xylophilus Melsheimeri* LeConte, new designation). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:36.

Diagnosis. Moderately slender, sparsely pubescent species, lacking interstitial setae. Color primarily in cuticle. Males with antennal segments 4–10 flabellate, and legs unmodified. Females differ from *Zonantes* females in that they lack a pit on the midline of the last visible abdominal sternum. Two additional species in the Southwest, others in the Neotropical Region.

Emelinus melsheimeri (LeConte)

Figs. 12, 13, 18

Xylophilus Melsheimeri LeConte 1855:275. [Described from "York county, Pennsylvania; Messrs. Melsheimer & Ziegler." Lectotype, new designation, male, in LeConte Coll., MCZC, labeled "pink disk / melsheimeri 2," examined.] Casey, 1895:778 (*Emelinus*). Werner, 1960:36 (*Emelinus*).

Emelinus ashmeadi Casey 1895:778. [Holotype, male, labeled "Tampa, Fla, 12.4 / Type USNM 36499 / subtropicus Csy," in Casey Coll., USNM, examined by D. S. Chandler.] **New synonymy.**

Diagnosis. Tan with zig-zag pattern of dark markings on elytra, mainly in cuticle. Separation of eyes 3%, length of antennae 249%, rami 155% of head width in male; 29% and 188% in female. The eyes of males are large and nearly contiguous in all southern specimens, smaller and more widely separated toward the northern edges of the range. A male from northern Illinois has the separation of the eyes 17% of head width. Length 2.20, width 0.84 mm, elytra 1.66 (1.50–1.90) mm long.

Distribution. Florida to northeastern Mexico and eastern Arizona, north in East to Illinois and Massachusetts. U.S.A. : Alabama: Chickasaw. Arizona: Chiricahua Mts. (Werner, 1960). Florida: Devil's Millhopper State Park, East Point, Gainesville, Highlands Hammock, Hillsboro River State Park, St. Nicholas (Casey, 1895, *ashmeadi*), Torreya State Park. Illinois: Clark Co., LaSalle Co. Indiana: Clarke Co., Eddyville, Marion Co., Tippecanoe Co. Louisiana: Jackson, Opelousas. Maryland: College Park, Great Falls of Potomac River, Greenbelt. Massachusetts: Tyngsboro. Missouri: Ashland, Columbia, Fulton, Moberly. New Jersey: Highlands. New York (state label). Ohio: Delaware Co., Franklin Co., Greene Co. Oklahoma: Latimer Co.

Pennsylvania: Allegheny, Castle Rock, Jeannette, Neversink, Pittsburg, York Co. (LeConte, 1855). South Carolina: Florence, Liberty Hill, Pineville, Summerville. Texas: Gillespie Co. West Virginia: McClintick Wildlife Sta. Mexico: San Luis Potosi: Tamazunchale (CDAE, CNCI, CUIC, EGRC, FMNH, FSCA, GHNC, ICCM, KSTC, MAIC, MCTC, MCZC, NMDC, OSUC, PSKC, SEMC, VMKC, UAIC, UMRM, WSCC, WVDA).

Cnopus Champion

Cnopus Champion 1893:460 (type-species: *Cnopus flohri* Champion, by monotypy). Casey, 1895:802. Pic, 1905:237, 245. Baguena, 1948:76.

Diagnosis. Small, delicate, sparsely pubescent species, lacking interstitial setae. Segment 1 of hind tarsi shorter than segments 2–4 combined. Basal third of pronotum with a conspicuous deep transverse depression, moderately sharply defined, deeper laterally. Males with longer antennae than females, otherwise barely distinguishable. Additional species in the Southwest, and at least one species in the desert region of northern Argentina. Both sexes may be frequent at light.

Cnopus impressus (LeConte)
Fig. 14

Xylophilus impressus LeConte 1875:175. [Described from "Texas, Belfrage." Gustav Wilhelm Belfrage collected in eastern Texas, and lived longest at Waco. Lectotype, new designation, female in LeConte Coll., MCZC, labeled "Tex. / X. impressus Lec., with "Lec." underlined / Type 4888," examined.] Casey, 1895:803 (*Cnopus*).

Diagnosis. Head dark brown, prothorax and appendages pale, rest reddish brown; varying through prothorax no paler than elytra to all dark brown with reddish appendages. Separation of eyes 43%, length of antennae 186% of head width in male, 48% and 150% in female. Length 1.19, width 0.54 mm, elytra 0.85 (0.74–1.11) mm long.

Distribution. Florida to eastern Texas, north to Missouri. Alabama: LeRoy, Walker Co. Arkansas: Fulton Co., Polk Co. Florida: Camp Mahachee, Gainesville, Homestead, Monroe Co. (Upper Key Largo), Rainbow Springs, Torreya State Park. Louisiana: Baton Rouge, Natchitoches Parish. Missouri: Boone Co., Moberly. Mississippi: Jackson Co. (Gulf Islands National Seashore), Tishomingo Co. Oklahoma: Latimer Co. Texas: (LeConte, 1875) (CNCI, CUIC, DENH, EGRC, FSCA, KSTC, LSUC, MCTC, MCZC, MUIC, UAIC, WSCC).

Axylophilus Casey

Axylophilus Casey 1895:808 (type-species: *Axylophilus yuccae* Casey, by monotypy).

Diagnosis. Despite its unusual features, this genus is properly placed in the family Aderidae. The tarsal formula is 5-5-4; the antepenultimate segment of each tarsus is lobed; and the first two exposed abdominal sterna are fused (Fig. 54). The conformation of the head and mouthparts (Fig. 49) is different from any seen in any other Aderidae.

The whole base of the head, from vertex laterally to the genae, is apparently a thin lamina that abuts the front of the pronotum almost perfectly. The whole frons is swollen from the deeply emarginate eyes and bases of the antennae to the deep frontoclypeal suture, 0.21 mm wide, ca. 0.13 mm long. Lateral to the frons there is a narrow elevated strip from front of eye to base of mandible. The clypeus is small and flat, 0.07 mm long, 0.09 wide, and the labrum quite normal, 0.05 mm long, 0.08 mm wide, with a slight notch at the middle. The mandibles are extraordinary, and certainly do not look like mandibles in Figure 4. The whole front face is a plate and the combined mandibles form a slightly bulged plate 0.17 mm wide, 0.07 mm long, its side margins thin and almost evenly curved. Not visible in Figure 4 but evident in a slide preparation is the fact that the mandibles meet in a straight line down the middle of this plate, each of them having about 8 tiny teeth in this location. The other mouthparts seem more or less normal, but are difficult to see in the available specimen. The last segment of the maxillary palpi is in the form of an almost perfectly isosceles triangle with apex at attachment, and the last segment of the labial palpi is very small, almost circular.

Axylophilus yuccae Casey
Figs. 49, 54

Axylophilus yuccae Casey 1895:809. [Lectotype, new designation, male, labeled "Crescent City Fla (10 3 on underside) / nov. gen. Chamacropis S3+ / Type USNM 36494 / Axylophilus yuccae Csy," in Casey Coll., USNM, examined.]

Diagnosis. Shiny, moderately deeply punctured, with short appressed primary setae, no interstitial setae, brown with dull yellow marking dorsally. Lectotype male: length 1.04, width 0.57 mm, 0.49 mm thick at metasternum, elytra 0.78 (0.76–0.78) mm long. Head and pronotum dull yellow; scutellum brown; elytra brown with dull yellow markings at base to 0.07 mm at humeri, 0.17 near suture; in an interrupted midband 0.22 to 0.35; and interrupted subapical band, 0.56 to 0.65; pale markings not reaching side margins. Appendages yellow, the femora brownish across middle. Antennae slender, 0.63 mm long. Antennae arising near edge of deep excavation of eyes. Middle lobe of eyes 0.06 mm wide, narrowest part at back 0.04. Length of antennae 189%, separation of eyes 21% of head width. Last visible sternum not modified, with evenly curved apex. Aedeagus slender and straight-sided, protruding part 0.26 mm long, 0.05 wide; a slender structure, almost as long as aedeagus and apparently sclerotized, protruding from its apex.

Distribution. Known only from specimens collected on the east coast of Florida by Hubbard and Schwarz: Palm Beach Co. (Cape Jupiter, 10 May) and Putnam Co. (Crescent City, 24 April). Casey (1895) indicates that they were abundant on plants of a species of *Yucca* (FSCA, USNM). Lectotype and 2 specimens in FSCA seen.

Ariotus Casey

Ariotus Casey 1895:788 (type-species: *Xylophilus quercicola* Schwarz, new designation). Pic, 1905:235 (subgenus of *Hylophilus*).

Scanylus Casey 1895:800 (type-species: *Scanylus pruinosus* Casey, =*Hylophilus caseyi* Pic, by original designation). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:96. **New synonymy.**

Diagnosis. As here redefined, *Ariotus* is unique in the Nearctic fauna in having a single row of short, erect setae on the hind margin of the hind femora. The brush may be limited to the basal third or extend as far as the apex; it is usually more strongly developed in the male. The brush found on the hind femora of other genera is always more than one seta thick. Another distinctive feature is the shape of the prothorax, which tends to be broadest and slightly angular near the front and slightly constricted at the middle of the sides, with weak depressions onto the disc from the constriction (Fig. 22). Pubescence moderately dense, appressed. Probably a largely Neotropical genus. One described and several undescribed species in the southwestern U.S.A.

Key to Species

1. Uniformly light to dark brown, without any darker markings. Brush on hind femora nearly complete in both sexes, with a slight break at basal third. (Fig. 63) .... *Ariotus luteolus*

– Elytra pale with brown markings in both cuticle and pubescence. Brush on hind femora of variable length, not interrupted at basal third 2

2(1). Antennae pale with segment 11 contrastingly darker. Elytra with dark markings at base, middle and apex. Male sternum 8 with only a V-shaped excision .... *Ariotus quercicola*

– Antennal segment 11 not contrastingly darker than rest. Elytra dark across midzone, sometimes on omoplates. Male sternum 8 bilobed, the lobes flat, pubescent on front face .... *Ariotus subtropicus*

Ariotus luteolus (Casey), **New Combination**

Fig. 63

Scanylus luteolus Casey 1895:801. [Holotype, male, labeled "[Ente]rprise Fla 22 / Type USNM 36512 / luteolus Csy" in Casey Coll., USNM, examined.]

Diagnosis. Moderately slender, light to dark brown, antennae, palpi and legs paler. Moderately shiny, with evenly distributed small punctures, deep and round-bottomed, becoming less distinct behind middle of elytra. Both primary and interstitial setae fine and appressed, uniformly dark. Head longer behind eyes than usual, its base truncate and covering prothoracic collar. The row of short setae on the hind femora extends almost the whole length, with a break in the series at basal ⅓. In the male this seems to mark two series, the proximal short and of even length, the distal longer, directed more dorsad, and of a more golden hue. The setae in the female are of almost uniform length and color. Trochanters and tibiae not modified in either sex. Separation of eyes 46%, length of antennae 192% of head width in male, 48% and 212% in female. Length 1.81, width 0.76 mm, elytra 1.37 (1.35–1.44) mm long.

Distribution. Florida to eastern Oklahoma, north to New York and Wisconsin. Alabama: Sheffield. Arkansas: Montgomery Co., Waldron. District of Columbia (Ulke Coll.). Florida: Lake Monroe (Casey, 1895), Tall Timbers. Indiana: Tippecanoe Co. Missouri: Steelville. New York (Ulke Coll.). Oklahoma: Latimer Co. Pennsylvania: Pittsburg. Virginia: Penington Gap. Wisconsin: Cedar Lake (DENH, FSCA, ICCM, KSTC, MCZC, UAIC, USNM).

Ariotus quercicola (Schwarz)
Figs. 20, 21, 23

Xylophilus quercicola Schwarz 1878:371. [Lectotype, new designation, male, labeled "Tampa, Fla 9.4 / Coll. Hubbard & Schwarz / Type! Schwarz / Type No. 4533 U.S.N.M.," examined by D. S. Chandler.] Casey, 1895:788 (*Ariotus*).

Diagnosis. Moderately slender, shiny; head brown, prothorax slightly paler, elytra dull yellowish with extensive brown markings; in a specimen with elytra 1.30 mm long they are brown; in adscutellar area to 0.22 mm and almost to humeri, weakly along suture to midband (0.46–0.74 mm), which is narrowly divided from behind at suture and narrowed midway between suture and sides; and broadly at apex (1.11–1.30 mm), with a narrow anterior projection along suture to 0.83 mm from base. Appendages dull yellowish except for antennal segment 11 and all but bases of femora, which are brown. Ventral part of thorax bright reddish brown, abdomen brown. Eyes moderately large, 0.19 × 0.15 mm in male. Separation of eyes 48%, length of antennae 183% of head width in male, 52% and 168% in female. Length 1.78, width 0.67 mm, elytra 1.30 (1.30–1.43) mm long.

Male hind trochanters with a tuft of setae 0.03 mm long and less than 0.02 thick, from near middle; hind femora 0.52 mm long, with a brush of setae ca. 0.01 mm long along hind margin, from apex of trochanter at 0.07 mm from base to 0.37 from base, and with an erect tuft of a few 0.02 mm setae at 0.26 mm from base and dorsal to row; middle trochanters with a slightly angular bulge; dorsal part of apex of hind tibiae projecting flatly by ca. 0.04 mm.

Female hind legs different. In a female with hind femora 0.57 mm long there is an extremely narrow brush from apex of trochanter at 0.07 mm to 0.20 mm from base; the hind tibiae have a thin, flat plate 0.09 mm long and 0.04 wide, its apex slightly oblique and pointed posteriorly, on dorsal side of apex; this plate seems to be cuticular.

Distribution. Known only from Florida: Alligator Point (Franklin Co.), Gainesville, Hillsboro (Casey, 1895), Jena (Dixie Co.), Orlando, Tampa (Schwarz, 1878) (DENH, EGRC, FSCA, ICCM, MCZC, USNM).

Ariotus subtropicus Casey
Figs. 19, 22

Ariotus subtropicus Casey 1895:789. [Holotype, female?, labeled "Tampa Fla, 12.4 / Type USNM 36499 / subtropicus Csy" in Casey Coll., USNM, examined by D. S. Chandler.]

Diagnosis. Moderately slender; bright tan, head brown and elytra with a slightly postmedian brown band, interrupted at suture and weakened at sides. Eyes large, 0.33 × 0.19 mm in male. Separation of eyes 33%, length of antennae 166% of head width in male, 35 and 169% in female. Length 1.83, width 0.70 mm, elytra 1.35 (1.35–1.54) mm long.

A male with hind femora 0.52 mm long has a narrow brush from 0.07 mm at end of trochanter to 0.28 mm from base; simple front and middle trochanters, and hind tibiae with apex just slightly produced. In the female there is an apical plate on the hind tibiae, much as in *quercicola* but much smaller, 0.05 × 0.04 mm, and a brush on the hind femora as long as in the male but very feeble.

Distribution. Florida, coastal Mississippi, and a state label specimen from Maryland. Florida: Alachua Co., Bradford Co., Putnam Co. (Red Water Lake), Winter Park, Tampa (Casey, 1895). Maryland (Ulke Coll.). Mississippi: Lucedale (CNCI, CUIC, FMNH, FSCA, ICCM, UAIC, USNM).

Pseudariotus Casey

Pseudariotus Casey 1895:790 (type-species: *Pseudariotus amicus* Casey, =*Xylophilus notatus* LeConte, new designation). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:28 (subgenus of *Syzeton*).

Diagnosis. Species with an elongate pit containing inconspicuous short, erect setae, on ventral surface of hind margin of hind femora of both sexes. Relatively broad, sparsely pubescent, the cuticle rather translucent and thin. A single species in the Nearctic fauna. Pic (1905) assigned some Neotropical species to *Pseudariotus,* but the placement cannot be verified from the descriptions. Specimens assignable to the genus seen from Mexico and the West Indies.

Pseudariotus notatus (LeConte)

Figs. 15–17, 55

Xylophilus notatus LeConte 1855:276. [Holotype: male, in LeConte Coll., MCZC, labeled "orange disk / Type 4883 / Xylophilus notatus Lec., Ga.," examined.] Casey, 1895:791 (*Pseudariotus*).

Pseudariotus amicus Casey 1895:791. [Holotype, female, labeled "Biscayne, Fla 16.5 / Type USNM 36500 / Pseudariotus amicus Casey," examined by D. S. Chandler.] **New synonymy.**

Diagnosis. Shiny, moderately sparsely punctured and pubescent, brown with all appendages paler, a vague lateral zone in postbasal transverse impression and an interrupted postmedian band on elytra yellowish. Some specimens have the pale elytral markings less extensive. Pronotum with a shallow depressed zone before base and another nearly straight zone from side to side at middle, connecting feeble midlateral notches. These depressions have distinct punctures, lacking on their borders. Separation of eyes 37%, length of antennae 167% of head width in male, 42% and 171% in female. Last segment of labial palpi very transverse, 0.05 mm long, 0.15 wide, attached at about the middle. Length 1.46, width 0.73 mm, elytra 1.20 (1.20–1.22) mm long.

Male with first 2 segments of front tarsi swollen and modified (Fig. 55). A male with hind femora 0.44 mm long, 0.15 wide has a pit 0.02 mm wide from 0.11 to 0.30 mm from base, 0.02 mm from hind margin and parallel to it. The pit is inconspicuous because it is filled with setae that match the surface setae. The pit is essentially identical in the female.

Distribution. Florida to eastern Oklahoma, north to the District of Columbia. District of Columbia: Washington. Florida: Biscayne Bay (Casey, 1895, *amicus*), Crystal Beach, Hose Sound, Micanopy, Old Town, Torreya State Park. Georgia: Habersham Co. (LeConte, 1855). Louisiana: Baton Rouge. Oklahoma: Latimer Co.

Few specimens have been collected (CNCI, EGRC, FSCA, ICCM, KSTC, MCTC, MCZC, PSKC, UAIC, USNM).

Subfamily II, Tribe 2

Diagnosis. Female with pit on midline of last visible sternum. Hind femora either without a brush or with a very extensive pad made up of thick-based, erect, curved "setae," covering most of underside. Interstitial setae present or absent. Two genera, both widespread in the Neotropical Region.

Zonantes Casey

Zonantes Casey 1895:779 (type-species: *Xylophilus subfasciatus* Leconte, new designation). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:161 (subgenus of *Syzeton*).

Diagnosis. Shiny, often fairly broad species, usually pale with contrasting dark markings in cuticle, bearing sparse setae and no interstitial setae. Male front tibiae at least gently curved and excavated on inside of apical fourth (angularly so in Fasciatus-Group) and terminating in a short spine at inner apex; front trochanters usually bearing a spine; antennae usually longer and more slender than in female; hind femora never with a brush or zone of plush-like pubescence. Female with a small, seta-filled pit on midline of basal half of last visible sternum and usually with small spines directed down from apex of last visible tergum and up from apex of last visible sternum. Female legs unmodified, except for a swelling and apical brush on segment 1 of hind tarsi in *Z. ater.* Well represented in Mexico and Central America, with additional species in at least northern South America.

Key to Species

1.	Anterior tibiae angularly bowed (male of some species, Fig. 62)	2
–	Anterior tibiae straight or evenly curved	4
2(1).	Posterior femora abruptly expanded dorsally from near middle to apex (Fig. 46). See couplet 7 for markings	male *Zonantes fasciatus*
–	Posterior femora not so expanded	3
3(2).	Elytra with brown adscutellar zone and broad median band, sometimes broken into 2 blotches on each elytron (Figs. 25–27)	male *Zonantes hubbardi*
–	Elytra all pale across base, dark in a weak, almost transverse postmedian mark, interrupted at suture (Fig. 32)	male *Zonantes ouachitanus*
4(1).	Elytra and whole body brown	5
–	Elytra all pale or pale with dark markings	6
5(4).	Eyes deeply excised. First segment of female hind tarsi with an oblique apical brush (Fig. 52)	*Zonantes ater*
–	Eyes shallowly excised. First segment of female hind tarsi simple	*Zonantes mississippiensis*
6(4).	Elytra with broad midband not interrupted at suture	7
–	Elytra with at most a midband that is interrupted at suture, or with dark blotches or spots in midzone, to entirely pale	8
7(6).	Midband very broad, its posterior margin not cut into two lobes on each elytron (Fig. 24), often continuing forward along suture and merging with broad adscutellar	

zone and scutellum. Last visible abdominal tergum with 3–4 evenly spaced laminar teeth on underside of middle of apex .... female *Zonantes fasciatus*

– Midband moderately broad, its posterior edge cut into 2 lobes on each elytron, the lateral lobe shorter, often isolated from quadrate dark adscutellar zone and scutellum (Fig. 27). Last visible tergum with 4 ventral laminar teeth on apex, with gap in middle greater than separation of lateral pairs .... heavily-marked female *Zonantes hubbardi*

8(6). With at least some dark marking at base of elytra 9

– Whole base of elytra and scutellum pale 11

9(8). Dark marking at base of elytra a small spot centered midway between the pale scutellum and the humerus of each elytron; midzone of each elytron with a pair of sharply demarcated dark spots, the lateral the more anterior (Fig. 38) .... some *Zonantes signatus*

– Adscutellar area, and usually scutellum dark. Midzone with a dark band, interrupted at suture, the midband sometimes reduced to 2 blotches on each elytron 10

10(9). Midzone of elytra with a pair of narrow diagonal dashes, nearly touching at suture at apical ⅔–¾, their mesal margins directed toward the humeri, with a ca. 30 degree angle between them (Figs. 30, 31). Palest individuals have the dashes connected to the side margin by a dark band from the anterior portion, and have the adscutellar area only vaguely darkened. Darkest individuals with dark elytral markings: sides from middle markings almost to humeri; adscutellar zone and scutellum; an oval to elongate mark in shallow depression posterolateral to omoplates, aligned between dashes and humeri; and sutural cloud behind dashes. Last tergum of female with small ventral teeth all across apex .... most *Zonantes nubifer*

– Midzone of elytra with a similar pair of narrow dashes, but these less diagonal, the two separated by <10 degrees and the mesal edges oriented toward middle of base (Fig. 25). These may be connected to a lateral dark mark from near the front, and the lateral mark to the margin, but sides not dark much anterior to level of front of dashes. Pronotum usually pale with a pair of dark blotches. Scutellum pale, often flanked by dark spots. Last tergum as described in couplet 7 .... some female *Zonantes hubbardi*

11(8). Pronotum with a pair of dark blotches. Markings otherwise as in couplet 10 ... . a few female *Zonantes hubbardi*

– Pronotum entirely pale 12

12(11). Moderately slender. Rare species and rare variants of commoner species 13

– Relatively stout species, much more abundant 14

13(12). Dark midband weak, transverse, slightly postmedian, and vaguely interrupted at suture (Fig. 32) .... female *Zonantes ouachitanus*

– Dark midband usually broken into 2 blotches on each elytron, separated at suture by pale zone only slightly wider in front. See couplet 10 .... a very few female *Zonantes hubbardi*

– Dark midband, sometimes broken into 2 blotches on each elytron, divided at suture by 30 degree triangular zone. See couplet 10 ... a very few *Zonantes nubifer*

14(12). Each elytron with 2 small, nearly circular isolated dark spots in midzone, the lateral one the more anterior (Fig. 37). Female with apex of last exposed tergum evenly curved (Fig. 39). Male tegmen moderately slender, tapered to a slender apex .... most *Zonantes signatus*

– Elytra with dark blotches or a band across midzone, varying to all pale but not with small, isolated round spots 15

15(14). Lateral part of dark elytral markings centering slightly posterior to middle of elytron, marking angled backward toward suture, not divided into blotches, but often evanescent, sometimes absent (Figs. 33, 34). Head pale to reddish. Eyes unusually small. Female with apex of last exposed tergum evenly curved (Fig. 40). Male tegmen moderately broad, tapered to a slender point ...... *Zonantes pallidus*

– Lateral part of dark elytral markings centering very close to midpoint of elytron. Head usually brownish or darker 16

16(15). Band on elytra consisting of two, usually broadly connected, blotches on each elytron, the one nearer the suture centering slightly anterior to the one nearer the side (Figs. 28, 29). Head usually dark brown. Female with apex of last exposed tergum excavated, bearing moderately strong ventral spines (Fig. 41). Male tegmen slender. Widespread and common .... *Zonantes subfasciatus*

– Band on elytra with lateral blotch centering slightly anterior to one nearer the suture, the blotches almost always separate (Figs. 35, 36). Head slightly darkened but not dark brown. Female with apex of last tergum excavated, bearing strong ventral spines (Fig. 42). Male tegmen spearhead-shaped, with a ventral keel. Florida .... *Zonantes floridanus*

Subfasciatus-Group

Diagnosis. Small, rather stout pale species with pale elytra that usually have a band or 4 dark spots in midzone (tiny dark spot also in middle of base in some *signatus*). Male with front tibiae gently bowed and front trochanters bearing a small spine. The 4 known species are easily distinguishable when the dark markings of the elytra are well developed. The tip of the abdomen of the female and the tegmen of the male aedeagus appear to provide reliable characters that can be used for identification of paler individuals.

Zonantes subfasciatus (LeConte)

Figs. 28, 29, 41

Xylophilus signatus: LeConte, 1855:276, in part; not Haldeman.

Xylophilus subfasciatus LeConte 1875:176. [Described from "Middle, Southern and Western States." Lectotype, new designation, female, in LeConte Coll., MCZC, labeled "pink disk / X. subfasciatus Zimm., with Zimm. underlined. This designation restricts the type-locality to "Middle States."] Casey, 1895:782 (*Zonantes*).

Diagnosis. Moderately robust, pale but head usually dark, even brown; elytra pale, including base, with a slightly antemedian brown band, interrupted at suture. When this band is broken into 2 spots on each elytron, these are almost always elongate and the lateral one lies slightly behind the median one. Underside pale, hind femora dusky in dark individuals. Separation of eyes 25%, length of antennae 171% of head width in male, 35% and 162% in female. Length 1.50, width 0.79 mm, elytra 1.21 (1.21–1.35) mm long.

Female with apex of tergum 7 excavated, with moderately strong ventral teeth in excavation; apex of sternum 7 evenly curved, with many small dorsal teeth all across and a larger submedian pair. Male front trochanters with a nearly rectangular angulation, ending in a sharp point; tegmen of aedeagus slender.

Distribution. Almost always the most abundant aderid in its range, from Florida to eastern Texas and Oklahoma, north to New Hampshire and Wisconsin. Alabama: Mobile Co. Arkansas: Fulton Co., Logan Co., Montgomery Co., Newton Co., Polk Co., Scott Co., Washington Co. Delaware: Long Neck. District of Columbia: Washington. Florida: Alachua Co., Collier Co., Dunedin, Florida Caverns, Gainesville, Indian River Co., Okaloosa Co., Suwanee Co., Torreya State Park, Walton Co. Georgia: Chatooga Co., Forsyth, Okefenokee Swamp, Tybee Island. Illinois (Ulke Coll.). Indiana: Columbus, Tippecanoe Co. Kentucky: Knox Co., Morehead, Trigg Co. Louisiana: Baton Rouge, Caddo Parish, Feliciana Parish, Opelousas. Maryland: Cabin John, College Park. Massachusetts: Framingham, Hopkinton, Martha's Vineyard, Nashawena Island, Northboro, Sherborn, Tyngsboro. Mississippi: Hancock Co., Louisville, Oktibbeha Co., Richton, Stoneville. Missouri: Columbia, Gasconade Co., Moberly, Portageville, Randolph Co., St. Louis. New Hampshire: Durham. New Jersey: Highlands, Suffolk Co. New York: Bear Mountain, Elbridge, Groton, Long Island (Riverhead, Sea Cliff). North Carolina: Asheville, Balsam, Chapel Hill, Durham, Edgecombe Co., Lake Waccaman, Polloksville. Ohio: Fairfield Co., Greene Co., Hocking Co., Marietta, Pike Co., Scioto Co., Seneca Co., Sugar Grove. Oklahoma: Latimer Co. Pennsylvania: Allegheny, Jeannette, St. Martins. Rhode Island (Casey, 1895). South Carolina: Charleston, McClellanville, Myrtle Beach, Poinsett Beach. Tennessee: Burrville. Texas: Jasper Co. Virginia: Fredericksburg, Hampton, Munden. West Virginia: Guthrie, Mercer Co., Pineville. Wisconsin: Bayfield. (In all collections.)

Zonantes pallidus, new species

Figs. 33, 34, 40

Diagnosis. Similar to *subfasciatus* but pale, the head at most reddish tan, and with a slightly postmedian, continuous, oblique, narrow dark band on elytra in most individuals, the lateral part of the band the more anterior; eyes smaller than in other species of group. Separation of eyes 41%, length of antennae 178% of head width in male, 50% and 158% in female. Length 1.65, width 0.81 mm, elytra 1.37 (1.21–1.37) mm long.

Female with apex of tergum 7 evenly curved, with small but visible ventral teeth all across; apex of sternum 7 evenly curved and with many small dorsal teeth all across. Male front trochanters bearing a small, slender spine; tegmen of aedeagus moderately broad, tapered to a slender apex.

Description. Holotype: male, 1.65 mm long with head deflexed. Head 0.37 mm long, 0.50 wide across eyes, 0.43 just behind, base behind eyes 0.11 long. Eyes moderately small, 0.26 × 0.17 mm, separated by 0.20. Antennae 0.93 mm long, segment 11 0.07 wide. Prothorax 0.39 mm long, 0.50 wide. Elytra 1.37 mm long, 0.61 wide at points of humeri, 0.81 maximum, the dark band on each at 0.56 to 0.72 mm from base on sides, 0.69 to 0.78 near suture. Setae and tactile setae 0.09 mm long. Of the 28 Latimer Co., Oklahoma individuals, 15 males and 4 females have the elytral band distinct, 4 males and 4 females have it visible but faint, and 1 female has no markings. The head is more reddish in individuals with darker bands. The elytra range from 1.21 to 1.37 mm long in the Oklahoma series, similar to *subfasciatus.*

Specimens examined. Eastern Oklahoma and Texas to Florida, north to Ontario and Quebec. Holotype: male, Oklahoma: Latimer Co., 5 mi W Red Oak, VIII-85, Karl H. Stephan/beating low-land forest, in USNM. Paratypes: 27, Latimer Co., Oklahoma. Not designated as paratypes: U.S.A. : Alabama: Mobile Bay (Mobile Co.). Florida: Archbold Biol. Sta. (Highlands Co.), Pt. Orange, Sanford, Tallahassee. Louisiana: Central (E Baton Rouge Par.), Jackson (W Feliciana Par.), St. Tammany Par. Massachusetts: Belchertown, Marion, Martha's Vineyard, Lowell, Natick, Sherborn, Tewksbury, Tyngsboro. Mississippi: Lucedale. Missouri: Ashland Wildlife Refuge (Boone Co.). New Hampshire: Antrim, Durham, Wonalancet (Carroll Co.). Oklahoma: Ada, Hoxbar (Carter Co.), Willis (Marshall Co.). South Carolina: Florence. Texas: Bastrop Co. (Buescher State Park). West Virginia: White Sulphur. Wisconsin: Dane Co. Canada: Ontario: Bark Lake (Renfrew Co.). Quebec: Windsor (CNCI, CUIC, EGRC, DENH, FMNH, FSCA, GHNC, ICCM, KSTC, LSUC, MCZC, NMDC, SEMC, UAIC, USNM, VMKC, WSCC).

Rarest member of the Subfasciatus-Group in Latimer Co., Oklahoma but occurs with *subfasciatus* and *signatus* and peaks with them in April/May and August. Apparently not abundant anywhere in its range.

Zonantes floridanus, new species
Figs. 35, 36, 42

Diagnosis. Similar to *subfasciatus* but pale (head sometimes slightly brownish), and with a pair of moderately small dark spots in midzone of elytra, the lateral spot the more anterior. Separation of eyes 24%, length of antennae 183% of head width in male, 38% and 148% in female. Length 1.63, width 0.85 mm, elytra 1.33 (1.20–1.33) mm long.

Female with apex of tergum 7 strongly excavated, with several strong teeth in excavation and a transverse row of about 5 small ventral teeth anterior to them; apex of sternum 7 with several small and 2 longer submedian dorsal teeth in midzone. Male front trochanters nearly rectangularly produced, the projection ending in a sharp point; tegmen of aedeagus spearhead-shaped with a ventral keel.

Description. Holotype: male, 1.63 mm long with head deflexed, elytra 1.33 long. Head 0.35 mm long, 0.54 wide across eyes, 0.43 just behind, base behind eyes 0.05 mm long. Eyes moderately large, 0.26 × 0.22 mm, separated by 0.13. Antennae 0.98 mm long, segment 11 0.08 wide. Prothorax 0.37 mm long, 0.48 wide. Elytra 1.33 mm long, 0.63 wide at points of humeri, 0.85 maximum. The lateral dark spot extends 0.43–0.69 mm from base, 0.30–0.41 from suture; the median spot 0.52–0.74 from base, 0.07–0.19 from suture. Setae and tactile setae 0.09 mm long.

Specimens examined. Known only from Florida. Holotype: male, Florida: Dade County, Camp Mahachee, nr. Matheson Hammock, 27-IV-1983, M. C. Thomas & L. Parker, blacklight trap, in FSCA. Paratypes: 6 males, 8 females, same data, from 5-V to 14-IX-1983. Not designated as paratypes: Florida: Alachua Co. (Gainesville), Dade Co. (Everglades Nat. Park, Castellon Hammock), Duval Co. (Jacksonville), Marion Co. (Ocala), Pinellas Co. (Dunedin), Pt. Orange, Steinhatchee R., Tampa (BMNH, CNCI, CUIC, FSCA, MCTC, MCZC, UAIC, USNM).

Discussion. Apparently largely nocturnal; of the 35 specimens seen, 18 were taken in a blacklight trap, 1 at light, and 1 female on *Flavoria linearis* in Everglades National Park.

Zonantes signatus (Haldeman)
Figs. 37–39

Euglenes signatus Haldeman 1848:97. [Described from "New York, Carolina." Lectotype, new designation, female, in LeConte Coll., MCZC, labeled "orange disk /

3221 / MCZ Type 8388," examined. Since the orange disk indicates "Southern States," the designation restricts the type-locality to "Carolina."] LeConte, 1855: 276, in part (*Xylophilus*). Casey, 1895:781 (*Zonantes*).

Diagnosis. All pale, including head; elytra with small, sharply defined, longitudinally oval dark brown spots in midzone, the anterior one sublateral and barely postmedian, the other near the suture and ca. 45 degrees back from the other. Heavily marked individuals have a similar spot in the middle of the base of each elytron. Separation of eyes 25%, length of antennae 171% of head width in male, 35% and 162% in female. Length 1.79, width 0.91 mm, elytra 1.46 (1.28–1.46) mm long.

Female with apex of tergum 7 evenly curved, with very tiny ventral teeth all across; apex of sternum 7 evenly curved, apparently without dorsal teeth. Male front trochanters with a barely visible spine; tegmen of aedeagus moderately slender, tapered to a slender apex.

Distribution. Florida to eastern Oklahoma, north to North Carolina and Missouri. Florida: Gainesville, Ocala, Okaloosa Co., Suwanee River State Park, Torreya State Park, Volusia Co., Washington Co. Louisiana: Natchatoches Parish. Missouri: Steelville. Mississippi: Marshall Co. North Carolina: Barnesville, Edgecombe Co. Oklahoma: Latimer Co. South Carolina: Dorchester Co., Florence, Myrtle Beach, Poinsett State Park (CNCI, EGRC, FSCA, GHNC, KSTC, LSUC, MCTC, MCZC, UAIC, VMKC).

Nubifer-Group

Diagnosis. One moderately slender species, with male front tibiae gently bowed as in Subfasciatus-Group, but with a long spine on male front trochanters, and almost always with some dark markings on the base of the elytra in addition to a midzone band.

Zonantes nubifer (LeConte)
Figs. 30, 31

Xylophilus nubifer LeConte 1878:425. [Holotype, female, in LeConte Coll., MCZC, labeled "Enterprise, Fla., 15.6 / 1673 / Type 4882 / X. nubifer Lec., with Lec. underlined," examined.] Casey, 1895:780 (*Zonantes*).

Diagnosis. Moderately elongate, usually dark brown and contrastingly pale marked. Antennae, palpi, tarsi and front and middle tibiae pale. Elytra yellowish, dark in a postmedian band, which consists of a pair of oblique dashes at suture, almost meeting behind and set at 30 degrees to each other, connected to sides by a dark band from near front; on sides from midband forward toward humeri, and often in an isolated dash posterolateral to omoplates. Some individuals are less extensively marked, the dash next to the omoplates being the most evanescent. The 30 degree orientation of the separation of the midband at the suture persists even in the least marked individual seen, which is pale across the base of the elytra and has a pale prothorax. Separation of eyes 17%, length of antennae 183% of head width in male, 26% and 155% in female. Length 2.01, width 0.91 mm, elytra 1.50 (1.43–1.53) mm long.

Female with apex of tergum 7 evenly curved, with small ventral teeth all across, sternum 7 evenly curved, with small dorsal teeth all across. Male front trochanters bearing a slender spine almost as long as trochanter width.

Distribution. Florida to eastern Oklahoma and Texas, north to South Carolina. Alabama: Birmingham, Jefferson Co. Arkansas: Polk Co. Florida: Daytona, Dixie Co., Dunedin, Fort Mead, Gainesville, Highlands Hammock, Ocala, Old Town, Putnam Co., Silver Springs, Volasia. Georgia: Pine Mountain (Rabun Co.). Louisiana: Baton Rouge, Feliciana Parish. Mississippi: Richton. South Carolina: Florence, Myrtle Beach. Texas: Montgomery Co. (CNCI, CUIC, DENH, EGRC, FMNH, FSCA, KSTC, LSUC, MCZC, OSUC, PSKC, SEMC, UAIC, VMKC).

Fasciatus-Group

Diagnosis. Three North American species in which the males have the front tibiae strongly, angularly bowed in apical fourth. In *fasciatus* there is also a unique expansion of the male hind femora. All have dark markings across the elytral midzone. The females of two species have longitudinal lamellae in the midzone of the underside of the last visible tergum (tergum 7), these appearing as sharp teeth at the apex.

Zonantes fasciatus (Melsheimer)

Figs. 24, 46, 59

Xylophilus fasciatus Melsheimer 1846:55. [Described from "Pennsylvania." Lectotype, new designation, female, in Melsheimer-Ziegler Coll., MCZC, the bottom specimen of a 2-point mount labeled "Melsh. / fasciatus," the species label matching others in the Melsheimer Coll., examined. The lectotype lacks the last 4 segments of both antennae; the top specimen, a male, lacks head and prothorax.] Haldeman, 1848:97 (*Euglenes*). LeConte, 1855:276. Casey, 1895:783 (*Zonantes*).

Zonantes tricuspis Casey, 1895:784. [Lectotype, female, labeled "Iowa City Wickham / Type USNM 36497 / tricuspis Csy" in Casey Coll., USNM, examined by D. S. Chandler.] **New synonymy.**

Diagnosis. Robust, body dark brown to black, elytra reddish but dark brown to black in a well-defined broad midband from side to side, along suture from midband to base and on scutellum and adscutellar area; antennae, palpi and usually all of legs yellowish, even front and middle coxae; hind coxae and sometimes hind femora darkened. Separation of eyes 24%, length of antennae 176% of head width in male, 36% and 183% in female. Length 2.45, width 1.17 mm, elytra 2.01 (1.05–2.01) mm long.

Male front trochanters bearing a strong spine, and hind femora uniquely abruptly expanded on top at about middle and broad from there to end. Female with apex of tergum 7 evenly curved, with fine ventral teeth all across and 3–4 strong lamellate teeth in midzone, these truncate at apex but gently tapered anteriorly.

Distribution. Florida to eastern Oklahoma, north to Quebec and Michigan. U.S.A.: Alabama: Cullman Co. Arkansas: Garland Co., Logan Co., Montgomery Co., Newton Co., Polk Co., Scott Co. Connecticut: Cornwall. Delaware: Long Neck, Wyoming. District of Columbia (Ulke Coll.). Florida: Alachua Co., Daytona, Gainesville, Torreya State Park. Georgia: Prattsburg, Rabun Co. Illinois: Coles Co., Downers Grove, Glen Ellyn, Kahokia, Marion Co., Ravina, St. Clair Co., Shelby Co. Indiana: Bear

Wallow, Columbus, Grantsburg, Jefferson Co., Parke Co., Posey Co., Tippecanoe Co. Iowa: Iowa City (Casey, 1895, *tricuspis*), Polk Co. Kansas: Douglas Co., Leavenworth, Onaga. Kentucky: Kentucky Lake State Park, Louisville. Maine: Aurora, Casco, Paris. Maryland: Frederick, Great Falls, Odenton, Silver Spring, Takoma Park. Massachusetts: Ashland, Framingham, Marion, Natick, Sherborn. Michigan: Cheboygan Co., Whitmore Lake. Mississippi: Newton Co., Chickasaw Co., Pontatoc Co. Missouri: Ashland, Barry Co., Columbia, Creve Coeur Lake, Fulton, Gasconade Co., Jackson Co., Lathrop, Madison Co., Moberly, Mound City, New Hartford, Randolph Co., St. Francois Co., St. Louis. New Hampshire: Durham, Stinson Lake. New Jersey: Five-Mile Beach, Highlands, Mountain Lake, Orange Mts. New York: Elbridge, Ollcott, Pike, Southold. North Carolina: Asheville, Balsam, Chapel Hill, Highlands, Macon Co., Weaverville. Ohio: Ashland Co., Clinton Co., Delaware Co., Greene Co., Hocking Co., Scioto, Starke Co., St. Marys. Oklahoma: Latimer Co. Pennsylvania: Allegheny, Harrisburg, Jeannette, Manayunk, Pittsburg, St. Vincent. South Carolina: Florence, Poinsett Beach. Tennessee: East Ridge. Virginia: Hampton, Montgomery Co. West Virginia: Charleston, Grace, Guthrie, Sleep Creek Hunt Area, White Sulphur. Wisconsin: Adams Co., Beaver Dam, Shawane Co. Canada: Ontario: Ad & Lennox Co., Arnprior, Bell's Corners, Gravenhurst, Hastings Co., Leamington, Ottawa, Prince Edward Co., Simcoe, Walsingham. Quebec: Hull, Old Chelsea. (In all collections.)

Zonantes hubbardi Casey
Figs. 25–27, 62

Zonantes hubbardi Casey 1895:782. [Holotype, male, labeled "Washington DC 13.6 / Type USNM 36495 / hubbardi Csy" in Casey Coll., USNM, examined.]

Zonantes schwarzi Casey 1895:783. [Holotype, male, labeled "Biscayne Fla 27.9 / Type USNM 36496 / schwarzi Csy / head & thx missing (Nov. 19-1926) L.L.B.," in Casey Coll., USNM, examined.] **New synonymy.**

Diagnosis. Of general aspect of *Z. fasciatus* but less robust. Most eastern Oklahoma and northern individuals have the elytra yellowish with a complete dark midband that is more obviously made up of 2 elongate dashes on each elytron than it is in *fasciatus* and is sometimes interrupted at the suture, and dark in adscutellar area and usually on scutellum. Prothorax usually all dark. Florida populations are generally paler, with head brown, pronotum pale with posterolateral dark blotches, and elytral markings often reduced to 2 isolated dashes in midzone and a small adscutellar zone on each, leaving scutellum pale. Some individuals resemble lightly marked *nubifer,* but differ in having the separation of the midband at the suture nearly parallel-sided. Separation of eyes 14%, length of antennae 174% of head width in male, 28% and 172% in female. Length 2.12, width 1.02 mm, elytra 1.76 (1.35–1.87) mm long.

Male front trochanters strongly spinose, front tibiae angularly bowed, and hind femora simple. Female with apex of tergum 7 slightly excavated, bearing 2–3 long ventral teeth (truncated lamellae as in *fasciatus*) on each side, lateral to excavation, the most mesal the longest; apex of sternum 7 flattened and slightly truncate, with small dorsal teeth all across.

Distribution. Florida to eastern Texas and Oklahoma, north to New Jersey and Missouri. Alabama: Birmingham, Helena, Mobile. Arkansas: Hope, Polk Co. District of Columbia (Casey, 1895, *hubbardi*). Florida: Alachua Co., Archer, Biscayne Bay (Casey, 1895, *schwarzi*), Camp Mahachee, Coronado, Daytona, Dixie Co., Enterprise, Gainesville, Hernando Co., Homestead, Jackson Co., Jim Woodruff Dam, Ocala, Okaloosa, Pensacola, Putnam Co., Rainbow Springs, Salt River, Sebring, Taylor Co., Torreya State Park, Welaka. Georgia: Rabun Co. Indiana: Tippecanoe Co. Louisiana: Baton Rouge, Feliciana Par., Fort Polk, Natchatoches Par., Opelousas, Sabine Par., Vernon Par. Mississippi: Gulfport, Ocean Springs, Starksville. Missouri: Arnold, Boone Co., Columbia, Crawford Co., Danville, Henry Co., Jackson Co., Moberly, New Hartford, Wentzville. New Jersey: Westville. North Carolina: Duke Forest, Raleigh. Ohio: Delaware Co., Franklin Co. Oklahoma: Latimer Co., Summerfield. Pennsylvania: Jeannette. Texas: Karnack, Tatum. Virginia: Great Falls. West Virginia: Charleston, Guthrie (CDAE, CNCI, CUIC, DENH, FMNH, FSCA, GHNC, ICCM, KSTC, LSUC, MCTC, MCZC, MUIC, NMDC, OSUC, PSKC, UAIC, UMRM, USNM, WSCC, WVDA).

Zonantes ouachitanus, new species

Fig. 32

Diagnosis. Moderately slender, pale with darker head and a weak, nearly transverse postmedian dark band on elytra, isolated on each elytron in the known individuals; male front tibiae angularly bowed and hind femora simple. Eyes smaller than in *hubbardi*. Separation of eyes 42%, length of antennae 187% of head width in male, 39% and 170% in female.

Female with apex of last visible tergum evenly curved, bearing 5–6 slender, nonlaminar, ventral teeth on each side of a median gap, longest, ca. 0.03 mm, near middle; apex of last visible sternum also evenly curved, with 5–6 similar dorsal teeth on each side of a wider gap, the lateral teeth longer. Length 2.05, width 0.91 mm, elytra 1.69 (1.35–1.69) mm long.

Description. Holotype, male: 2.05 mm long with head deflexed; head 0.44 mm long to frontoclypeal suture, 0.64 wide across eyes, 0.56 behind, base 0.09 mm long behind eyes. Eyes 0.30 × 0.27 mm, separated by 0.25 mm. Antennae 1.20 mm long, segment 11 0.09 wide. Prothorax 0.50 mm long, 0.59 wide; elytra 1.69 mm long, 0.76 wide at points of humeri, 0.91 maximum, with band from 0.80 to 1.00 mm from base, weakly divided at suture, not reaching side margins. Elytral setae 0.11 mm long, tactile setae 0.09. Front trochanters with a short, acutely triangular spine ca. 0.04 mm long; front tibiae 0.30 mm from base to sharp curve, ca. 0.19 from there to apex.

Specimens examined. Eastern Oklahoma. Holotype: male, Oklahoma: Latimer Co., IX-1983, K. Stephan, in USNM. Paratypes in FSCA, FMNH. Paratypes: 5 males (IX-83, VIII-87, IX-88, in blacklight trap); 1 female, Oklahoma: McCurtain Co., Beaver Bend St. Park, 1 Sep. 1960, at light, W Suter, FMNH (FMNH, FSCA, KSTC, UAIC, USNM).

Ater-Group

Diagnosis. A single dark species that has no contrasting markings. The male has the front tibiae gently bowed and spinose at the apex, but lacks a spine on the front trochanters. The female is unique in having a brush on the apex of the first posterior tarsomere. *Zonantes mississippiensis* is placed here provisionally. It is dark like *Z. ater,* but the female lacks the modification of the hind tarsi and the male is unknown.

Zonantes ater (LeConte)
Fig. 52

Xylophilus ater LeConte 1875:175. [Described from "Texas, Belfrage." Holotype, sex?, abdomen and hind legs hidden in glue, in LeConte Coll., MCZC, labeled "Tex / 570 /Type 4881 / X. ater Lec., with Lec. underlined," examined.] Casey, 1895:785 (*Zonantes*).

Diagnosis. Brownish black with reddish brown antennae, palpi and legs; of general form of *fasciatus,* which is much more abundant. Separation of eyes 32%, length of antennae 215% of head width in male, 35% and 164% in female. Length 2.63, width 1.17 mm, elytra 2.05 (1.87–2.12) mm long.

Apex of segment 1 of female hind tarsi slightly swollen and bearing a diagonal brush of setae on side facing body (Fig. 7). Apex of female tergum 7 evenly curved, with small ventral teeth all across; apex of sternum 7 evenly curved, with sparse small dorsal teeth all across.

Distribution. Louisiana and Texas to Ohio and Illinois. Illinois: Lincoln Trail State Park. Indiana: Bear Wallow, Brown Co., Tippecanoe Co. Louisiana: Feliciana Parish, Natchatoches Parish. Missouri: Lee's Summit. Ohio: Highlands Co. Oklahoma: Latimer Co. Tennessee: Crabtree. Texas: Waco (probably LeConte, 1875 locality, since this is where Belfrage lived the longest). West Virginia: Guthrie (CUIC, EGRC, FSCA, GHNC, ICCM, KSTC, MCTC, MCZC, NMDC, UAIC, USNM, WVDA).

Zonantes mississippiensis, new species

Diagnosis. Body and elytra dark without markings, but differs from *Z. ater* in that the female has no brush on the first segment of the hind tarsi and has larger eyes (probably even larger in the unknown male). The 2 known specimens are slightly smaller, rich brown with paler appendages and a black head. Most *Z. ater* are brownish black with yellowish appendages. Separation of eyes 42%, length of antennae 128% of head width in female; male unknown. Length 2.24, width 1.11 mm, elytra 1.72 (1.72–1.76) mm long.

Description. Holotype, female: 2.24 mm long with head deflexed. Head 0.46 mm long to frontoclypeal suture, 0.69 wide across eyes, 0.57 behind; eyes 0.35 × 0.33 mm, separated by 0.17 and separated from hind margin by 0.06 (0.10 in a comparable *ater* female), a line across their hind margins 0.06 mm from middle of nearly truncate base of head; indented from front by 0.06 mm (by 0.11 mm in *ater* female). Setae at junction of facets rather long, 0.05 mm, and more conspicuous than usual. Head shiny, punctures distinct, 0.04 mm apart, setae subdecumbent, 0.07 mm. Antennae fairly short, 0.85 mm, gradually thicker to apex, where 0.09 mm wide. Prothorax 0.52 mm long, 0.56 wide across base, 0.65 maximum near middle, 0.38 at apex. Elytra 1.72 mm long, 0.89 wide across points of humeri, 1.11 maximum near middle; omoplates feebly developed; surface shiny, with punctures 0.04 mm apart, the intervals convex. Setae subdecumbent, 0.09 mm, tactile setae suberect, also 0.09.

Specimens examined. Holotype: female, labeled "Logtown, Hancock Co., Miss., VII-9-1965, collector H. R. Hepburn," from C. W. O'Brien, in USNM. Paratype: 1 female, labeled "Miss.: Hancock Co., I-10 rest area and Welcome Center, VI-17-82, E. G. Riley" (EGRC, USNM).

Elonus Casey

Elonus Casey 1895:774 (type-species: *Xylophilus nebulosus* LeConte, new designation). Pic, 1905:235 (subgenus of *Hylophilus*). Baguena, 1948:27.

Diagnosis. Rather large species, with deep, flat-bottomed punctures, especially well developed on elytra, moderately long and erect setae and quite dense interstitial setae, directed laterally on elytra. Eyes deeply emarginate, with long, erect setae. Abdomen with a lateral zone of short, appressed golden pubescence on fused visible sterna 1 and 2 (true 3 and 4) in both sexes. In the male this continues onto the sterna behind and outlines a median zone which becomes an elevated plate starting on visible sternum 4. Male with antennal segment 11 elongate (Fig. 66), an apical spine on the front tibiae, and most species with a broad pad of plush-like "setae" on the hind femora (Figs. 47, 60, 61, 67, 68). Female with a dorsal pencil of golden setae on apex of hind tibiae (Fig. 53) and a small, seta-filled pit on middle of posterior portion of last visible abdominal sternum. Several additional species known from Mexico, Central America and Brazil.

Key to Species

1\. Elytra with pattern of brown and gray markings over whole surface, mainly in pubescence .... *Elonus nebulosus*

– Cuticle of elytra dark with base reddish, rarely all reddish 2

2(1). Separation of eyes ca. 15% of head width in male, 29% in female. Red zone at base of elytra sharply defined. Pubescence dark over dark part of elytra but gray along suture behind middle and in a slightly postmedian sublateral cloud in very fresh specimens, best seen in oblique light from front .... *Elonus basalis*

– Separation of eyes ca. 27% of head width in male, 36% in female. Red zone at base of elytra poorly demarcated, rest of elytra and body not very dark in many individuals. Elytral pubescence uniform, setae and interstitial setae gray .... *Elonus hesperus*

Basalis-Group

Diagnosis. Species in which the body is largely black, with the base of the elytra red (sometimes more extensively red). One undescribed species from the Southwest has simple hind femora in the male.

Elonus basalis (LeConte)
Figs. 45, 60, 66

Xylophilus basalis LeConte 1855:276. [Described from "Illinois, Mr. Willcox." Holotype, male, in LeConte Coll., MCZC, labeled "yellow disk / basalis 4," examined. The first specimen in the series is labeled "Type 4879," but it has appendages noted as missing in the original description.] LeConte, 1878:426. Casey, 1895:776 (*Elonus*).

Elonus princeps Casey 1895:775. [Holotype, female, labeled "W.H.H., Ottawa / Type USNM 36492," examined.] **New synonymy.**

Diagnosis. Measured specimen 2.93 mm long, 1.28 mm wide, elytra 2.30 (2.12–2.41) mm long. Separation of eyes 14%, length of antennae 238% of head width in male, 31% and 207% in female. In a male with hind femora 1.06 mm long, there is a basal excavation from 0.06 to 0.48 mm, 0.13 mm wide maximum; it is partly covered by a dense zone of 0.04 mm setae extending from front edge, and forms a narrow groove occupying at most ½ the width of the femur, parallel to trochanter and not divided by a transverse ridge. Male front tibiae almost straight, bowed by 0.04 mm; middle tibiae gently bowed, by 0.07 mm. Casey's *princeps* was based on a clean specimen with the gray elytral setae well developed.

Distribution. Florida to eastern Oklahoma, north to Quebec and Minnesota. USA: Arkansas: Fulton Co. District of Columbia. Florida: Devil's Millhopper State Park, Gainesville, Ocala, Torreya State Park. Illinois (LeConte, 1855), Coles Co. Indiana: Beverly Shores, Lake Station, Marion Co., Starke Co., Tippecanoe Co. Iowa: Boone. Kansas: Onaga, Topeka. Louisiana: Baton Rouge, Clinton. Maine: Augusta. Michigan: Midland. Minnesota: Durham. Mississippi: Oktibbeha Co. Missouri: Barry Co., Moberly, Vernon Co. New Hampshire: Carroll Co. (The Bowl & Wonalancet), Durham. New Jersey: Morristown. New York: Elbridge, Ithaca, Long Island (Lloyds Neck, Riverhead, Southold), Putnam, Schenectady. Ohio: Champaign Co., Delaware Co., Franklin Co., Greene Co., Hocking Co. Oklahoma: Latimer Co. Pennsylvania: Allegheny, Jeannette, Julian, West View. South Carolina: Florence. Virginia: Emporium. West Virginia: Junction. Canada: Ontario: Brittania, Chatterton, Hastings Co., Hillcrest, Osgoode, Ottawa (Casey, 1895, *princeps*), Prince Edward Co., Pelee Island, Point Pelee. Quebec: Hudson Mts., LaTrappe, King Mt. (CDAE, CNCI, CUIC, CWOB, DENH, FMNH, FSCA, GHNC, ICCM, KSTC, MCTC, NMDC, OSUC, PSKC, SEMC, VMKC, UAIC, UMRM, USNM, WSCC, WVDA).

Elonus hesperus, new species
Figs. 44, 47, 67

Diagnosis. Slightly smaller than *E. basalis* from the same locality in eastern Oklahoma, with whole base of elytra and scutellum rufescent, and pubescence uniformly pale over dark parts of elytra. Separation of eyes 28%, length of antennae 208% of head width in male, 34% and 197% in female. Length 2.71, width 0.98 mm, elytra 1.91 (1.90–2.12) mm long.

Description. Holotype, male: 2.71 mm long with head deflexed, dark brown, basal zone of elytra and scutellum rufescent. Head 0.47 mm long to frontoclypeal suture, 0.72 wide across eyes, 0.69 behind, 0.11 mm long behind eyes. Eyes 0.38 × 0.30 mm, separated by 0.19. Antennae 1.57 mm long, last segment 0.37 × 0.13. Prothorax 0.67 mm long, 0.63 wide; elytra 1.91 mm long, 0.81 wide at points of distinct humeri, 0.98 maximum. Hind femora 0.87 mm long, with a weak basal excavation from 0.04 to 0.37, divided by a curved ridge 0.11 from base in front ⅓, 0.15 at middle, 0.22 at hind margin; maximum width of excavation ca. 0.13 mm of 0.24 across femur but excavation weak in front; posterior portion with sparse setae and appearing somewhat like the narrow excavation of male *basalis,* which has no transverse ridge; anterior portion with dense setae but these not forming a sharp border. Front tibiae weakly bowed, by 0.06 mm, middle tibiae more distinctly, by 0.09 mm. Paratype: female, head 0.47 mm long, 0.72 wide and 0.15 long behind eyes, which are 0.37 × 0.27 mm and separated by 0.26. Antennae 1.37 mm long, segment 11 0.26 × 0.15. Apex of hind tibiae with a firm dorsal pencil of golden setae, 0.13 mm long, 0.04 thick at base and tapering to a fine point. There is little variation in the Oklahoma specimens, except for the extent of rufescent coloration, which sometimes predominates.

Specimens examined. Eastern Oklahoma, Missouri and a disjunct population that is slightly different in eastern Arizona. Holotype, male, labeled "Oklahoma: Latimer Co., -VIII-83, Karl Stephan / in blacklight trap," in USNM. Paratypes: 29 males in blacklight trap, 1 female, same locality, collecting method not recorded. 2 males, Oklahoma: Marshall Co., UOBS, Willis, at light, W. R. Suter. 1 male, Missouri, Jackson Co., Raytown, at lite, G. H. Nelson. 1 male, Missouri, Barry Co., 3 mi SW Roaring River State Park, E. G. Riley. Apparently nocturnal, the males having been taken mainly or entirely at light (FMNH, FSCA, GHNC, LSUC, UAIC, USNM).

Associated with these, but not designated as paratypes, are some eastern Arizona specimens, all probably taken at light. These are all males with legs like the holotype but whole aspect generally darker than the Oklahoma series and with the eyes slightly larger and more narrowly separated (by 22% of head width vs. 27% in Oklahoma). Arizona: Greenlee Co.: 21 mi N Clifton; Yavapai Co.: Cherry; Pima Co.: Sta. Catalina Mts.: Molino Basin and Sabino Canyon (CNCI, UAIC).

Nebulosus-Group

Diagnosis. Species in which the elytra are not red at the base, but have a strong brown and gray color pattern. Several species in Mexico in addition to one in the U.S.A.

Elonus nebulosus (LeConte)

Figs. 43, 53, 61, 68, 70

Xylophilus nebulosus LeConte, 1875:175. [Described from "Pennsylvania, Louisiana." Lectotype, new designation, male, in LeConte Coll., MCZC, labeled "Pen., on pale blue paper / X. nebulosus Lec. / Type 4880," examined. This designation restricts the type-locality to Pennsylvania.] Casey, 1895:776 (*Elonus*).

Diagnosis. Brown, interstitial setae the main ones involved in a distinct brown and gray pattern on elytra, pale setae overlying pale cuticle. Separation of eyes 14%, length of antennae 286% of head width in male, 34% and 223% in female. Length 2.45, width 1.02 mm, elytra 1.94 (1.65–2.01) mm long.

Plush zone of male hind femora with a large and strong excavation in basal portion; in a male with hind femur 0.83 mm long the excavation extends from 0.06 to 0.28 mm in front, 0.34 behind; it is margined narrowly in front but almost flat behind; its pubescence fine, nearly erect, directed obliquely posteriorly.

Distribution. Florida to eastern Oklahoma, north to Quebec and Michigan. U.S.A.: Alabama: Birmingham, Helena, Sheffield. Arkansas: Jasper. Florida: Gainesville, Paynes Prairie, Torreya State Park. Indiana: Marion Co., Tippecanoe Co. Iowa: Ames. Louisiana: Baton Rouge, Feliciana Parish, Jackson. Maine: Casco. Maryland:

Great Falls of Potomac River. Michigan: Charlevoix Lake. Missouri: Boone Co., Columbia, Jackson Co., Moberly, Mound City, St. Francois Co. Nebraska: Litchfield. New York: Elbridge, Marlboro. Ohio: Ashland Co., Cincinnati, Delaware Co., Fairfield Co., Greene Co., Hocking Co., Putnam Co., Scioto Co. Oklahoma: Latimer Co. Pennsylvania: Allegheny, Jeannette, Pittsburg. South Carolina: Florence. Virginia: Mt. Vernon. West Virginia: Boyer, Guthrie. Canada: Ontario: Arnprior, Ottawa, Prince Edward Co. Quebec: Old Chelsea (CNCI, CUIC, DENH, EGRC, FMNH, FSCA, GHNC, ICCM, KSTC, LSUC, MCZC, NMDC, OSUC, PSKC, SEMC, UAIC, UMRM, USNM, VMKC, WSCC, WVDA).

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A REVIEW OF THE SPECIES OF *LIODESSUS* GUIGNOT OF NORTH AMERICA NORTH OF MEXICO WITH THE DESCRIPTION OF A NEW SPECIES (COLEOPTERA: DYTISCIDAE)

David J. Larson[1] and Robert E. Roughley[2]

[1] Department of Biology, Memorial University of Newfoundland,
St. John's, Newfoundland A1B 3X9, Canada, and
[2] Department of Entomology, University of Manitoba,
Winnipeg, Manitoba R3T 2N2, Canada

Abstract.—*Liodessus youngi*, n. sp., is described from specimens from New Mexico (type locality = Radium Springs, Dona Ana Co.), Colorado and South Dakota. Short diagnostic descriptions of each of the six species of *Liodessus* Guignot [*L. affinis* (Say), *L. cantralli* (Young), *L. flavicollis* (LeConte), *L. fuscatus* (Crotch), and *L. hobbsi* (Young)] found in the Nearctic region and a key for their identification are provided.

Examination of various collections of Dytiscidae revealed an undescribed species of *Liodessus* Guignot (Dytiscidae: Hydroporinae: Bidessini). The genus *Liodessus* is well characterized in Young (1967) and Biström (1988a). It is a moderately diverse genus distributed world-wide. Modern taxonomic treatments are available for the species occurring in Africa (Biström, 1988b), Australia (Watts, 1978), and New Zealand (Ordish, 1966); the New World species of *Liodessus* are listed in Young (1969). The species of the bidessines assigned to this genus are moderately well known for North America. However there is no key available which treats all of these species. One additional Nearctic species, not treated here, *L. abjectus* (Sharp), is known from Mexico but as it was described from Oaxaca it may well be a member of the Neotropical fauna. Therefore, the purposes of this paper are to provide a key to species of *Liodessus* of North America north of Mexico, to present uniform descriptions of these species, and to provide short diagnostic descriptions of each species including a previously un-named species along with collecting notes and comments about known distributions. In this review standard taxonomic methods were used (e.g., Larson, 1975).

DIAGNOSIS OF *LIODESSUS* GUIGNOT

The tribe Bidessini was erected by Sharp (1882). Presently, the principal character used to define all members of Bidessini is the common presence of two- or three-segmented parameres of the aedeagus of adult males (Biström, 1988a). Biström (1988a:18) provided a diagnosis for members of *Liodessus* based on the type species, *L. affinis* (Say). Young (1967:76) provided a diagnostic description of adult *Liodessus* in the New World.

Diagnosis. Among Nearctic genera of Bidessini, adult specimens of *Liodessus* can be recognized by the following combination of characters: head with a transverse stria or ridge extending across occiput just posterior to eyes; clypeal margin simple, not modified; pro- and mesotarsus apparently four-segmented; elytral epipleuron without a humeral, oblique carina; elytron dorsally with basal stria present or absent, one species (*L. cantralli*) with a sutural row of punctures forming a more or less distinct sutural groove, otherwise elytron simple, not modified; mesosternum simple, not modified; and abdominal sternum 6 (last visible) narrow and subtriangular in shape, with small basolateral impressions.

KEY TO SPECIES OF *LIODESSUS* GUIGNOT OF NORTH AMERICA NORTH OF MEXICO

1. Elytron with basal stria lacking or represented by at most a very small impression which is not produced linearly onto disc (Fig. 5); metacoxal plate and metasternum medially coarsely punctate 2

1′. Elytron with basal stria originating adjacent to base of pronotal stria, length of stria variable but evidently linear and longitudinal (Figs. 1–4); metacoxal plate and metasternum with punctation various 3

2(1). Elytron fuscous with sub-basal, sub-median and apical, transverse pale fascia (Fig. 5), some few specimens with elytron entirely fuscous; elytral surface very densely punctate, punctures separated less than their diameter, conspicuously setose .... *L. flavicollis* (LeConte)

2′. Elytron more or less uniformly dark brownish yellow, without distinct maculation; elytral surface coarsely punctate but punctures sparser and separated by about one to two times their diameter, less conspicuously setose .... *L. hobbsi* (Young)

3(1′). Elytron yellow with longitudinal brown vittae, or if mainly dark brown, with a few longitudinal, discal, paler spots (Fig. 4); metatibia mainly yellow with distinct infuscation limited to apical third, although some specimens with vague medial infuscation; metacoxal plate with punctures fine, on many specimens obscured by rugose sculpture; elytron with stria well developed, length of stria/length of elytron: 0.07 to 0.14 .... *L. affinis* (Say)

3′. Elytron uniformly brown to piceous, or if with pale discal markings, metacoxal plate coarsely punctate and elytral stria short, length of stria/length of elytron: 0.02 to 0.08; metatibia with distal two thirds distinctly infuscate 4

4(3). Elytron, on at least basal half, with a sutural groove formed by a longitudinal series of relatively deeply impressed punctures; body in dorsal aspect with lateral margin of pronotum and elytron forming a more or less continuous curve (Fig. 3); metasternum medially finely and inconspicuously punctate .... *L. cantralli* (Young)

4′. Elytron without a distinct subsutural groove; body in dorsal aspect with lateral margin of pronotum and elytron strongly discontinuous (Figs. 1, 2); metasternum medially distinctly punctate 5

5(3′). Pronotum with lateral stria short, 0.48 to 0.63 length of pronotum measured at same point; elytron with basal stria shorter, length of stria/length of elytron: 0.02 to 0.08; metacoxal plate with coarse punctures more or less evenly distributed .... *L. fuscatus* (Crotch)

5′. Pronotum with lateral stria long, 0.67 to 0.88 length of pronotum measured at same point; elytron with basal stria longer, length of stria/length of elytron: 0.09 to 0.12; metacoxal plate with coarse punctures few in number, shallower and irregularly distributed .... *L. youngi,* n. sp.

Liodessus youngi, new species

Description. Habitus, Figure 1. Body oval, lateral margin discontinuous in outline between pronotum and elytron, but not so strongly as in *L. fuscatus.* Measurements and ratios are presented in Table 1.

Table 1. Measurements and ratios for North American species of *Liodessus*. Range, mean, standard deviation.

	Species					
	L. affinis	*L. cantralli*	*L. flavicollis*	*L. fuscatus*	*L. hobbsi*	*L. youngi*
n	40	17	12	20	1	32
Length (L)	1.78–2.28 2.00 (0.10)	1.73–1.96 1.82 (0.05)	1.55–1.82 1.72 (0.08)	1.72–2.02 1.86 (0.07)	1.67	1.78–2.20 1.95 (0.06)
Width (W)	0.86–1.16 0.99 (0.06)	0.86–1.04 0.93 (0.03)	0.84–0.97 0.92 (0.05)	0.86–1.01 0.93 (0.03)	0.81	0.90–1.15 0.98 (0.04)
L/W	1.92–2.09 2.01 (0.04)	1.86–2.02 1.95 (0.03)	1.81–1.94 1.88 (0.03)	1.92–2.10 2.01 (0.03)	2.07	1.91–2.04 1.99 (0.03)
Elytron L/L	0.67–0.71 0.69 (0.01)	0.65–0.69 0.67 (0.01)	0.61–0.69 0.67 (0.02)	0.61–0.69 0.66 (0.02)	0.65	0.66–0.70 0.69 (0.01)
Prontal stria/ Pronotal L	0.56–0.67 0.61 (0.03)	0.57–0.80 0.70 (0.06)	0.25–0.35 0.29 (0.03)	0.48–0.63 0.55 (0.04)	0.54	0.67–0.88 0.73 (0.06)
Elytral stria/ Elytral L	0.07–0.14 0.11 (0.02)	0.11–0.17 0.14 (0.02)	elytral stria absent	0.02–0.08 0.05 (0.02)	elytral stria absent	0.09–0.12 0.10 (0.01)
W between eyes/ W across eyes	0.56–0.61 0.59 (0.02)	0.61–0.66 0.64 (0.01)	0.52–0.57 0.55 (0.01)	0.61–0.64 0.63 (0.01)	0.62	0.59–0.65 0.62 (0.01)

Dorsal surface dark reddish brown, except anterior margin of head, lateral margin of pronotum, as well as humeral and posterior margins of elytron paler, yellowish brown to pale reddish brown, gradually darkening mesally. Some specimens with vaguely defined maculations on elytron. Metasternum, metacoxal plates and abdominal sterna dark brown to piceous, abdomen at least as dark as metacoxa and metasternum. Antennomeres 1 to 4 or 5 mainly yellow, outer antennomeres largely or entirely infuscate. Palpi each with apical palpomere dark, basal palpomeres yellow. Front and middle legs pale brown, hind legs darker, metatibia yellowish basally, at least apical two-thirds distinctly darker brown.

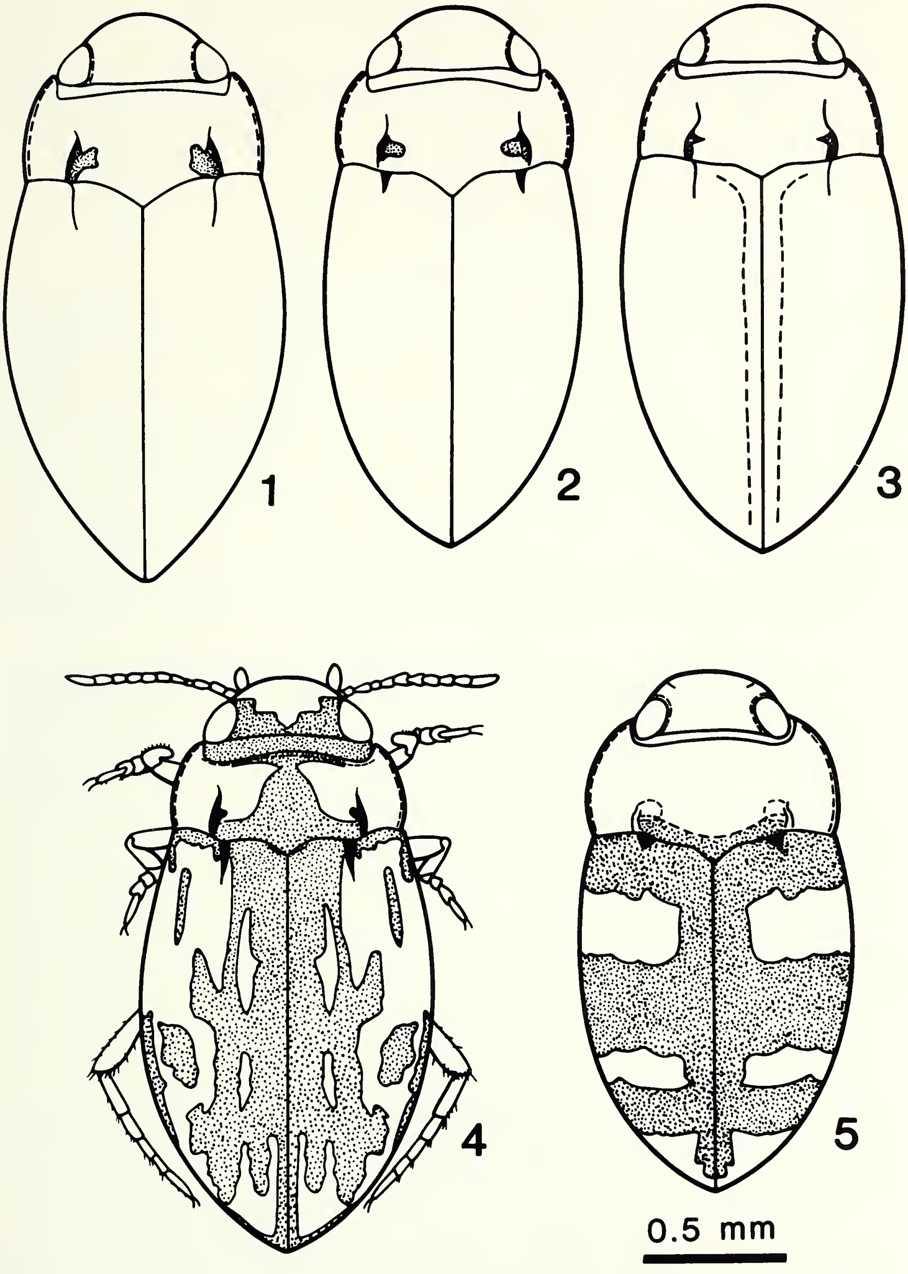
Head rather finely punctate except for a group of coarse punctures medially on frons. Pronotum conspicuously punctate, punctures small medially on disc, coarser posteriorly and most specimens with two to five large punctures along hind margin between posterolateral angle and base of lateral stria. Elytron coarsely punctate, punctures separated by about their own diameter, each puncture bearing a fine seta subequal in length to or slightly shorter than distance between punctures; epipleuron finely punctate. Metasternum medially with small but evident punctures. Metacoxal plate slightly rugose but not so coarsely as to obscure rather widely spaced, coarse punctures. Abdomen with sternum 1 coarsely punctate along anterior and posterior margins; sterna 2 to 5 very finely and sparsely punctate; sternum 6 with small deep punctures medioapically. Dorsal surface of males smooth and shiny between punctures; females various, some male-like in sculpture, some with entire surface finely microreticulate and somewhat dulled, others with reticulation restricted to apical third of elytron.

Pronotum relatively strongly rounded laterally (Fig. 1), with point of maximum width slightly anterior from hind angles; basal margin strongly sinuate, margin between base of stria and lateral angle arcuate, posterolateral angle evidently produced; lateral stria well developed, two-thirds or more length of pronotum measured along same line, strongly delimited laterally; lateral bead of moderate width, broadest basally and gradually narrowed apically. Elytra elongate oval in dorsal aspect, moderately narrowed towards base; in lateral profile, dorsal margin gently and evenly rounded to apex in apical half; basal stria sharply impressed, about one-half to three-fourths length of pronotal stria; epipleuron in lateral aspect visible to or almost to humeral angle. Metacoxal lines diverging anteriorly.

Aedeagus (Fig. 6) arcuate in lateral aspect, slightly broadened medially; shaft subparallel and straight for a short distance submedially, apex not differentiated.

Etymology. We take pleasure in naming this species after Dr. Frank N. Young, in recognition of the important contributions he has made to the understanding of American Bidessini.

Type material. Holotype, male, USA, New Mexico, Dona Ana Co., Radium Springs, nr. Rio Grande, 29 April 1984, D. Larson & J. Zimmerman. Deposited in United States National Museum of Natural History [USNM]. Allotype, female, same collection data as holotype. Deposited in USNM. Paratypes, all other specimens of this species that were examined have been labelled as paratypes. Colorado, state locality only, (2, Canadian National Collection, Ottawa [CNC]). New Mexico, type locality and date, (16, California Academy of Sciences, San Francisco [CAS], Museum of Comparative Zoology, Harvard University [MCZ], and USNM). South Dakota, 2 mi NW Rapid City, 22 June 1940, H. C. Severin (10, CNC); Rapid City, 7 Sept.



Figs. 1–5. North American *Liodessus,* body outline. Fig. 1. *L. youngi.* Fig. 2. *L. fuscatus.* Fig. 3. *L. cantralli.* Fig. 4. *L. affinis.* Fig. 5. *L. flavicollis.*

1940, pond, H. C. Severin (1, J. B. Wallis Museum of Entomology, University of Manitoba, Winnipeg [JBWM]).

Collecting notes. The New Mexican specimens were collected from among flooded grasses and plant debris in very shallow water at the margin of a large spring-fed marsh.

Liodessus fuscatus (Crotch)

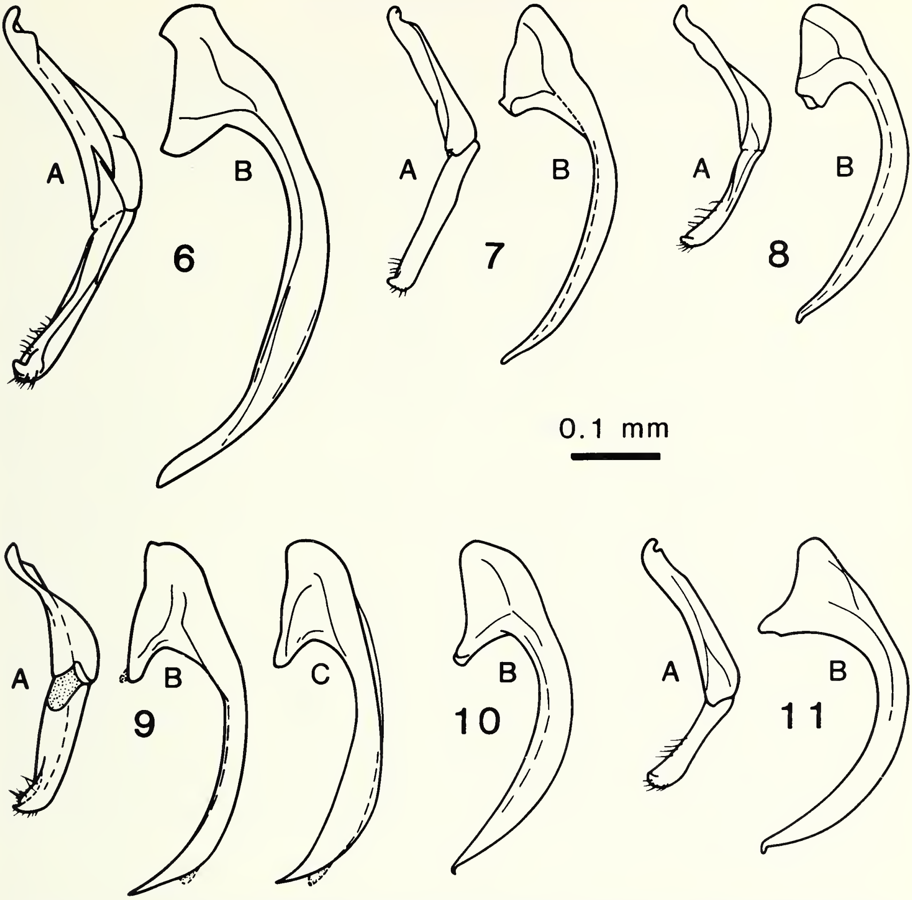
Hydroporus fuscatus Crotch 1873:391.
Selected references: Young, 1954:60, 62; Brigham, 1982:10.71.

Description. Habitus, Figure 2. Body ovate, lateral margin strongly discontinuous in outline between pronotum and elytron. Measurements and ratios presented in Table 1.

Dorsal surface reddish brown to piceous. Head yellowish to dark brown, darker than pronotum, pronotum yellowish anteriorly and laterally becoming brown to piceous basomedially, elytron maculate or not, maculations consisting of darker brown blotches on mainly yellowish brown elytron, or isolated yellowish brown spots on dark brown to piceous elytron. Ventral surface more or less uniformly brown to piceous. Antennomeres 1 to 2 yellow, outer antennomeres largely to entirely infuscate. Palpi unicolorous and yellow or each with apical palpomere darker. Legs brown with tibiae and tarsi darkened, metatibia lighter basally, at least apical three-fourths darker brown.

Head rather finely punctate except for a group of coarse punctures medially on frons. Pronotum conspicuously punctate, punctures small anterolaterally, larger but well separated on disc, coarser posteriorly and most specimens with two to three large punctures along hind margin between posterolateral angle and base of lateral stria. Elytron coarsely punctate, punctures separated by about 1.5 to 2 times their own diameter, each puncture bearing an inconspicuous seta generally shorter than distance between punctures; epipleuron finely but evidently punctate. Metasternum with distinct punctures, smaller than those of metacoxa. Metacoxal plate slightly rugose but not so coarsely as to obscure numerous, coarse punctures. Abdomen with sternum 1 coarsely punctate along anterior and posterior margins; sternum 2 coarsely punctate laterally; sterna 3 to 5 very finely and sparsely punctate; sternum 6 with small, deep punctures medioapically. Dorsal surface of males smooth and shiny between punctures; females various, some male-like in sculpture, some with entire surface finely microreticulate and somewhat dulled, others with reticulation restricted to apical third of elytron.

Pronotum relatively strongly rounded laterally (Fig. 2), with point of maximum width clearly anterior to hind angles, some specimens with sides of pronotum subparallel in basal half; basal margin strongly sinuate, margin between base of stria and lateral angle arcuate, posterolateral angle strongly produced; lateral stria well developed, about one-half to two-thirds length of pronotum measured along same line, strongly delimited laterally; lateral bead of moderate width, broadest basally and gradually narrowed apically. Elytra elongate oval in dorsal aspect, slightly narrowed towards base; in lateral profile, dorsal margin abruptly rounded to apex in apical half; basal stria sharply impressed, short; epipleuron in lateral aspect narrowly visible to humeral angle. Metacoxal lines slightly diverging anteriorly.



Figs. 6–11. North American *Liodessus,* male genitalia, A—paramere, lateral aspect; B and C—aedeagus, lateral aspect. Fig. 6. *L. youngi.* Fig. 7. *L. fuscatus.* Fig. 8. *L. cantralli.* Fig. 9. *L. affinis,* B—Sable I., Nova Scotia, C—Summerland, British Columbia. Fig. 10. *L. flavicollis.* Fig. 11. *L. hobbsi.*

Aedeagus (Fig. 7) arcuate in lateral aspect; shaft subparallel and more or less straight medially, apex narrower, otherwise not differentiated.

Collecting notes. In eastern North America, these beetles are most often found in sphagnum moss mats at the margin of small pools and ponds. Young (1954) considered *L. fuscatus* to be "the most characteristic species of the sphagnum-leatherleaf bogs, seldom occurring outside of them except where isolated patches of sphagnum occur." However, in Manitoba and Michigan specimens were collected from small pools with sandy substrates and aquatic plants such as *Carex, Chara* and *Utricularia,* as well as in a *Drepanocladus* fen.

Distribution. The known range of this species extends from Labrador to Saskatchewan and south to northern Florida and Texas.

Liodessus cantralli (Young)

Bidessus cantralli Young 1953:111.
Selected references: Young, 1953:111–112; Larson, 1975:262–264.

Description. Habitus, Figure 3. Body oval, lateral margin not strongly discontinuous in outline between pronotum and elytron. Measurements and ratios in Table 1.

Dorsal surface chestnut brown, slightly paler along margins. Elytron not maculate although some specimens with the sutural margin slightly darkened. Ventral surface pale brown to chestnut brown, abdomen lighter than metacoxa and metasternum basally, darker apically. Antennomeres 1 to 2 mainly yellow, outer antennomeres largely to entirely infuscate. Palpi unicolorous, pale brown or with apical palpomeres darker. Front and middle legs pale brown, tibia and tarsi darkened, hind legs darker, metatibia paler basally, at least apical two-thirds distinctly darker brown.

Head rather finely punctate. Pronotum not conspicuously punctate, punctures small medially and more or less widely spaced, coarser and more dense posteriorly, with two or three small basolateral punctures. Elytron conspicuously punctate but punctures sparse, separated by two to three times their diameter, except suturally a series of closely set, deep punctures forming a longitudinal impression in basal half of most specimens, area between impression and suture minutely, sparsely punctate; each puncture bearing an inconspicuous seta, shorter than distance between punctures; epipleuron quite finely punctate. Metasternum medially with punctures very small and sparse. Metacoxal plate somewhat rugose but not so coarsely so as to obscure rather widely spaced, coarse punctures. Abdomen with sternum 1 coarsely punctate along anterior and, on most specimens, posterior margin; sterna 2 to 5 very finely and sparsely punctate; sternum 6 with only a few punctures medially on some specimens. Dorsal surface of males smooth and shiny between punctures, appearing polished; females various, most male-like in sculpture, some with rudiments of effaced microreticulation; both sexes with sternum 6 microreticulate, more strongly so in female specimens.

Pronotum relatively weakly rounded laterally (Fig. 3), with point of maximum width at hind angles; basal margin slightly sinuate, margin between base of stria and lateral angle slightly arcuate, posterolateral angle only slightly produced; lateral stria well developed, long, about three-fourths length of pronotum measured along same line, strongly delimited laterally; lateral bead narrow. Elytra broadly oval in dorsal aspect, only slightly narrowed towards base; in lateral profile, dorsal margin gently rounded to apex in apical half; basal stria sharply impressed, shorter than pronotal stria; epipleuron in lateral aspect hidden behind lateral margin for a short distance behind humerus. Metacoxal lines diverging anteriorly.

Aedeagus (Fig. 8) arcuate in lateral aspect; shaft uniformly tapered, apex with a small dorsal hook.

Collecting notes. Specimens of *L. cantralli* occur in small pools and depressions in moss (usually *Drepanocladus*) mats. It is more characteristic of fen than bog habitats. Adults have been collected in early spring and late fall indicating adult overwintering. No flight records are available.

Distribution. The known range of this species is from Alberta to Manitoba in Canada. In the United States it is recorded only from Michigan, however, as its habitat is poorly collected it is probably much more wide-spread but only locally distributed.

Liodessus affinis (Say)

Hydroporus affinis Say 1823:104.

Selected references: Young, 1954:60–61, 70–71; Larson, 1975:262–263; Brigham, 1982:10.71; Biström, 1988a:18, 21.

Description. Habitus, Figure 4. Body ovate, lateral margin more or less continuous between pronotum and elytron or with a slight discontinuity. Measurements and ratios in Table 1.

Color various. Dorsal surface yellow to reddish with darker markings as follows: hind margin of head, a central spot on pronotum and more or less linear maculations on elytra. Ventral surface of most specimens with at least metasternum and metacoxal plates dark brown to piceous and strongly contrasting with yellowish abdomen; some specimens with most of ventral surface dark. Antennomeres 1 to 4 mainly yellow, outer antennomeres largely to entirely infuscate. Palpi unicolorous and yellow or each with apical palpomere darker. Legs mainly yellow, metatibia lighter basally, at most apical third darker.

Head relatively coarsely punctate, larger punctures more widespread on frons, larger punctures as large as medial punctures of pronotum. Pronotum not conspicuously punctate, punctures small mediolaterally and more or less widely spaced, coarser and denser medially on darkened area and posteriorly between bases of striae, basolateral punctures relatively small. Elytron conspicuously punctate, punctures separated by about 1.5 to 2 times their own diameter, each puncture bearing a fine, conspicuous seta, subequal in length to or slightly longer than distance between punctures; epipleuron with punctation obsolete. Metasternum inconspicuously punctate. Metacoxal plates rugose, rugae largely obscuring sparse, shallow punctures. Abdomen with sternum 1 coarsely punctate along anterior and posterior margins; sterna 2 to 5 sparsely punctate, punctures shallow and somewhat effaced; sternum 6 with small deep punctures medially, basolateral impression impunctate. Dorsal surface of males smooth and shiny between punctures; females various, some male-like in sculpture, some with entire surface finely microreticulate and somewhat dulled, others with reticulation restricted to apical third of elytron.

Pronotum weakly rounded laterally (Fig. 4), with point of maximum width at hind angles; basal margin slightly sinuate, margin between base of stria and lateral angle slightly arcuate, posterolateral angle slightly produced; lateral stria well developed, one-half to two-thirds length of pronotum measured along same line, strongly delimited laterally; lateral bead of moderate width, broadest basally and gradually narrowed anteriorly. Elytra elongate oval in dorsal aspect, moderately narrowed towards base; in lateral profile, dorsal margin gently and evenly rounded to apex in apical half; most specimens with basal stria sharply impressed, about one-half to as long as pronotal stria, basal stria shorter and less strongly delimited on microreticulate specimens; epipleuron in lateral aspect hidden behind lateral margin for a short distance behind humerus. Metacoxal lines diverging anteriorly.

Aedeagus (Fig. 9; see also Biström, 1988a, fig. 15) arcuate in lateral aspect; shaft subparallel or broadened subapically, apex not differentiated.

Remarks. It is likely that this species is composite (Young, 1954). Throughout North America, at least, a great deal of variation occurs in body shape, colour and structure. However, no author has identified points of discontinuity in the distribution of these characters which would permit definition of more homogeneous and narrowly defined species. A careful study of geographical patterns of variation is needed. Our remarks are confined to specimens occurring north of Mexico.

Collecting notes. These beetles occur in a wide variety of habitats. Adults and larvae are frequently collected in gravel and sand along quiet stretches of warm streams and springs (Harris et al. 1981). They are also abundant in newly formed ponds as well as in warm, shallow areas of vegetation-rich ponds. Specimens are often common in mats of filamentous algae. Adults fly readily and will colonize new habitats quickly. The mature larva of *L. affinis* was described from Delta, Manitoba by Watts (1970) and the urogomphi and distal, two abdominal segments are figured in Matta (1983).

Distribution. As presently defined this species occurs throughout North America and as far south as Chile and Argentina within South America. We have seen records from virtually every state (except Hawaii) and province in the U.S. and Canada. It occurs as far north as tree-line but does not seem to extend into the arctic zone.

Liodessus flavicollis (LeConte)

Hydroporus flavicollis LeConte 1855:291, 295.
Selected reference: Young, 1954:60–62.

Description. Habitus, Figure 5. Body broadly ovate, lateral margin strongly discontinuous in outline between pronotum and elytron. Measurements and ratios in Table 1.

This species is the most distinctly colored species of *Liodessus* in our fauna. Dorsal surface with head yellow, pronotum yellow except basal margin between lateral striae, narrowly fuscous; elytra dark brown to black with pale transverse spots (Fig. 5) situated sub-basally, sub-medially and apically, these spots contiguous with pale lateral margin but separated from suture by fuscous area on most specimens; some specimens differing as follows: dark areas of elytron expanded so that pale fascia largely reduced or eliminated, others differ in that pale areas are expanded and longitudinally confluent along suture. Ventral surface various, entirely yellow to brown. Antennomeres entirely yellow, or with outer antennomeres infuscate apically. Palpi yellow. Legs yellow, metatibia yellow.

Head rather finely and sparsely punctate, punctures obscured by well impressed microreticulation. Pronotum conspicuously and very densely punctate, punctures uniformly distributed over entire disc. Elytron conspicuously and very densely punctate, punctures closely spaced, somewhat confluent, and forming irregular transverse rugae, punctures separated by much less than to about their own diameter, each puncture with a conspicuous, slightly flattened, yellowish seta, setae predominantly suberect and longer than distance between punctures; epipleuron densely, finely punctate. Metasternum medially densely and coarsely punctate. Metacoxal plate densely and coarsely punctate. Abdomen with sternum 1 coarsely punctate, punctures distributed in three or more transverse rows; sterna 2 to 5 increasingly finely and sparsely punctate; sternum 6 with a few coarse punctures medially. Dorsal surface of both sexes with microreticulation which is more strongly impressed in female specimens.

Pronotum strongly rounded laterally (Fig. 5), with point of maximum width clearly anterior to hind angles; basal margin more or less straight lateral to stria, posterolateral angle not produced; lateral stria poorly developed, short, about a fourth to a third length of pronotum measured along same line, poorly delimited laterally; lateral bead fine and of more or less uniform width. Elytra relatively short and oval in dorsal aspect, distinctly narrowed towards base; in lateral profile, obliquely truncate to apex in apical half; basal stria lacking or at most represented by a small impression; epipleuron in lateral aspect broadly visible to humeral angle. Metacoxal lines evidently diverging anteriorly.

Aedeagus (Fig. 10) arcuate in lateral aspect; shaft tapering apically, apex with a dorsally directed hook. The paramere (not figured) is similar to that of *L. hobbsi.*

Collecting notes. Roberts (1913:120), Hatch (1925:106) and Young (1954:61) suggest that *L. flavicollis* is a relatively deep-water resident which is associated with algal mats, and Young further noted that he had not observed adults visiting the pond surface to renew their subelytral air supply. Specimens were collected from Walpole Island, Ontario, by dredging aquatic plants and algae from narrow, deep sandspit ponds. No flight records of this species were found. Sharp (1882:349) found a specimen to be wingless, but Young (1954:61) recorded winged specimens. Specimens with short, non-functional wings were seen from Ontario, Minnesota and Maryland.

Distribution. We have records of this species from throughout eastern North America, west to eastern Manitoba, Minnesota and Mississippi and from southern Ontario and southern Quebec to Florida.

Liodessus hobbsi (Young)

Bidessus hobbsi Young 1950:4.
Selected references: Young, 1950:4–6; 1954:60, 62.

Description. Our description is based on Young (1950:4–6) and a male paratype (FL, Liberty Co., det. F. N. Young, MUN). Habitus, see figure 2 in Young (1950); habitus apparently various, in dorsal aspect similar to *L. flavicollis* (Fig. 5), or body, especially elytra, narrower, at widest scarcely broader than pronotum; lateral margin strongly discontinuous in outline between pronotum and elytron. Measurements and ratios are presented in Table 1.

Dorsal surface uniformly testaceous to pale brown. Ventral surface uniformly testaceous to pale brown. Antennonmeres 1 to 4 or 5 mainly yellow, outer antennomeres slightly infuscate. Palpi unicolorous and yellow or each with apical palpomere darker. Legs uniformly testaceous to pale brown.

Head rather finely punctate. Pronotum conspicuously punctate, punctures large but shallow and widely separated; with two or three enlarged punctures along hind margin between posterolateral angle and base of lateral stria. Elytron coarsely punctate, punctures separated by one to two times their own diameter, each puncture bearing a fine seta subequal in length to distance between punctures; epipleuron inconspicuously punctate. Metasternum and metacoxal plate with coarse, irregularly spaced punctures. Abdomen with sternum 1 coarsely punctate along anterior and posterior margins; sternum 2 medially, and sterna 3 to 5 finely punctate; sternum 6 sparsely punctate medially. Dorsal surface of single male examined microreticulate.

Pronotum relatively strongly rounded laterally, with point of maximum width clearly anterior to hind angles; basal margin strongly sinuate, margin between base of stria and lateral angle arcuate, posterolateral angle evidently produced; lateral stria moderately developed, about half as long as pronotum measured along same line, strongly delimited laterally; lateral bead fine and of more or less uniform width. Elytra elongate oval in dorsal aspect, distinctly narrowed towards base; in lateral profile, obliquely truncate to apex in apical half; basal stria lacking or at most represented by a small impression; epipleuron in lateral aspect broadly visible to humeral angle. Metacoxal lines subparallel.

Aedeagus (Fig. 11) arcuate in lateral aspect; shaft subparallel, apex with a dorsally directed hook.

Collecting notes. According to Young (1954:62), the two type specimens of *L. hobbsi* ". . . were taken from a shallow pool almost filled with filamentous algae." He also believed that it would be ecologically similar to *L. flavicollis.*

Distribution. Known only from a few specimens from near Wilma, Liberty Co., which is in the Apalachicola flatwoods region of the panhandle of Florida.

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NEW SPECIES OF *NEOTRICHIA* (TRICHOPTERA: HYDROPTILIDAE) FROM CENTRAL AND SOUTH AMERICA

S. C. Harris

Aquatic Biology Program, Department of Biology,
University of Alabama, Tuscaloosa, Alabama 35487

Abstract.—The males of nine new species of *Neotrichia* (Trichoptera: Hydroptilidae) from Central and South America are described and illustrated: *N. colmillosa* (Venezuela), *N. browni* (Venezuela), *N. cuernuda* (Venezuela), *N. arista* (Venezuela), *N. dientera* (Venezuela), *N. botonia* (Venezuela), *N. negroensis* (Venezuela), *N. flowersi* (Panama), and *N. colombiensis* (Colombia).

Neotrichia is a widely distributed New World genus, occurring throughout North, South and Central America. Adults of this genus are recognized by their small size, tibial spur formula of 0, 2, 3, presence of ocelli, and mesoscutellum lacking a transverse suture (Marshall, 1979). In the review of Marshall (1979), the genus contained 45 species in six species groups. Since this publication, 24 additional species have been described from the United States (Kelley and Harris, 1983; Harris, 1985), Mexico (Malicky, 1980; Bueno and Hamilton, 1986), Cuba (Botosaneanu, 1980), and austral South America (Flint, 1980, 1982, 1983; Angrisano, 1986). This paper adds nine more species to the total and makes species names available for several faunistic compilations underway in South America. With the additional species, the species groups of Marshall (1979) are in need of revision and are not utilized in this paper.

Morphological terminology generally follows that of Marshall (1979). Type material is deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Neotrichia colmillosa, new species
Fig. 1

Diagnosis. This species appears to be most similar to *N. filifera* Flint in the long, lateral processes from the ninth segment. The bilobed subgenital plate and curving spines of the phallus serve to differentiate the new species.

Description. Male: Length 1.5 mm. 18 antennal segments. Brown in alcohol. Ninth abdominal segment in lateral view with anterior margin rounded, posteroventral margin produced into a long, narrow lobe; posterodorsal margin with long, thin processes which crisscross, in dorsal and ventral views; pair of small lobes on dorsum each bearing seta. Segment X membranous and fused with segment IX; slightly emarginate in dorsal view. Subgenital plate bilobed in ventral aspect, each sclerotized lobe thin and emarginate along inner surface. Inferior appendages short and narrow in both lateral and ventral views; widely separate basally, tapering apically and curving outward in ventral aspect. Phallus with large lateral hook near middle of

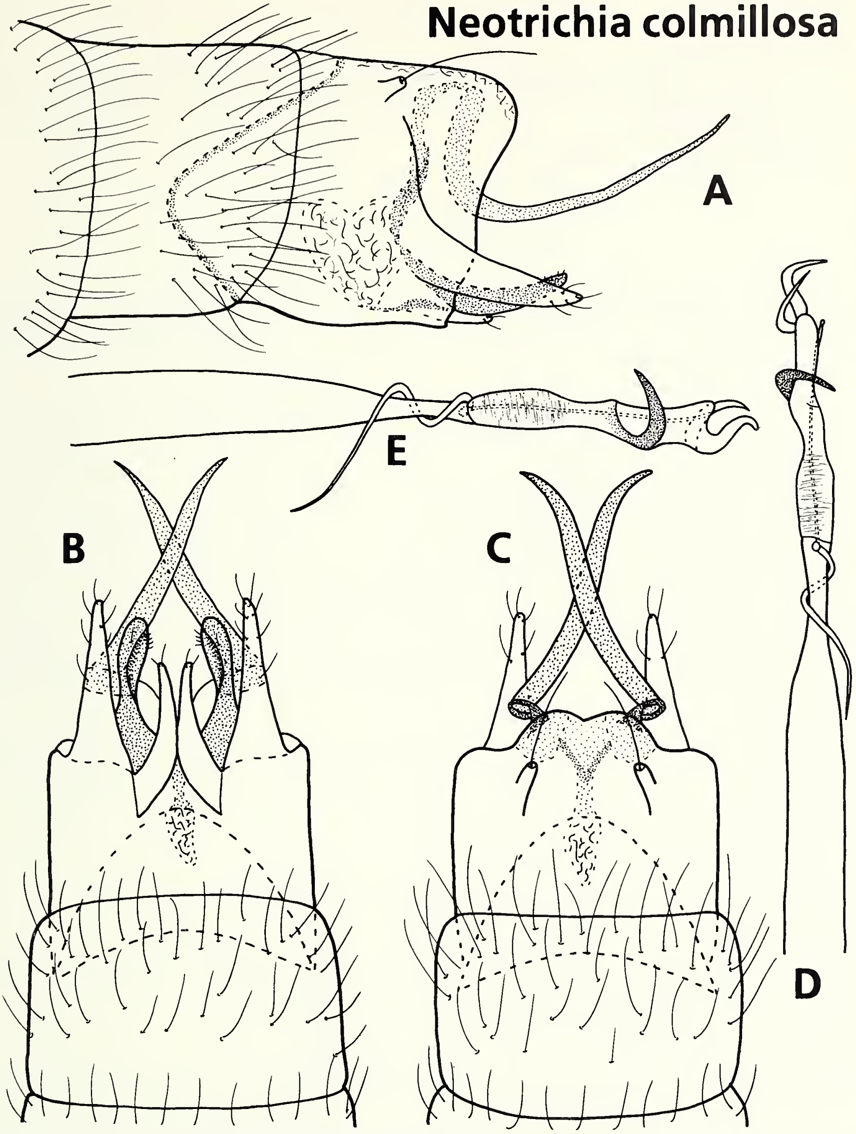

Fig. 1. *Neotrichia colmillosa.* Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal; E, phallus, lateral.

distal portion and two narrow hooks at apex; thin paramere encircling shaft and extending anteriorly.

Type material. Holotype: Male, Venezuela, Territorio Federal Amazonas, Cerro de la Neblina basecamp, 0°50'N, 66°9'W, 140 m, 24 November–1 December 1984, R. L. Brown.

Etymology. Spanish, having tusks.

Neotrichia browni, new species

Fig. 2

Diagnosis. This species is most similar to *N. colmillosa* in general genitalic features. Both have long lateral processes from the dorsum of the ninth segment and similarly shaped subgenital plates, but the phallus of *N. browni* lacks the prominent distal hooks of *N. colmillosa.*

Description. Male: Length 1.6 mm. 18 antennal segments. Brown in alcohol. Ninth abdominal segment in lateral view with anterior margin rounded, posteroventral margin produced into a long, truncate lobe; posterodorsal margin with long processes which curve ventrally in lateral view and crisscross in dorsal view; pair of small lobes dorsally, each bearing seta. Segment X fused with segment IX, produced into two triangular lobes distally. Subgenital plate bilobed in ventral aspect, each lobe thin and curving inward, apex of each with numerous short spines. Inferior appendages short and narrow in lateral and ventral views; widely separate basally, tapering apically and converging distally in ventral aspect. Phallus with distal portion tapering apically, apex curved into narrow hook; paramere encircling shaft and extending posteriorly.

Type material. Holotype: Male, Venezuela, Territorio Federal Amazonas, San Carlos de Río Negro, 1°56'N, 67°03'W, 13–17 December 1984, R. L. Brown.

Etymology. Named for Dr. Richard L. Brown, the collector of much of the material from Venezuela.

Neotrichia cuernuda, new species

Fig. 3

Diagnosis. With *N. colmillosa* and *N. browni,* this species shares the elongate posterodorsal processes of the ninth segment. It differs from these species in the structure of the subgenital plate and inferior appendages.

Description. Male: Length 1.8 mm. 18 antennal segments. Brown in alcohol. Ninth abdominal segment in lateral view with anterior margin rounded, posterodorsal margin produced into a long, thin, straight process; posteroventral margin produced into two narrow processes, upper more lateral in position and longer than lower; pair of lobes dorsally, each bearing seta. Segment X fused with segment IX, rounded distally with mesal notch. Subgenital plate prominent, dome-shaped in ventral view, with narrow apex bearing pair of setae; in lateral view tapering to acute apex which bends ventrad. Inferior appendages appearing bifid; in lateral view outer portion narrow at base, widening apically, inner portion narrow over entire length; in ventral view, outer portion curving laterad in lower third then caudad, slightly tapering to apex which abruptly bends outward, inner portion of appendage narrow, widely separate basally, tapering to apex. Phallus darkly sclerotized in distal half, parallel

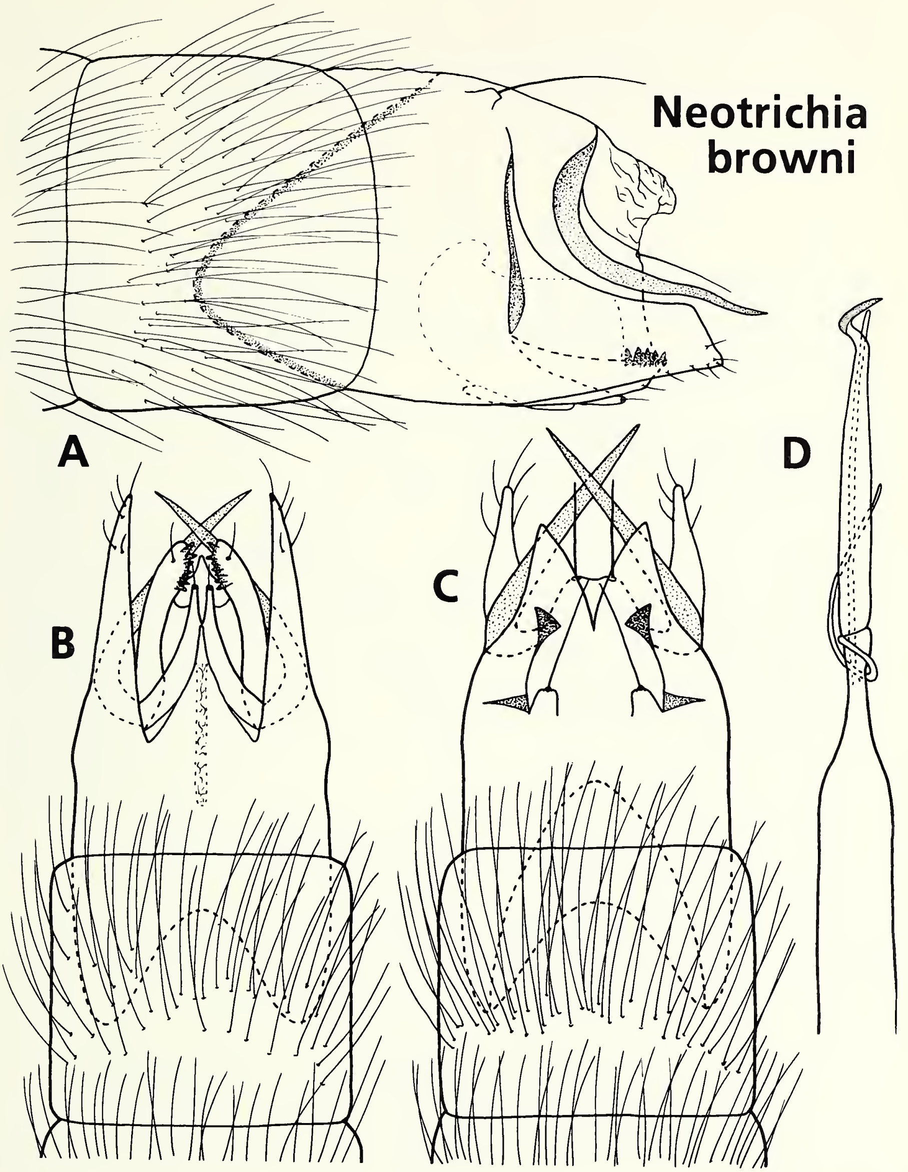

Fig. 2. *Neotrichia browni.* Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal.

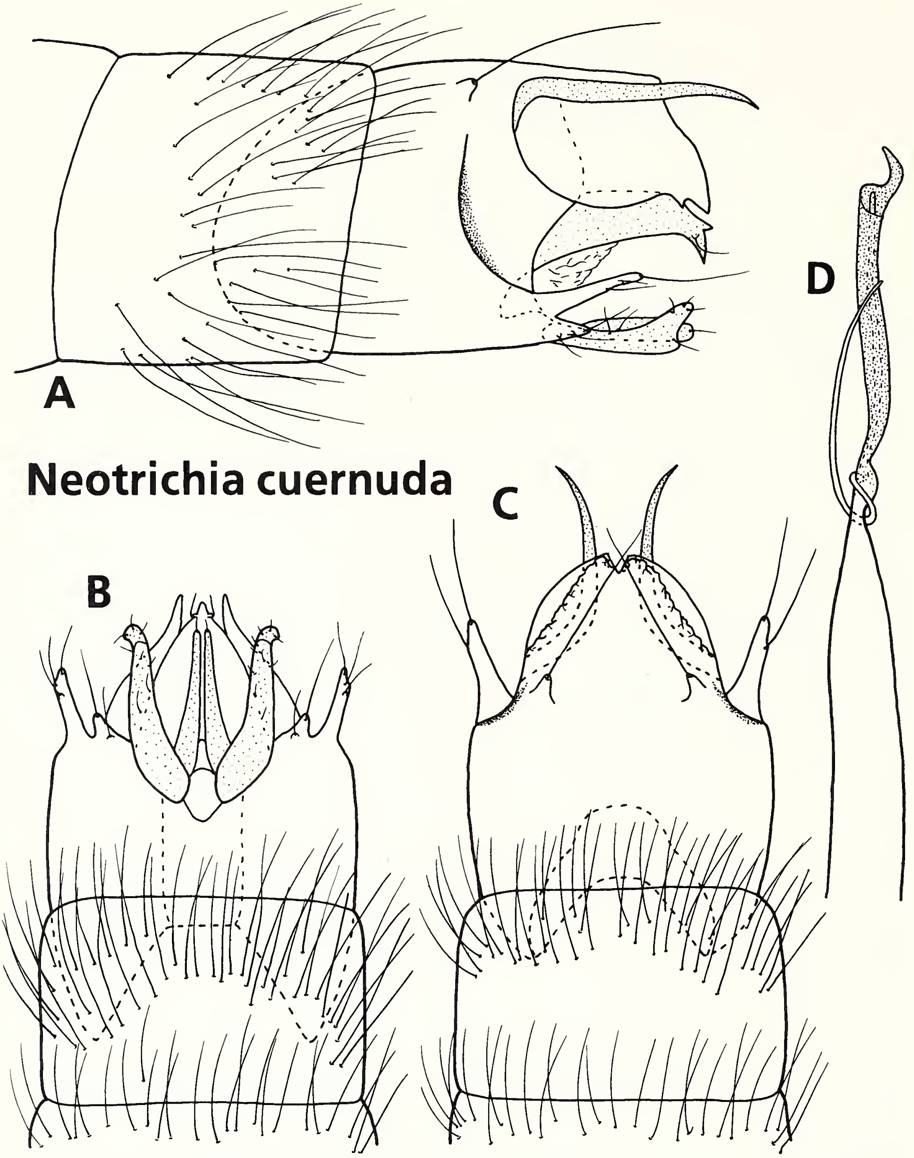

Fig. 3. *Neotrichia cuernuda.* Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal.

sided and ending with a short hook; paramere encircling shaft and extending posteriorly.

Type material. Holotype: Male, Venezuela, Territorio Federal Amazonas, Agua Blanca, Cerro de la Neblina, 0°49′N, 66°08′W, 160 m, 20–21 March 1984. O. S. Flint, Jr. and J. A. Louton.

Etymology. Spanish, having horns.

Neotrichia arista, new species

Fig. 4

Diagnosis. This species is most similar to *N. alata* Flint and *N. tertia* (Mosely) in the dorsolateral processes of the ninth segment and the lateral bracteoles. The folding of these dorsolateral processes and the complex phallic structure differentiate *N. arista.*

Description. Male: Length 1.7 mm. 18 antennal segments. Brown in alcohol. Ninth segment in lateral view with ridge-like posterodorsal projection which is sclerotized and folded at midlength, anterior margin tapered and extending through segment VIII; bracteoles posteroventrally, about half length of segment X, rectangular in shape with rounded apex. Segment X fused with IX, elongate and membranous apically. Subgenital plate in ventral aspect with mesal incision apically. Inferior appendages sclerotized; in lateral view wide basally, narrowing to apex; in ventral view generally elongate-oval in shape, wide at base, curving inward and narrowing apically, notched on mesal margin near apex. Phallus complex in distal half with much infolding, heavy internal spine at midlength visible in lateral view; paramere extending posteriorly.

Type material. Holotype: Male, Venezuela, Territorio Federal Amazonas, Río Cataniapo, 10 km S Puerto Ayacucho, 9 March 1984, O. S. Flint, Jr. Paratype: same data as holotype, 1 male.

Etymology. Spanish, ridge, referring to the ridgelike extension of the ninth segment.

Neotrichia dientera, new species

Fig. 5

Diagnosis. This species has some similarity to *N. caxima* (Mosely) in the acute spine projecting from the ninth segment and the lack of bracteoles. However, *N. dientera* lacks the paired phallic spines of *N. caxima.*

Description. Male. Length 1.2–1.6 mm. 18 antennal segments. Brown in alcohol. Ninth segment in lateral view with elongate, lateral spine on posteromesal margin, three excisions on posteroventral margin, anterior margin rounded and short, barely extending into segment VIII. Segment X fused with IX, membranous with numerous longitudinal folds laterally. Subgenital plate short, rounded apically in ventral view. Sclerotized inferior appendages rectangular in lateral view; in ventral view trapezoidal and fused laterally with segment IX. Phallus with distal portion tapering to apex, sclerotized projection arising near midlength and extending to apex, ejaculatory duct protruding apically; paramere encircling shaft and extending posteriorly.

Type material. Holotype: Male, Venezuela, Territorio Federal Amazonas, San Carlos de Río Negro, 1°56′N, 67°03′W, 13–17 December 1984, R. L. Brown. Paratypes: same data as holotype, 11 males.

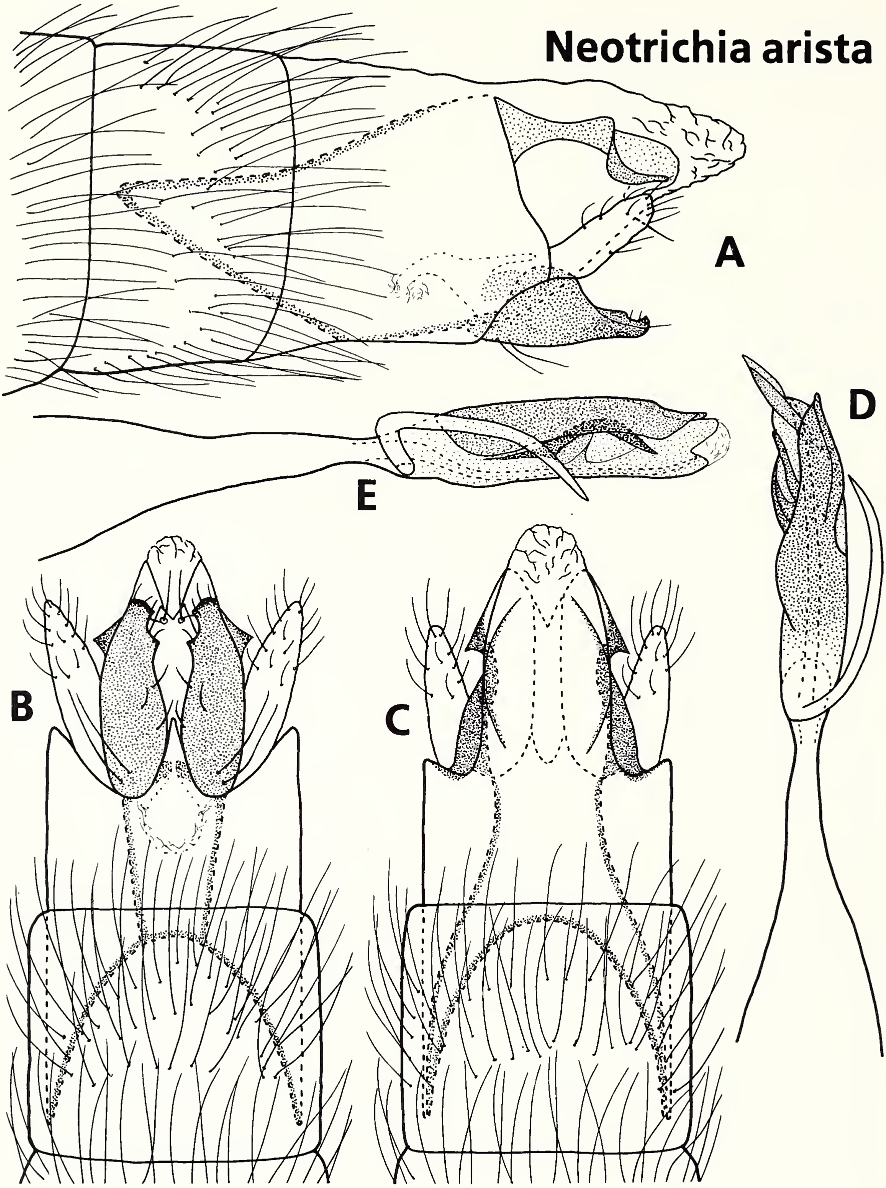

Fig. 4. *Neotrichia arista.* Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal; E, phallus, lateral.

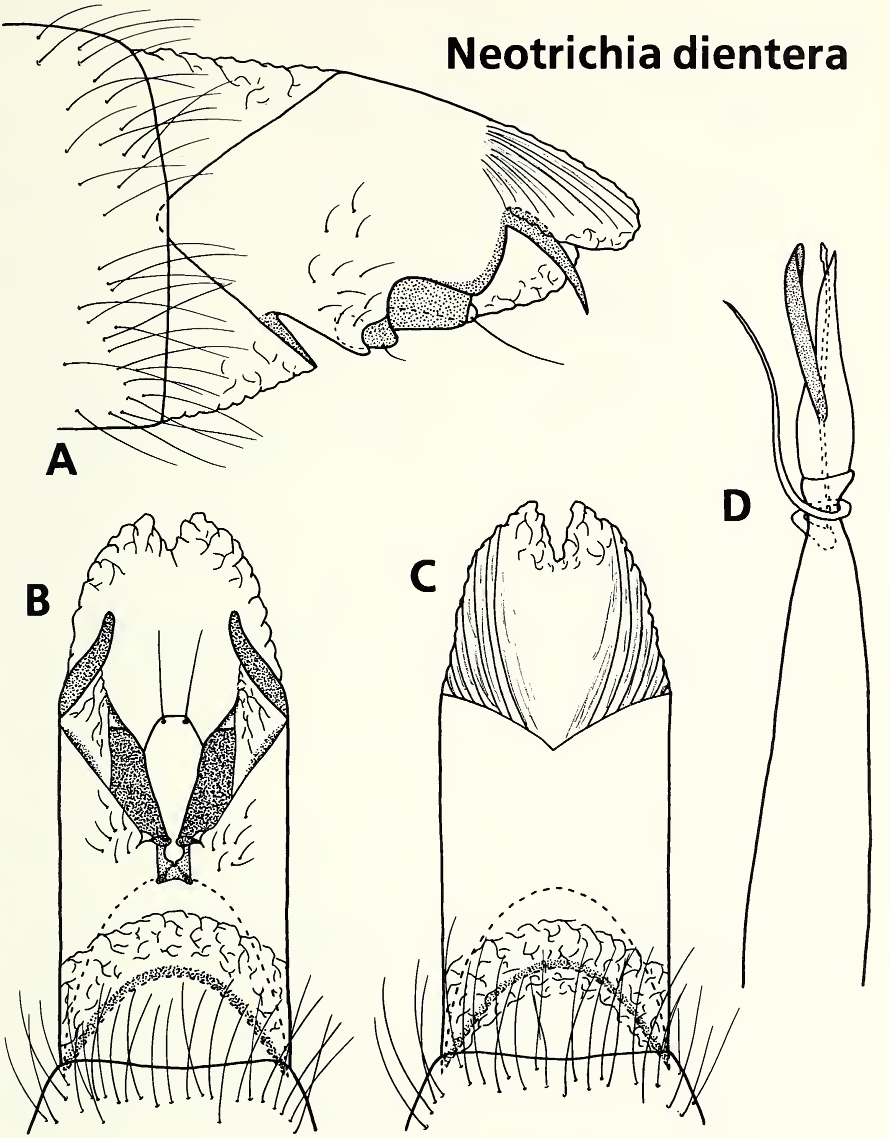

Fig. 5. *Neotrichia dientera.* Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal.

Etymology. Spanish, toothlike, referring to the sclerotized lateral spine of the ninth segment.

Neotrichia botonia, new species

Fig. 6

Diagnosis. In many respects this species is similar to *N. dientera.* It is easily separated by the posteroventral elongation of the ninth segment and the numerous ventral lobes adjacent to the inferior appendages.

Description. Male. Length 1.7 mm. 18 antennal segments. Brown in alcohol. Ninth segment in lateral view with two thin lateral processes on posteromesal margin, inner process about ⅓ length of outer process, posteroventral margin produced as a triangular process extending beyond the inferior appendages; in ventral view these lateral processes appear as six elongate lobes. Segment X partially fused with IX, membranous with many narrow longitudinal folds. Subgenital plate short and wide in ventral aspect, slightly rounded apically, bearing two elongate, heavy setae. Inferior appendages narrow and curving upward in lateral view; in ventral view fused mesally, triangular apically. Phallus with distal portion divided, sclerotized lateral process narrowing to acute apex with small spine near base, central tube widening at apex with sclerotized ejaculatory duct protruding; paramere encircling shaft and extending posteriorly.

Type material. Holotype. Male, Venezuela, Territorio Federal Amazonas, San Carlos de Río Negro, 1°56′N, 67°03′W, 13–17 December 1984, R. L. Brown.

Etymology. Spanish, knobby, referring to the ventral lobes of the ninth segment.

Neotrichia negroensis, new species

Fig. 7

Diagnosis. This species is similar to *N. lobata* Flint in the general plan of the genitalia, particularly the phallus. The inferior appendages in *N. negroensis* are not bifid as they are in *N. lobata* and the lateral margin of the ninth segment is produced as a large lobe.

Description. Male. Length 1.8 mm. 18 antennal segments. Brown in alcohol. Ninth segment in lateral view with posteromesal margin produced as a large, lateral, rounded lobe, posteroventral margin produced as two narrow projections, each bearing setae, the upper twice as long as the lower; in dorsal view, lateral lobes narrow and heavily setose. Segment X elongate and fused with IX, lightly sclerotized laterally, membranous mesally and deeply incised. Subgenital plate in lateral view narrowing to an acute apex; in ventral view rectangular with mesal point apically, pair of heavy setae on ventral lobes. Inferior appendages darkly sclerotized, in lateral view narrowing from base to acute apex; in ventral view wide basally, with small seta bearing lateral lobes, fused mesally, tapering apically. Phallus with distal portion slender, widened base with three sclerotized spines; paramere partially encircling shaft and extending posteriorly.

Type material. Holotype. Male, Venezuela, Territorio Federal Amazonas, San Carlos de Río Negro, 1°56′N, 67°03′W, 6–12 December 1984, R. L. Brown.

Etymology. Named for the Río Negro.

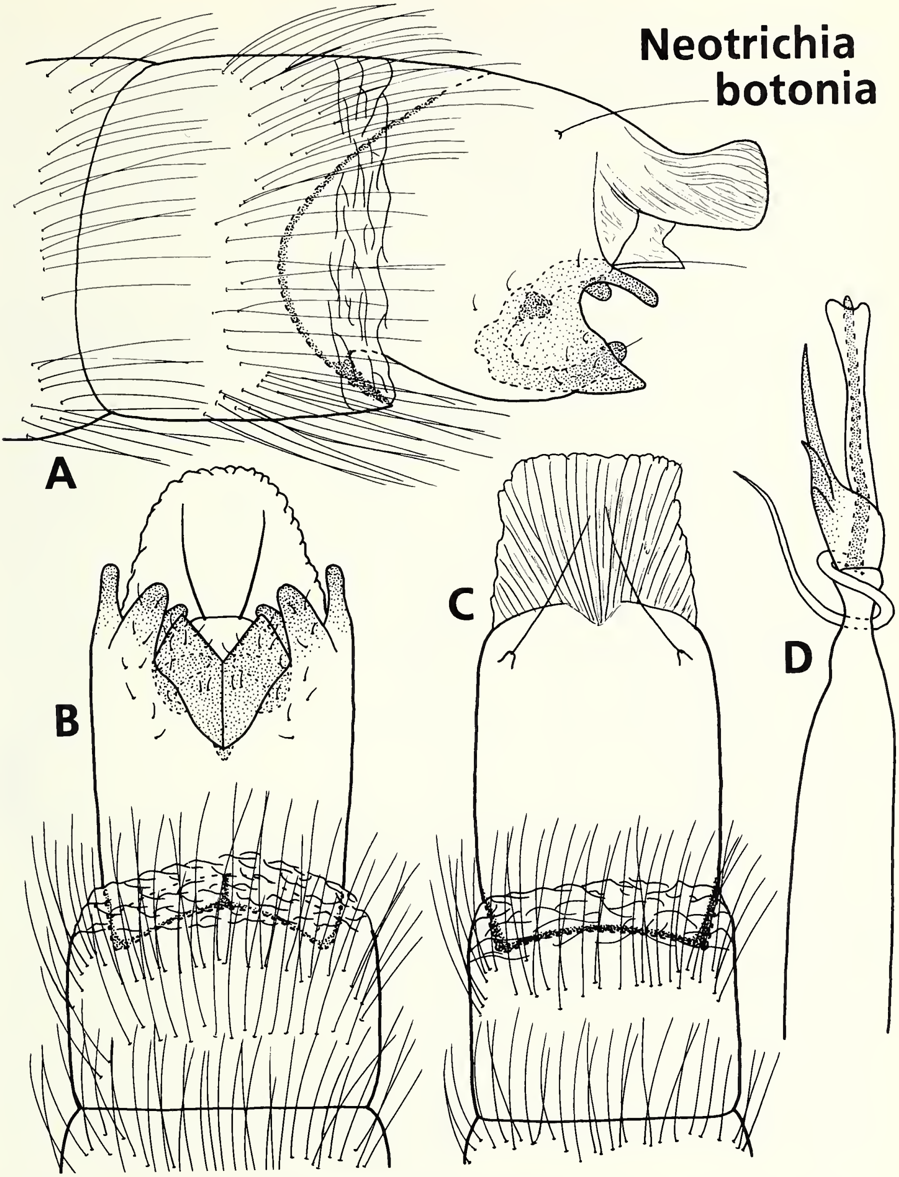

Fig. 6. *Neotrichia botonia.* Male genitalia; A, lateral; B, ventral; C, dorsal; D, phallus, dorsal.

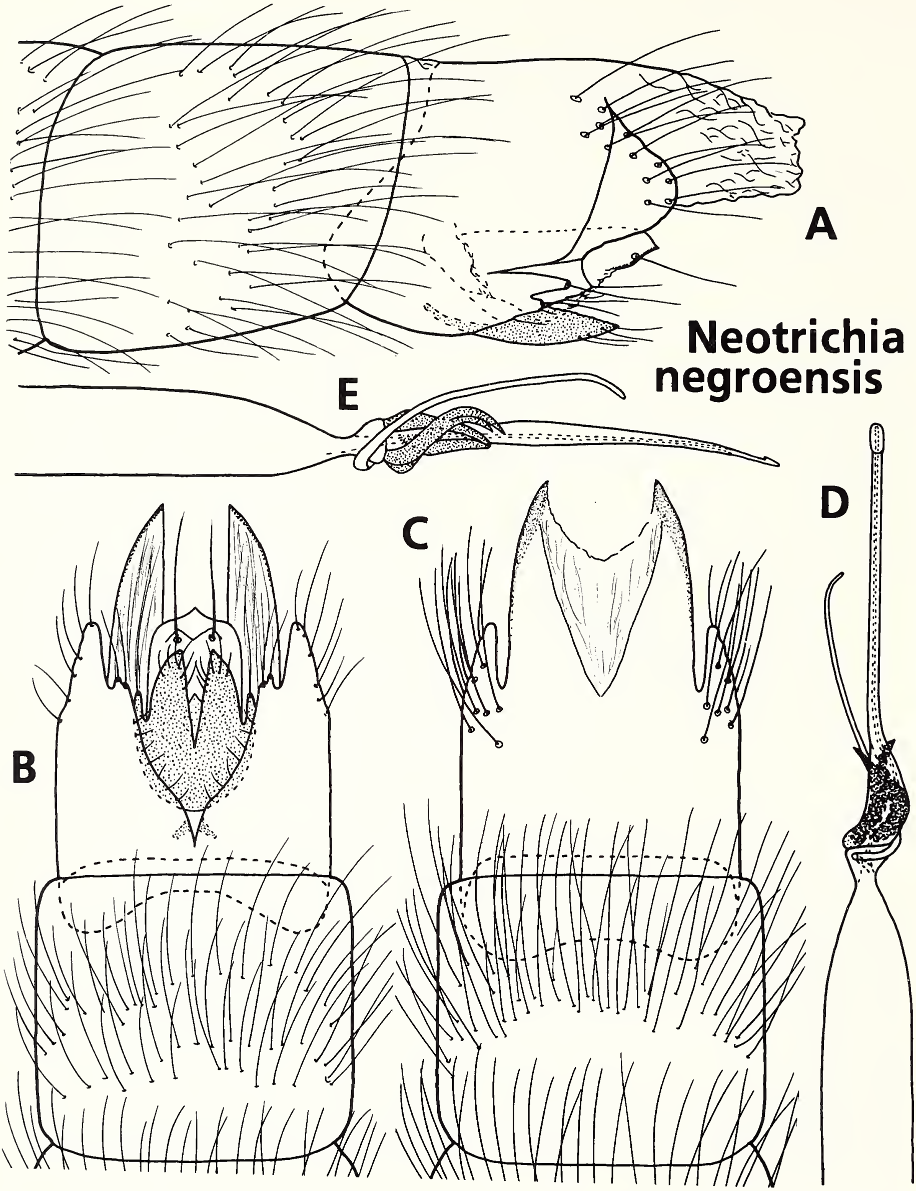

Fig. 7. *Neotrichia negroensis.* Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal; E, phallus, lateral.

Neotrichia flowersi, new species
Fig. 8

Diagnosis. This species has some similarity to *N. cuernuda* and *N. lobata* Flint in the bifid inferior appendages. However, these appendages are more elongate in *N. flowersi.*

Description. Male. Length 1.5 mm. Antennae broken. Brown in alcohol. Ninth segment in lateral view with posteromesal margin produced as a rounded lateral lobe; anterior margin tapered to acute apex and extending midway into segment VIII; bracteoles posteroventrally, elongate and thin, slightly widened apically and rounded in lateral view; in dorsal and ventral views slender and curving inward. Segment X fused with IX, narrow dorsally with shallow emargination apically, pair of small dorsal lobes, each bearing seta. Subgenital plate in lateral view with apex forming sclerotized, posteriorly directed point; in ventral view truncate with sinuate distal margin. Inferior appendages bifid; outer, ventral portion thin and elongate in lateral view; in ventral view fused mesally, diverging and tapering apically; inner, dorsal portion thin and about ¾ length of ventral portion. Phallus with distal section lightly sclerotized, pair of small spines laterally near apex, darkly sclerotized protuberances subapically; paramere nearly encircling shaft and extending posteriorly.

Type material. Holotype: Male, Panamá, Bocas del Toro Province, Quebrada Canza at pipeline road, 90 m, 18 May 1985, R. W. Flowers.

Etymology. Named in honor of the collector Dr. R. Wills Flowers who has made many contributions to our knowledge of the Neotropical fauna.

Neotrichia colombiensis, new species
Fig. 9

Diagnosis. In most aspects of the genitalia, this species resembles *N. noteuna* (Mosely). It differs in the short ventral process of the subgenital plate, emarginate tenth tergum, and structure of the phallus.

Description. Male. Length 1.5–1.7 mm. 18 antennal segments. Brown in alcohol. Ninth segment in lateral view sinuate on posterior margin, narrowing anteriorly and extending into segment VII; bracteoles posteroventrally, elongate and thin, rounded apically. Segment X fused with IX, deeply emarginate distally with pair of long, thin lateral lobes dorsally, each bearing seta. Subgenital plate darkly sclerotized; thin and elongate in lateral view with small ventral point at midlength; in ventral view rectangular, deeply incised apically, pair of small setae ventrally near apex. Inferior appendages narrow in lateral view, particularly near apex, serrate on dorsal surface at midlength; in ventral view wide basally, angled on mesal margin at middle, tapering to blunt apex. Phallus with sclerotized distal portion divided subapically to form short and long acute processes; paramere encircling shaft and extending anteriorly.

Type material. Holotype: Male, Colombia, Antioquia Department, Quebrada la Jiminez, Sopetrán, 780 m, July 1983, U. Matthias. Paratypes: same data as holotype, but September 1983, 1 male, 1 female.

Etymology. Named for Colombia.

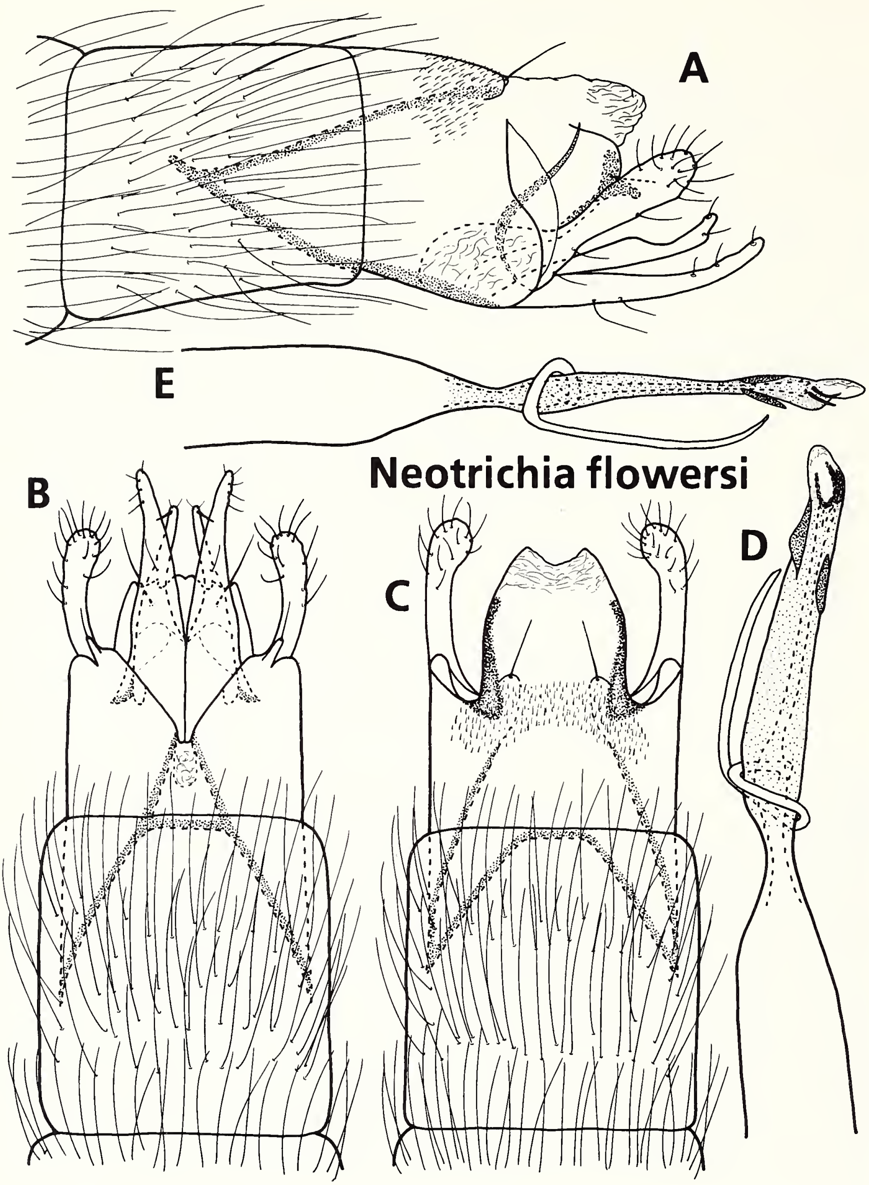

Fig. 8. *Neotrichia flowersi*. Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal; E, phallus, lateral.

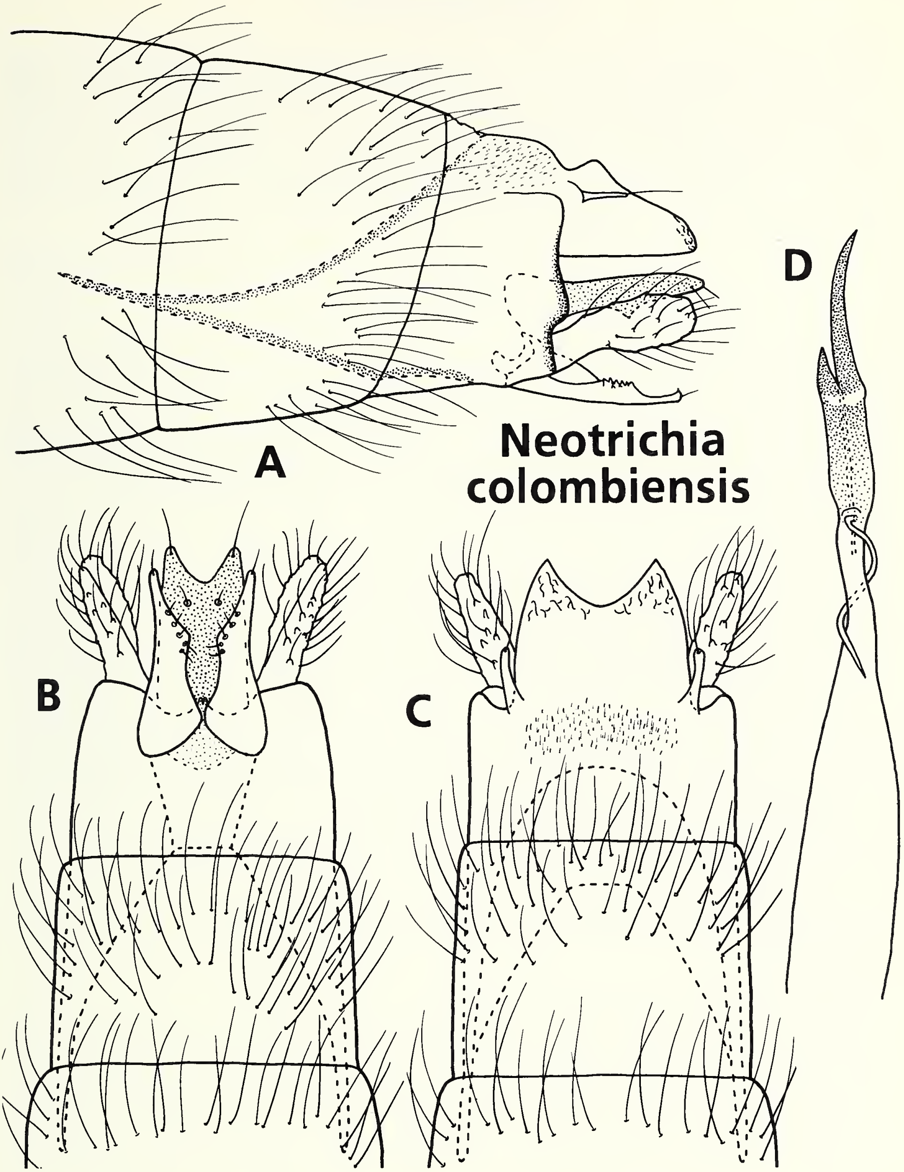

Fig. 9. *Neotrichia colombiensis.* Male genitalia: A, lateral; B, ventral; C, dorsal; D, phallus, dorsal.

ACKNOWLEDGMENTS

Dr. Oliver S. Flint, Jr. kindly made available the *Neotrichia* collections from the National Museum of Natural History and has been very helpful in the descriptions of the new species and supportive of my efforts to revise the genus. Dr. R. Wills Flowers is due my thanks for providing Panama material for study. The Geological Survey of Alabama provided supplies and facilities during this study and is gratefully acknowledged. Mrs. Peggy Marsh typed several drafts of the manuscript and Ruth Turner photographed the plates. This publication is contribution number 122 of the Aquatic Biology Program, University of Alabama.

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BOOK REVIEWS

J. New York Entomol. Soc. 98(2):261–263, 1990

EVERYTHING YOU EVER WANTED TO KNOW ABOUT SPECIATION (BUT WERE AFRAID TO ASK)

Speciation and its Consequences.—D. Otte and J. A. Endler, eds. 1989. Sinauer Associates, Inc., Sunderland, Massachusetts. xiii + 679 pp. $29.95 (paper), $50.00 (cloth).

Vrijenhoek's contribution for this 25-chapter edited volume, in which he describes the origin of parthenogenetic clones from sexual populations of *Poeciliopsis* fish, reminds us that sex and speciation are intimately related. In *Poeciliopsis,* the genetic diversity of sexual lineages allows them to exploit heterogeneous environments. Triploid clones derived from sexual lineages freeze sexual genotypes, and interdemic selection sorts out these genotypes relative to the environment. Sexual lineages respond to habitat changes and fragmentation by speciating, whereas clonal lineages respond by going extinct. By analogy, if sex is the symptom, speciation is the disease. However, one should not falsely conclude that there is a subject safe from contention in these contributed papers based on a symposium celebrating the 175th anniversary of the founding of the Academy of Natural Sciences of Philadelphia. In this case you need only read Gill's contribution, in which he asks how can it be that 8,000 out of the 30,000 orchid species do not reward their pollinators and set fruit only 1–8% of the time? The editors preface the book by suggesting that it fulfill three purposes: 1) to illustrate the diverse patterns and processes involved in speciation and differentiation; 2) to explore the consequences of this diversity for ecological, paleontological and systematic studies; 3) to present the "extreme diversity of concepts and viewpoints" (p. xii) on speciation. Their success in this endeavor is enhanced by the fact that current questions about speciation are recurring and fundamental questions on the subject. The various means by which biotic diversity multiplies ensures the variety of viewpoints used to explain that diversification.

The most fundamental issue dealt with by many of the contributors entails the nature of species and whether any single definition is optimal. Endler asks if a species is considered a snapshot of present-day organismal interactions, as stressed in reproductive and recognition concepts, how can we avoid a phenetic approach to delimiting species? If we adopt the cladistic species concept do we gain the ability to study speciation patterns at the expense of understanding present-day anagenetic change? Or must we recognize that populations, not species, are the fundamental unit of evolution—as argued by Nelson—and, therefore, species evolve just like genera, families, and other higher taxa? If there is a consensus, it is to the degree that we can delimit the disadvantages of all species definitions so far proposed. Templeton endorses a cohesion concept, whereby the species is "the most inclusive population of individuals having the potential for phenotypic cohesion through intrinsic cohesion mechanisms" (p. 12). Cracraft advocates a cladistic definition, i.e., a species is "an irreducible (basal) cluster of organisms diagnosably distinct from other such clusters, and within which there is a parental pattern of ancestry and descent" (p. 34). Futuyma and Larson advocate the more theoretical cohesion species concept, yet examine the properties of these species in a cladistic framework. Cracraft illustrates how reliance on reproductive isolation as a criterion for species diagnosis can obfuscate cladistic relationships when hybridization occurs between non-sister species. Larson illustrates the opposite syndrome, i.e., salamanders that don't evolve morphologically, but have become genetically distinct, parapatric entities. Patton and Smith argue that biological species will always be parapatric, because speciation involves isolation and derivation of peripheral populations. This last argument can be made irrelevant by decoupling delimitation of sister species from cladistic analysis. The former focuses on the cohesion of species, whereas the latter attempts to determine the hierarchical patterns of sister-group relationship. Such decoupling is necessary as certainty regarding the attributes of ancestors is not possible.

The diversity of opinions on founder and sympatric speciation is also well represented. Lynch reviews distributional data in light of cladistic relationships and concludes that allopatric speciation accounts for over 70% of the speciation events across a number of vertebrate taxa, whereas peripheral speciation—both "microvicariance" of small peripheral portions of an ancestral range and founder events—account for only 5–10%, and sympatric speciation 5–20%. His analysis admits the possibility of sympatric speciation when the range of one species is entirely contained within the range of its sister, claiming this to be a more parsimonious solution than a vicariant event followed by dispersal. By this interesting argument, vicariance and disperalist biogeographers become strange bedfellows, sharing the viewpoint that sympatric distributions are due to secondary dispersal. Lest we sense agreement, Barrett advocates founder events and mating system changes in heterostylous plants as one means for diversification, whereas Barton argues that any founder events would leave a trail of reduced heterozygosity, which we do not see.

Recent developments regarding sympatric speciation are well represented, with three chapters presenting recent field data in conjunction with discussions on prior models based on aspects of this mechanism. A fourth chapter by Diehl and Bush offers a new model incorporating habitat preference and assortative mating. All contributions go beyond whether sympatric speciation might occur and how common it might be. The current emphasis focuses on the multiplicity of conditions under which sympatric speciation is the most supportable mechanism. Factors such as habitat association (Tauber and Tauber, Diehl and Bush), infraspecific polymorphism and resource partitioning (Wilson), and frequency and density dependent selection (Grant and Grant) are investigated.

The interaction of species via hybridization, infraspecific reinforcement, and character displacement is also covered. Butlin examines a linear infraspecific hybrid zone in search of reinforcement and does not find it. Harrison and Rand present a more complicated interspecific mosaic hybrid zone which is associated with differences in habitat. Hewitt argues that intrinsic factors as well as differences in habitat may cause coincidence of multiple clines, and the resultant hybrid zone.

Empirical studies can offer new directions for theoretical studies. Otte presents an overview of species patterns and diversity of Hawaiian crickets (there are lots of them). The potential for using these musical creatures for studies of character displacement and reinforcement has yet to be explored. Wake et al. present a detailed investigation of a narrow hybrid zone in the classical ring species, *Ensatina eschscholtzii,* using morphological and biochemical data. Ryder et al. present chromosomal divergence in African dik-dik antelopes and its implication for managing captive vertebrates.

Community evolution is investigated by ecologists who are now *emphasizing* that historical factors impact present-day community structure. Both Roughgarden and Pacala, and Ricklefs present the taxon cycle as a general—or at least sort of general—model of community organization. The former analysis incorporates paleontological data to provide a historical context. Paleontological presentations are otherwise conspicuously absent, although Nelson's discussion of species is most comprehensible from a paleontological viewpoint. Ricklefs also suggests that comparison of traits of sister groups can elucidate factors affecting their respective diversity, a viewpoint seconded by Larson. Futuyma suggests that speciation is the means by which anagenetic change is preserved, and therefore increased speciation should be correlated with increased anagenesis, all other things being equal.

Whereas the editors were cautious about claiming to assemble a consensus view on speciation, there appears to be a consensus forming with regard to methodology. Speciation is increasingly being viewed in its historical context, and cladistic analysis is the means to present that context. Contention about the nature of species may sort itself out as we more carefully define just what we want to accomplish in any particular analysis. Sympatric speciation studies are clearly becoming more and more sophisticated. A comparison of the data generated by research programs either supporting or denying its existence aptly illustrated who is contributing to science and who isn't.

In summary, this book contains numerous thought provoking contributions that will enhance the understanding of any reader. Far from being an "advances" volume that gets dusty on the shelf, this book ought to be repeatedly consulted. Its use will no doubt stimulate further advances in evolutionary biology and systematics.—*James K. Liebherr, Department of Entomology, Comstock Hall, Cornell University, Ithaca, New York 14853-0999.*

J. New York Entomol. Soc. 98(2):263–264, 1990

Invertebrate-Microbial Interactions: Ingested Fungal Enzymes in Arthropod Biology. M. M. Martin. 1987. Cornell University Press, Ithaca and London. 148 pp., illus. $32.50 hardbound, $14.95 paperback.

This is the first volume in a series titled *Explorations in Chemical Ecology,* edited by T. Eisner and J. Meinwald. In the preface, author Martin describes how he evolved from organic chemist to chemical ecologist during his 20 year research career. Chapter 1 introduces the reader to the subject by lucidly explaining the chemistry of digestion of cellulose, hemicellulose and pectin. Arthropods that are known or suspected to be capable of digesting these substrates, usually with the aid of microbial enzymes, are reviewed and discussed, with a nod to the pioneering research of P. Buchner, L. Cleveland, R. Hungate and W. Trager.

Chapter 2 brings the reader to the rather complex affairs of the fungus-growing

Asian and African termites. Mutualistic *Termitomyces* fungi that are cultured in their nests provide the termites with cellulolytic enzymes and nitrogen. Martin explains each step in the research that showed how the enzymes are produced, ingested and used, and points out the need for more quantitative research to assess the roles of mutualistic fungi as well as the bacteria that live in the guts of various ages and castes of these termites. Chapters 3, 4, and 5 review the literature and describe efforts to determine how widespread is the use of ingested microbial enzymes among Arthropoda. Wood-eating siricid woodwasp and cerambycid beetle larvae utilize ingested enzymes that have been secreted by fungi in the rotting wood. However, only one of seven detritus feeders was clearly shown to use ingested microbial enzymes.

The final chapter deals with the well-known mutualism between attine ants and the fungi that they tenderly cultivate on plant tissue and other materials in their nests. In this case, Martin found that the ants, unlike the other arthropods studied, do not depend on microbial cellulases, but instead they recycle proteases that are produced by their fungi.

I detected only a few minor typos, and the photographs are a bit fuzzy, but they don't really detract from the book. A brief final comparative review and summary chapter, with recommendations for future research, would have been beneficial. I recommend this book because it is well written, thus easy to read and understand. It demonstrates the thought processes of a curious scientist as he probed a relatively unexplored research frontier of considerable complexity. It shows that nature cannot be accepted at face value but requires deep inquiry in order to achieve any understanding.—*S. W. T. Batra, Beneficial Insects Laboratory, USDA, ARS, Beltsville, Maryland.*

INSTRUCTIONS TO AUTHORS

The *Journal of the New York Entomological Society* is devoted to the advancement and dissemination of knowledge of insects and related taxa. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie. The Journal will consider for publication manuscripts of any length dealing with original research in entomology. Longer papers will be printed as articles, shorter ones as "scientific notes." Book reviews will be solicited by the Book Review Editor.

Manuscripts should be submitted in triplicate to: Dr. James K. Liebherr, Editor, Journal of the New York Entomological Society, Department of Entomology, Comstock Hall, Cornell University, Ithaca, New York 14853-0999. All material must be double-spaced (including references, tables, captions, etc.) and prepared in the format of a recent issue of the Journal.

Longer manuscripts intended for submission as articles should be accompanied by a brief abstract. Footnotes should be avoided. Tables should be prepared as separate pages; they should be kept to a minimum because of the high cost of typesetting, but may be submitted as photographically reproducible material (see below). The list of references is headed "Literature Cited" and should follow the format indicated in the CBE Style Manual or as found in a recent issue of the Journal.

Illustrations (originals whenever possible) should be submitted flat, never rolled or folded, with the manuscript. Size of illustrations should be kept manageable and suitable for shipment through the US mail without being damaged. Proportions of illustrations should conform to single column format, actual page size 11.5 × 17.5 cm. Please assemble illustrations in a compact fashion in order to use journal space effectively. *Mount line drawings and halftones on separate plates.* Figures should be numbered consecutively. Figure captions should be double-spaced, grouped together and placed at the end of the manuscript. If tables are submitted for photographic reproduction, they should be neat and clean and conform to journal format proportions.

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THE COCCINELLIDAE (COLEOPTERA) OF BERMUDA

Robert D. Gordon
Systematic Entomology Laboratory, BBII, Agricultural Research Service, USDA,
% U.S. National Museum of Natural History, Washington, D.C. 20560

Daniel J. Hilburn
Bermuda Department of Agriculture and Fisheries,
P.O. Box HM834, Hamilton HMCX, Bermuda
Current address, P.O. Box 1015, Brunswick, Maine 04011

Abstract.—The 14 species of Coccinellidae occurring on Bermuda are treated, with discussions of distribution, hosts, and immature stages. Keys for the identification of adults and larvae are included. The adult and larva of *Decadiomus hughesi* n. sp., and the larvae of *Scymnus* (*Scymnus*) *floralis* (F.), *Exochomus jamaicensis* Sicard, *Clitostethus arcuatus* (Rossi), and *Naemia seriata* (Melsheimer) are described.

Bermuda has had a rather intensive, albeit short, history of biological control, primarily because of severe damage to the endemic cedar, *Juniperus bermudiana* L., caused by 2 scale insects, *Carulaspis minima* (Targioni-Tozzetti), and *Lepidosaphes pallida* (Maskell) (listed as *Lepidosaphes newsteadi* Sulc in most literature). Documentation of biocontrol efforts has been relatively thorough, especially by Bennett and Hughes (1959) and Bennett et al. (1985). A great deal of information found in these 2 publications is not repeated herein. These publications approach the subject from the pest aspect. Our objective is to present a complementary approach from the predator standpoint and to provide information on taxonomy, distribution, hosts, and immature stages of the predators.

The natural history of Bermuda is relatively uncomplicated and has received considerable attention. A recent publication on terrestrial arthropods by Kevan (1981) is particularly well done and comprehensive from the earliest times to 1928. Ogilvie (1928) provided a list of Bermuda insects, including 7 species of Coccinellidae, 4 of which he considered established. Of the latter, 2 species were intentionally introduced and 2 had arrived by unknown means. Bishop (1902) was the first to record coccinellid, *Rodolia cardinalis* (Mulsant), intentionally introduced from Australia to control the cottonycushion scale, *Icerya purchasi* Maskell. This introduction was followed by those of *Chilocorus bipustulatus* (L.) from Europe, *Rhyzobius lophanthae* (Blaisdell) from Australia, and *Cryptolaemus montrouzieri* Mulsant from Australia (Ogilvie, 1928). Waterston (1940, 1945) provided supplements to Ogilvie (1928) but included no additional species of Coccinellidae. Thompson (1947), in discussing cedar scale, stated he had obtained "from California and Trinidad preliminary shipments of four or five species of ladybirds" and that "two colonies of one ladybird (*Chilocorus distigma*) have already been liberated in infested areas." In 1946 the Commonwealth Institute of Biological Control was asked to undertake cedar scale control (Bennett and Hughes, 1959) and this marked the beginning of one of the most massive biological control assaults in history. Between 1948 and 1951 thousands of individuals of at least 44 species of Coccinellidae were released, and still other releases were made in ensuing years, resulting in the establishment of 9 species. In addition to the intentionally introduced coccinellids, 5 adventive species have become established on Bermuda, including some of the 4 reported by Ogilvie, bringing the total to 14 species.

The establishment rate of coccinellids on Bermuda seems to be rather low given the favorable climate. Simmonds (1958) expressed the opinion that lizard predation might be responsible for the disappearance of some species and supported this suggestion with experiments. Lizards of several species of *Anolis* are very abundant on Bermuda, and we feel that predation may be a factor.

Type specimens and representative material are deposited in the collections of the British Museum, Natural History, London; Bermuda Department of Agriculture; and United States National Museum, Washington, D.C.

We thank R. D. Pope, British Museum (Natural History), London, N. Vandenberg, Berkeley, California, and A. Menke, Systematic Entomology Laboratory, Washington, D.C., for reviewing the manuscript. We are also indebted to Debbie Roney for providing many of the illustrations used, and to Bryant Reese, whose manuscript on coccinellid larvae was the source of most of the rest of the illustrations.

KEY TO BERMUDA COCCINELLIDAE (ADULTS)

1.	Clypeus expanded laterally, shelflike, partially dividing eye; dorsal surface not pubescent	2
–	Clypeus not expanded laterally, or if so, briefly and not shelflike; dorsal surface pubescent or not	3
2(1).	Postcoxal line on 1st abdominal sternum merging with posterior margin of sternum (Fig. 51)	*Chilocorus cacti* (L.)
–	Postcoxal line on 1st abdominal sternum not reaching posterior margin of sternum; curved forward apically (Fig. 44)	*Exochomus jamaicensis* Sicard
3(1).	Apical segment of maxillary palpus conical; anterior angle of pronotum separated from disc by surface line; length less than 1.5 mm	*Microweisea suturalis* Schwarz
–	Apical segment of maxillary palpus dilated apically (securiform) or nearly parallel sided; anterior angle of pronotum not separated from disc by surface line; length usually more than 1.5 mm	4
4(3).	Prosternum enlarged, expanded, capable of concealing mouthparts in repose	*Cryptolaemus montrouzieri* Mulsant
–	Prosternum not enlarged, not concealing mouthparts	5
5(4).	Disc of elytron with arcuate yellow band encircling brown or black spot (Fig. 8)	*Clitostethus arcuatus* (Rossi)
–	Disc of elytron without marking, or if so, then not as above	6
6(5).	Antenna short, ⅔ or less as long as head width; apical segment of maxillary palpus usually parallel sided or barrel shaped (Fig. 12), rarely securiform; middle coxal cavities broadly separated	7
–	Antenna long, usually more than ⅔ as long as head width; apical segment of maxillary palpus securiform; middle coxal cavities narrowly separated	10
7(6).	Postcoxal line on 1st abdominal sternum merging with posterior margin of sternum (Fig. 31)	8
–	Postcoxal line on 1st abdominal sternum curved forward apically	9

8(7). Elytron yellow in apical ¼ (Fig. 32) .... *Diomus terminatus* (Say)

– Elytron completely brown or black .... *Decadiomus hughesi,* n. sp.

9(7). Postcoxal line on 1st abdominal sternum not reaching base of sternum (Fig. 20); elytron yellowish red with suture and lateral margin black (Fig. 21) .... *Scymnus* (*Scymnus*) *floralis* (F.)

– Postcoxal line on 1st abdominal sternum reaching base of sternum (Fig. 25); elytron black with apex narrowly red .... *Scymnus* (*Pullus*) *creperus* Mulsant

10(6). Dorsal surface pubescent 11

– Dorsal surface glabrous 13

11(10). Abdomen with 5 visible sterna; epipleuron deeply excavated for reception of femoral apices of middle and hind legs; elytron with dark spot on disc composed of brown hairs (Fig. 76) .... *Azya orbigera orbigera* Mulsant

– Abdomen with 6 visible sterna; epipleuron not excavated; elytron not as above 12

12(11). Antenna 8-segmented, short (Fig. 67); elytron red with black markings (Fig. 70) .... *Rodolia cardinalis* (Mulsant)

– Antenna 11-segmented, long (Fig. 57); elytron dark reddish brown with metallic tint (Fig. 62) .... *Rhyzobius lophanthae* (Blaisdell)

13(10). Elytron immaculate, entirely red or yellow .... *Cycloneda munda* (Say)

– Elytron pink or pinkish yellow with bold, black maculation .... *Naemia seriata* (Melsheimer)

Genus *Microweisea* Cockerell

Microweisea Cockerell, 1903:38 (new name for *Epismilia* Cockerell, 1990); Pope, 1962:637; Gordon, 1970:207; Gordon, 1977:204; Gordon, 1985:37. Type-species: *Smilia felschei* Weise (=*Pentilia ovalis* LeConte), by monotypy.

Smilia Weise, 1891:288 (not Germar, 1833).

Epismilia Cockerell, 1900:606 (not Fromental, 1861) (new name for *Smilia* Weise).

Pseudoweisea Schwarz, 1904:118 (lapsus calami).

Microweisini with form elongate, oval; dorsum glabrous. Head slightly prolonged anterior to antennal insertion (Fig. 1); eyes separated by 4 times the width of an eye. Apical segment of maxillary palpus elongate, slender, conical. Antenna 10-segmented with 3-segmented club (Fig. 2). Prosternum with small anterior lobe. Tarsus trimerous (Fig. 3). Male genitalia asymmetrical, paramere reduced.

This is a Western Hemisphere genus of 5 North American species and an unknown number of neotropical species. One species has become established on Bermuda. Members of *Microweisea* are scale predators with available host records as follows: *Lepidosaphes beckii* (Newman), *Lepidosaphes* sp., *Melanaspis obscura* (Comstock), *Chionaspis pinifoliae* (Fitch), *Pseudaonidia duplex* (Cockerell), and *Quadraspidiotus perniciosus* (Comstock).

Microweisea suturalis (Schwarz)

Pseudoweisea suturalis Schwarz, 1904:118.

Microweisea suturalis: Leng, 1920:213; Gordon, 1970:209; Gordon, 1985:38.

Pentilia suturalis: Korschefsky, 1932:225.

Diagnosis. Length 1.00 to 1.10 mm, width 0.90 to 0.95 mm. Ground color piceous; elytron yellowish brown with suture narrowly piceous (Fig. 4); ventral surface brown. Male genitalia as in Figures 5–7.

Figs. 1–7. *Microweisea* spp. 1. *Microweisea* sp., head. 2. *Microweisea* sp., antenna. 3. *Microweisea* sp., leg. 4. *Microweisea suturalis,* habitus. 5–7. *Microweisea suturalis,* male genitalia.

World distribution. California: Long Beach: Los Angeles Co.

Bermuda distribution. Island wide, but patchy.

Bermuda temporal distribution. Adults present September through May.

Discussion. This tiny species is unmistakable in the Bermuda fauna because of its size and the anterolateral line on the pronotum. *Microweisea suturalis* was introduced in 1949 for control of the Bermuda cedar scales, *Lepidosaphes pallida* (Maskell) and *Carulaspis minima* (Targioni-Tozzetti). Individual trees or stands of *J. bermudiana* may support populations of *M. suturalis* while adjacent trees, though also infested with scale, often have no *M. suturalis* on them.

Genus *Clitostethus* Weise

Scymnus (*Clitostethus*) Weise, 1885:65. Type-species: *Coccinella arcuata* Rossi, by monotypy.
Clitostethus: Weise, 1899:375.
Clithostetus: Korschefsky, 1931:114 (misspelling).

Scymnini with form elongate, oval. Length less than 1.60 mm. Head with mouthparts directed posteroventrally in repose, concealing prosternum; clypeus extending beyond eye, anterolateral angle produced, rounded, anterior margin truncate, lateral margin emarginate at antennal insertion; lateral projection of gena broad, partially dividing eye. Maxillary palpus with apical segment somewhat securiform (Fig. 12). Antenna long, 11-segmented, extending to posterolateral angle of pronotum, all segments except apical 3 longer than wide, basal segment not strongly widened. Pronotum widest at posterolateral angle, narrowed apically. Prosternum short, only slightly longer than anterior coxa, intercoxal process narrow, apex truncate. Metasternum tumid. Front and middle femora slender; hind femur not enlarged, hind tibia with coarse, long setae, particularly near outer margin; tarsus trimerous (Fig. 13).

This Old World genus resembles the New World *Nephaspis* Casey, but *Nephaspis* has the basal segments of the antenna enlarged, hind femur enlarged medially, and anterior clypeal margin feebly emarginate. There are approximately 5 species in *Clitostethus,* one of which has become established on Bermuda.

Clitostethus arcuatus (Rossi)

Coccinella arcuata Rossi, 1794:88.
Scymnus arcuatus: Mulsant, 1846:245.
Scymnus (*Clitostethus*) *arcuatus*: Weise, 1885:73.
Clitostethus arcuatus: Weise, 1899:375; Korschefsky, 1931:114; Gordon, 1972a:145.

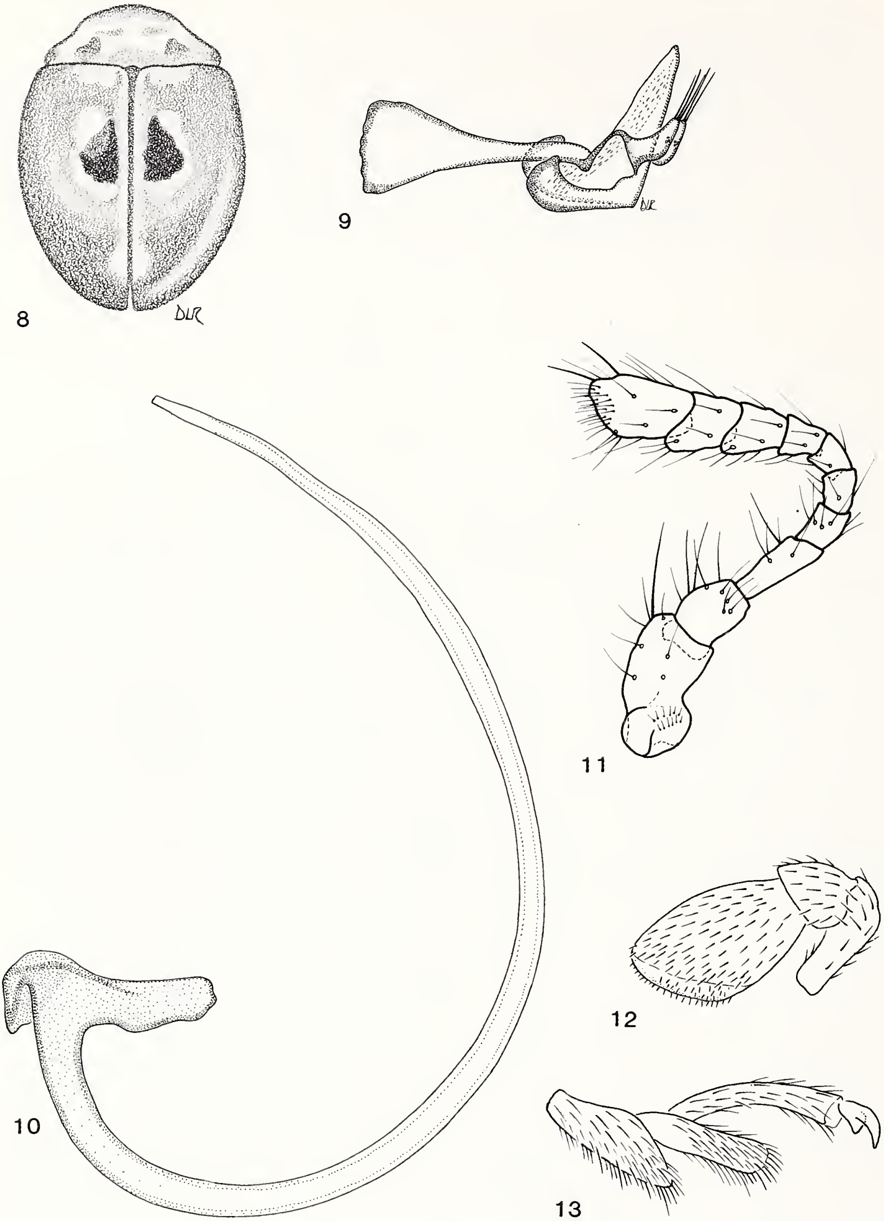
Diagnosis. Length 1.30 to 1.50 mm, width 0.90 to 1.00 mm. Form elongate, slightly tapered posteriorly. Dorsal color black to light brown; lateral portion of pronotum yellow; elytron with arcuate yellow band on disc usually partially enclosing dark discal spot (Fig. 8). Male genitalia as in Figures 9, 10.

World distribution. Europe.

Bermuda distribution. Island wide.

Bermuda temporal distribution. Adults present year round, most common in winter and spring when the host is abundant.

Discussion. The dorsal color pattern is unique among Bermuda coccinellids, thus making this species easily recognizable. *Clitostethus arcuatus* is one of the few species



Figs. 8–13. 8. habitus. 9. 10. male genitalia, *Clitostethus arcuatus*. 11. antenna, *Cryptolaemus montrouzieri*. 12. maxillary palpus. 13. tarsus, *Clitostethus arcuatus*.

occurring on Bermuda that was apparently not intentionally introduced, and we suspect it arrived on imported plant material. It was first observed in the early 1950's (Bennett et al., 1985). Members of both *Clitostethus* and the related New World genus *Nephaspis* are whitefly predators, and the Bermuda host of *C. arcuatus* is *Metaleurodicus cardini* (Back), a pest of fiddlewood, *Citharexylum spinosum* L. *Nephaspis oculatus* (Blatchley) (then known as *Nephaspis amnicola* Wingo or misidentified as *Clitostethus dispar* Sicard) was introduced in the early 1960's, but survived in the field for only a few months (Bennett et al., 1985).

Genus *Cryptolaemus* Mulsant

Cryptolaemus Mulsant, 1853:268, Korschefsky, 1931:169; Gordon, 1985:105; Booth and Pope, 1986:704. Type-species: *Cryptolaemus montrouzieri* Mulsant, by monotypy.

Scymnini with length more than 3.00 mm; form oval, convex. Antenna 10-segmented with 3-segmented club, loose (Fig. 11). Maxillary palpus with apical segment securiform. Prosternum broadly rounded anteriorly, concealing mouthparts and antenna; carinae weak, parallel, extending less than halfway to anterior margin of prosternum. Tibial spurs absent; tarsus trimerous; tarsal claw with broad basal tooth equal to half the length of claw. Abdomen with postcoxal line complete, as in *Scymnus* (*Pullus*) (Fig. 14). Male genitalia with basal lobe symmetrical. Female genitalia with strong spermathecal capsule; sperm duct short; infundibulum reduced to small sclerite at head of bursa; genital plates long, triangular.

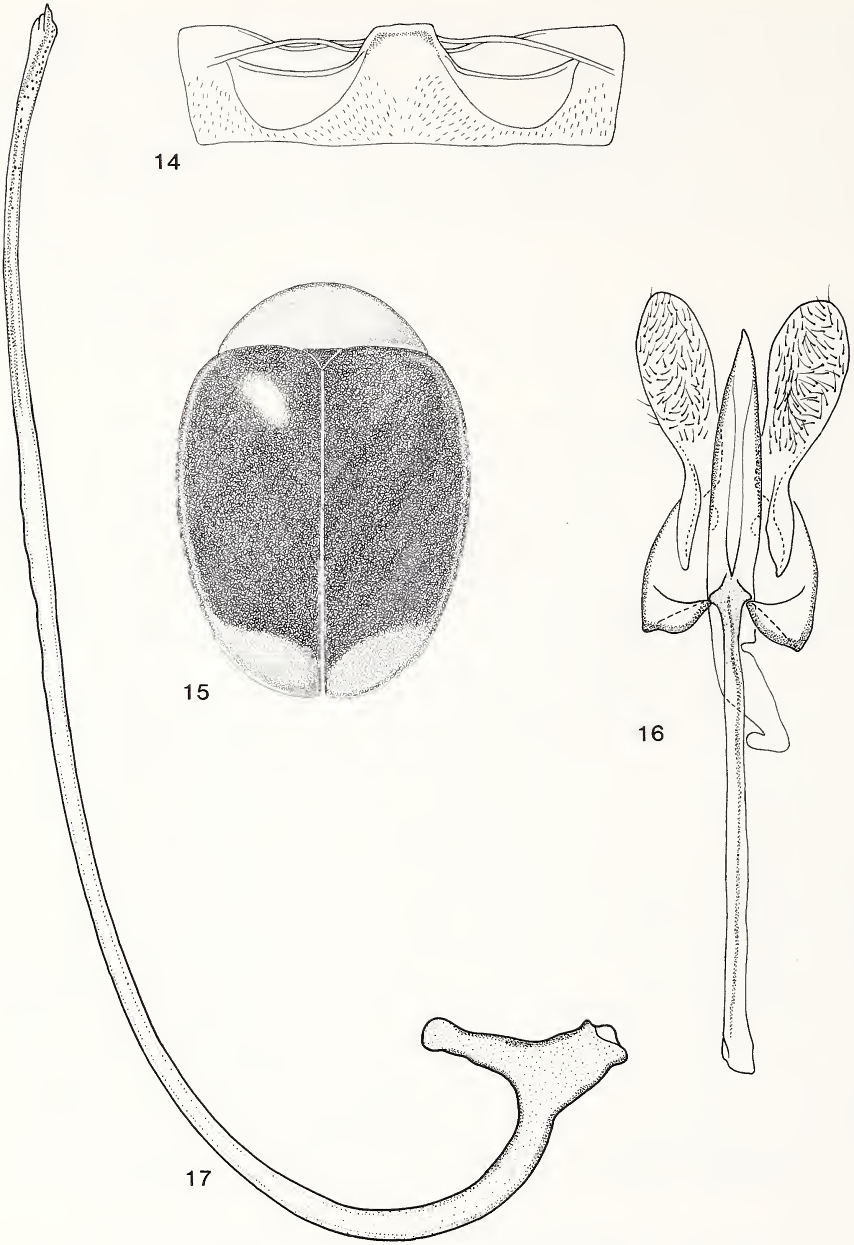
Cryptolaemus is a small genus indigenous to the Australian region. The only species present in the Western Hemisphere is *C. montrouzieri* which was introduced as a scale predator at several times and in different places, including Bermuda. The expanded prosternum and large size readily separate *Cryptolaemus* from other genera of New World Scymnini. Host records for the genus are as follows: *Chloropulvinaria psidii* (Maskell), *Chrysomphalus pinnulifer* (Maskell), *Coccus viridis* (Green), *Dactylopius confusus* (Cockerell), *Dactylopius opuntiae* (Cockerell), *Dactylopius tomentosus* (Lamarck), *Dysmicoccus boninsis* (Kuwana), *Dysmicoccus brevipes* (Cockerell), *Eriococcus araucariae* (Maskell), *Ferrisia virgata* (Cockerell), *Maconellicoccus hirsutus* (Green), *Nipaecoccus aurilanatus* (Maskell), *Nipaecoccus filamentosus* (Cockerell), *Nipaecoccus nipae* (Maskell), *Planococcus citri* (Risso), *Planococcus krauhniae* (Kuwana), *Planococcus lilacinus* (Cockerell), *Planococcus vitis* (Neidielski), *Pseudococcus affinis* Maskell, *Pulvinaria icerya* (Guerin), *Pseudococcus calceolariae* (Maskell), *Pseudococcus comstocki* (Kuwana), *Pseudococcus longispinus* (Targioni-Tozzetti), *Pseudococcus maritimus* (Ehrhorn), *Pulvinaria psidii* (Maskell), *Rastrococcus iceryoides* (Green), *Saccharicoccus sacchari* (Cockerell), *Trionymus insularis* (Ehrhorn). Ghorpade (1981) recorded *C. montrouzieri* as feeding on *Aphis gossypii* Glover in India.

Cryptolaemus montrouzieri Mulsant

Cryptolaemus montrousieri Mulsant, 1853:149; Gordon, 1985:105.

Cryptolaemus montrouzieri: Crotch, 1874:204 (emendation); Korschefsky, 1931:169; Gordon, 1985:105.

Cryptolaemus montrouzieri montrouzieri: Booth and Pope, 1986:706.



Figs. 14–17. *Cryptolaemus montrouzieri*. 14. 1st abdominal sternum. 15. habitus. 16. 17. male genitalia.

Diagnosis. Length 3.40 to 4.50 mm, width 2.40 to 3.10 mm. Head, prothorax, tip of elytron and abdomen reddish yellow; mesosternum, metasternum, leg, and elytron (except apex) black or blackish (Fig. 15). Punctation of head and pronotum dense, elytral punctation similar except on humeral callus which is shining, almost devoid of punctures. Male genitalia as in Figures 16, 17. Female genitalia as in Figure 18.

World distribution. Native to Australia, but because of biological control introductions, it now occurs in parts of the world too numerous to mention. In North America it occurs from San Francisco to San Diego, California, and in Clearwater, Florida. It has also been recorded from Indiana and Missouri, but is probably not established there.

Bermuda distribution. Botanical Gardens, Paget; St. Paul's Church, Paget.

Bermuda temporal distribution. Adults present May through September.

Discussion. This species was introduced in 1926 for control of the coconut mealybug, *Nipaecoccus nipae* (Maskell), and again in 1953 for control of the long-tailed mealybug, *Pseudococcus longispinus* (Targioni-Tozzetti). Bennett et al. (1985) state that it did not become established in either case although small colonies persisted for several months. We found it to be established at two Bermuda localities, feeding on the long-tailed mealybug on sago palm, *Cycas revoluta,* and on *Pseudococcus* sp. on croton, *Codiaeum variegtum* (L.).

Scymnus (*Scymnus*) Kugelann

Scymnus Kugelann, 1794:545; Mulsant, 1846:219, Casey, 1899:138; Korschefsky, 1931:115; Gordon, 1976:10; Gordon, 1985:115. Type-species: *Scymnus nigrinus* Kugelann, by subsequent designation of Westwood, 1838.

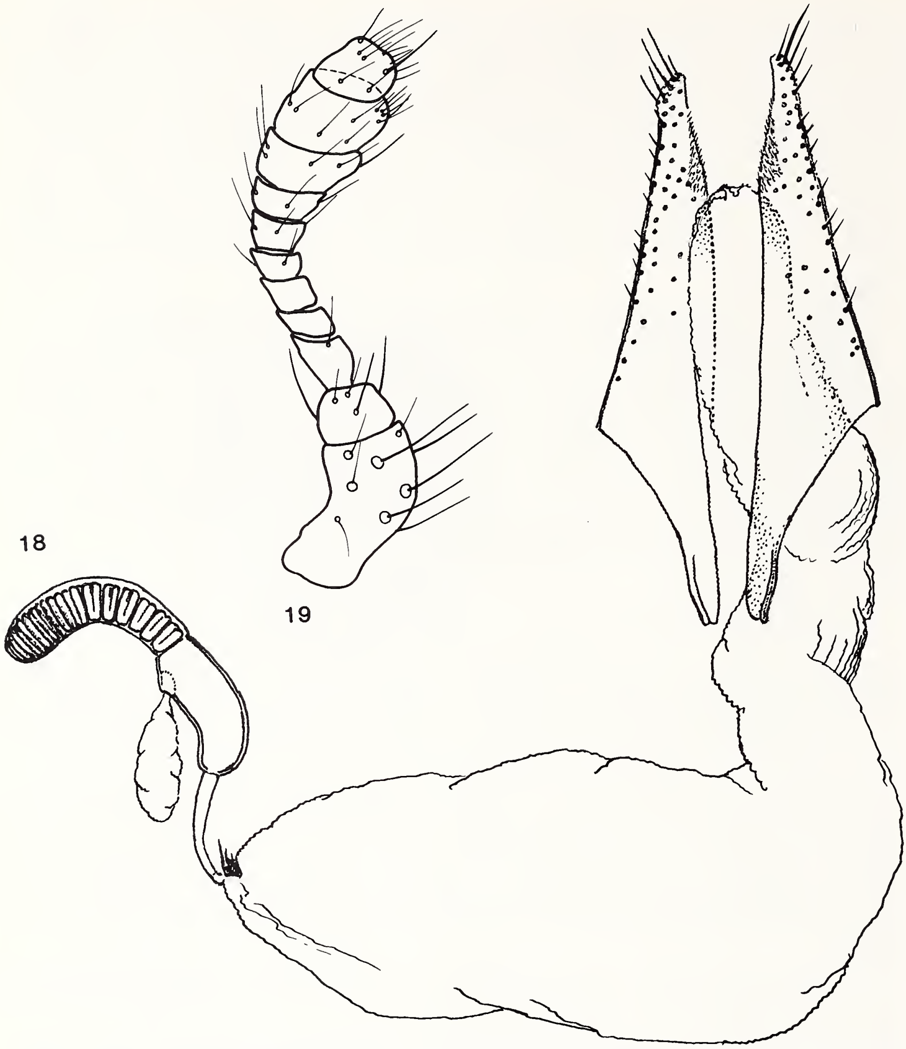
Scymnini with antenna 10- or 11-segmented; apical segment of maxillary palpus cylindrical, obliquely truncate apically. Prosternum with 2 strong carinae nearly always reaching anterior margin. Tarsus cryptotetramerous. Postcoxal line curved forward apically, not reaching basal margin of 1st sternum (Fig. 20); male 5th and 6th abdominal sterna truncate or emarginate apically. Female with distinct infundibulum.

This subgenus is distributed worldwide but is predominantly holarctic. One species has become established on Bermuda, but whether or not it was intentionally introduced is undetermined.

Scymnus (*Scymnus*) *floralis* (F.)

Coccinella floralis Fabricius, 1792:260.
Scymnus (*Scymnus*) *floralis*: Mulsant, 1850:981; Korschefsky, 1931:158.

Diagnosis. Length 1.65 to 2.00 mm, width 1.20 to 1.40 mm. Form oval, somewhat elongate. Dorsal color yellowish red except pronotum mostly black, elytron with basal and sutural margins black, lateral margin black, at least medially (Fig. 21). Postcoxal line on 1st abdominal sternum extending to hind margin of sternum, apex feebly curved forward. Male genitalia as in Figures 22, 23. Female genitalia as in Figure 24.



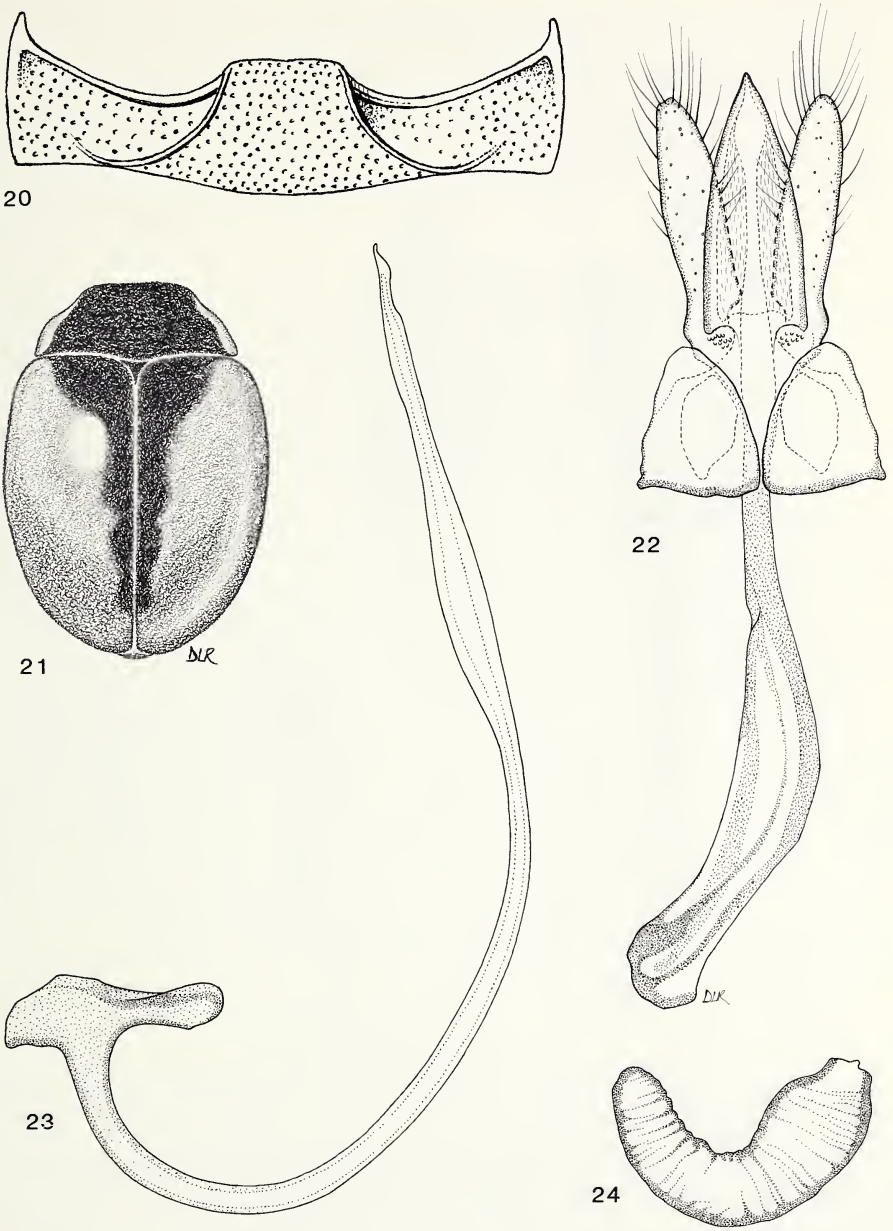
Figs. 18, 19. 18. *Scymnus* (*Pullus*) sp., antenna. 19. *Cryptolaemus montrouzieri,* female genitalia.

World distribution. West Indies.

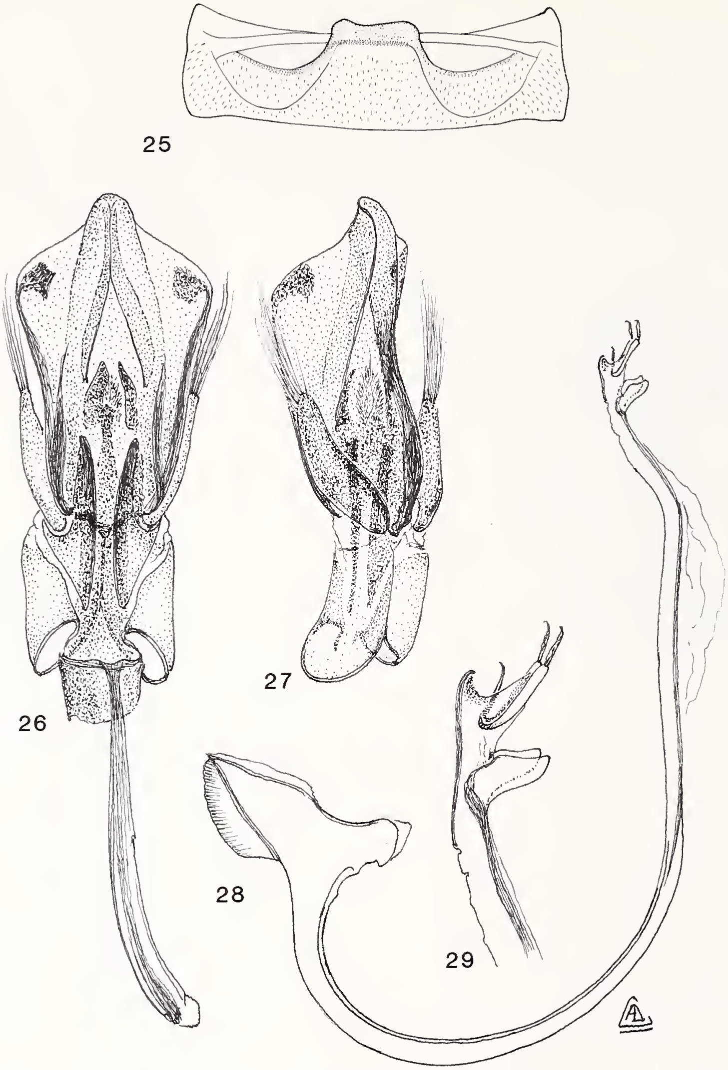
Bermuda distribution. Island wide.

Bermuda temporal distribution. Adults common year round.

Discussion. The dorsal color pattern does not resemble that of any other species of Bermuda Coccinellidae but is nearly identical to that of *S.* (*Pullus*) *loewii* Mulsant. The latter species is native to Mexico and has been widely introduced and established in other parts of the world. This is the first known instance of *S. floralis* becoming established anywhere outside of its natural range. We cannot determine the method of introduction; it may be accidental or this may be one of the species of "*Scymnus*"



Figs. 20–24. *Scymnus* (*Scymnus*) spp. 20. *Scymnus* (*S.*) sp., 1st abdominal sternum. 21. *Scymnus* (*S.*) *floralis,* habitus. 22. 23. *Scymnus* (*S.*) *floralis,* male genitalia. 24. *Scymnus* (*S.*) *floralis,* female spermathecal capsule.



Figs. 25–29. *Scymnus* (*Pullus*) spp. 25. *Scymnus* (*P.*) sp., 1st abdominal sternum. 26–29. *Scymnus* (*P.*) *creperus,* male genitalia.

listed in Bennett et al. (1985). This species is an aphid predator and one of the most commonly collected species on Bermuda. It is often collected when sweeping weedy areas.

Scymnus (*Pullus*) Mulsant

Scymnus (*Pullus*) Mulsant, 1846:241; Mulsant, 1850:976; Casey, 1899:139; Gordon, 1976:48; Gordon, 1985:139. Type-species: *Coccinella subvillosa* Goeze, by subsequent designation of Korschefsky, 1931.

Scymnini with antenna 11-segmented (Fig. 19); apical segment of maxillary palpus cylindrical, obliquely truncate apically. Prosternum with 2 strong carinae nearly always reaching anterior margin. Tarsus cryptotetramerous. Postcoxal line recurved apically, reaching basal margin of 1st sternum (Fig. 25); male 5th and 6th abdominal sterna moderately to strongly emarginate and impressed apically.

Members of the subgenus *Pullus* are found worldwide, but the distribution is primarily holarctic with some species occurring in tropical regions. One mainland North American species occurs on Bermuda.

Scymnus (*Pullus*) *creperus* Mulsant

Scymnus (*Pullus*) *creperus* Mulsant, 1850:985; Casey, 1899:140; J. Chapin, 1974:28; Gordon, 1976:260; Gordon, 1985:276.
Scymnus creperus: LeConte, 1852:139; Horn, 1895:101.
Scymnus (*Pullus*) *medionotans* Casey, 1899:143; J. Chapin, 1974:29 (synonymy).
Scymnus (*Pullus*) *subtropicus* Casey, 1899:143; J. Chapin, 1974:29 (synonymy).
Scymnus (*Pullus*) *hortensis* Wingo, 1952:36; J. Chapin, 1974:29 (synonymy).

Diagnosis. Length 1.76 to 2.68 mm, width 1.23 to 2.00 mm. Form oval, somewhat elongate. Head and pronotum yellowish red except pronotum with small, black triangular spot that extends to middle of pronotum anterior to scutellum; elytron black except apex narrowly red. Male genitalia as in Figures 26, 29.

World distribution. Southeastern United States, Pennsylvania to Colorado, south to Texas and Florida.

Bermuda distribution. St. George's Parish; Sandy's Parish; Southampton Parish.

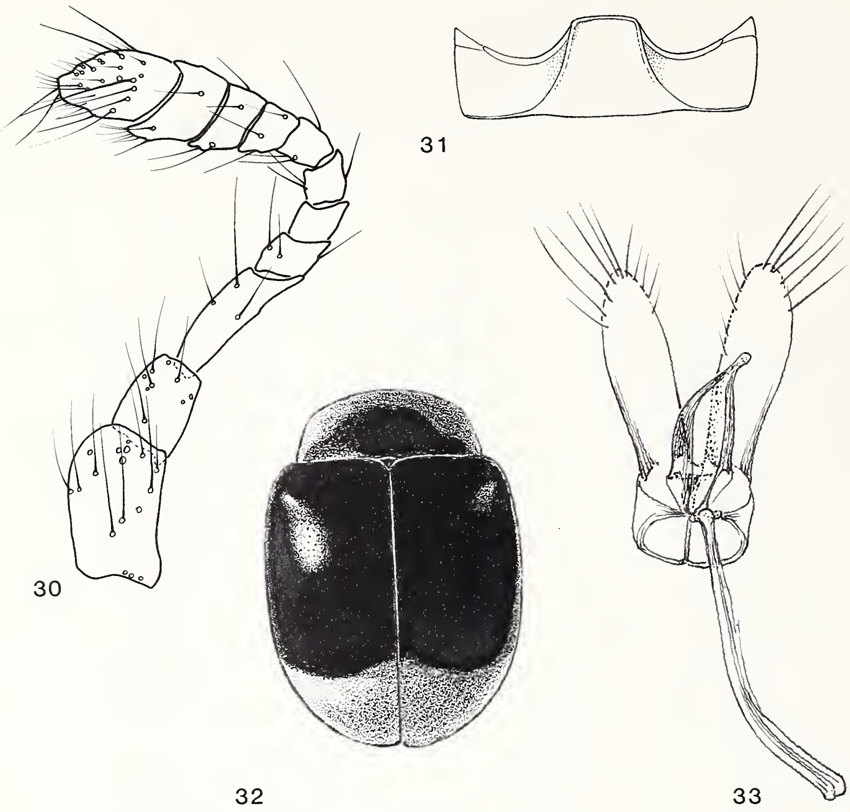
Bermuda temporal distribution. Adults present year round.

Discussion. Scymnus creperus is the only member of the subgenus *Pullus* on the island, thus the combination of a complete postcoxal line on the first abdominal sternum and the dorsal color pattern are diagnostic. This mainland North American species apparently was not intentionally introduced but has become established. The first record we have of its occurrence is in Simmonds (1958), where he lists a "*Scymnus* (*Pullus*) sp." The host prey has not been determined, but we have collected *S. creperus* in association with heavy aphid infestations, therefore we tentatively regard it as an aphid predator. This species is established only at the eastern and western ends of the island.

Genus *Diomus* Mulsant

Scymnus (*Diomus*) Mulsant, 1850:951; Casey, 1899:139; Korschefsky, 1931:116.
Diomus: Weise, 1885:83; Gordon, 1976:319; Gordon, 1985:315. Type-species: *Coccinella thoracica* Fabricius, by subsequent designation of Korschefsky, 1931.

Scymnini with clypeal margin truncate, gena extending onto eye beside antennal insertion; antenna 11-segmented, 3rd segment as long as segments 4–6 combined (Fig. 30), or 10-segmented; apical segment of maxillary palpus securiform. Prosternum with 2 fine carinae extending to anterior margin of prosternum. Tarsus 3- or 4-segmented. Postcoxal line joining hind margin of 1st abdominal sternum (Fig. 31). First abdominal sternum fused to 2nd medially; male with sterna 2–6 contracted, 5th sternum broadly, feebly emarginate apically. Male genitalia with basal lobe asym-



Figs. 30–33. *Diomus* spp. 30. *Diomus* sp., antenna. 31. *Diomus* sp., 1st abdominal sternum. 32. *Diomus terminatus,* habitus. 33. *Diomus terminatus,* phallobase of male genitalia.

metrical; sipho extremely long, slender, or short, robust. Female genitalia with genital plates short, rounded, or truncate apically; sperm duct short, simple.

This genus has a large number of species in the Neotropical Region. One species is established on Bermuda. Food preferences for members of *Diomus* are poorly known, but some appear to feed only on mealybugs and others only on aphids. *Diomus pumilio* Weise was introduced from Australia into California for control of the Albizzia psyllid, *Psylla uncatoides* Ferris & Klyver, on *Acacia*; obviously members of the genus have a wide range of host preferences.

Diomus terminatus (Say)

Scymnus terminatus Say, 1835:203.
Scymnus (*Diomus*) *terminatus*: Mulsant, 1850:952; Casey, 1899:158; Korschefsky, 1931:166.
Scymnus femoralis LeConte, 1852:136.
Scymnus (*Diomus*) *femoralis*: Casey, 1899:158 (synonymy).
Scymnus (*Diomus*) *terminatus* ab. *femoralis*: Korschefsky, 1931:67.

Scymnus (*Diomus*) *partitus* Casey, 1899:158; Korschefsky, 1931:164; Gordon, 1976: 342 (synonymy).
Diomus terminatus: Gordon, 1976:341; Gordon, 1985:337.

Diagnosis. Length 1.50 to 1.90 mm, width 1.04 to 1.49 mm. Form elongate, somewhat oval. Color predominantly black; anterolateral angle of pronotum, head, mouthparts, prosternum, hypopleuron, leg, and last 4 abdominal sterna and apical ¼ of elytron yellow (Fig. 32), pronotum often yellow with median black basal spot. Male genitalia as in Figures 33–35. Female genitalia as in Figure 36.

World distribution. Eastern United States, New England to Iowa, south to Texas and Florida.

Bermuda distribution. Island wide.

Bermuda temporal distribution. Adults present year round.

Discussion. In addition to the generic characters, *Diomus terminatus* is distinguished from *Decadiomus hughesi,* n. sp., by the yellow elytral apex. It is not as frequently found as the latter species, and we have not as yet associated it with a definite host. According to the available literature, it is supposed to be an aphid predator (Whitehead, unpubl.). This is one of 7 species of Coccinellidae listed as occurring on Bermuda by Ogilvie in 1928, therefore it was probably not intentionally introduced for biological control purposes. *Diomus terminatus* is never commonly collected on Bermuda; most specimens have been collected sweeping weedy areas.

Genus *Decadiomus* Chapin

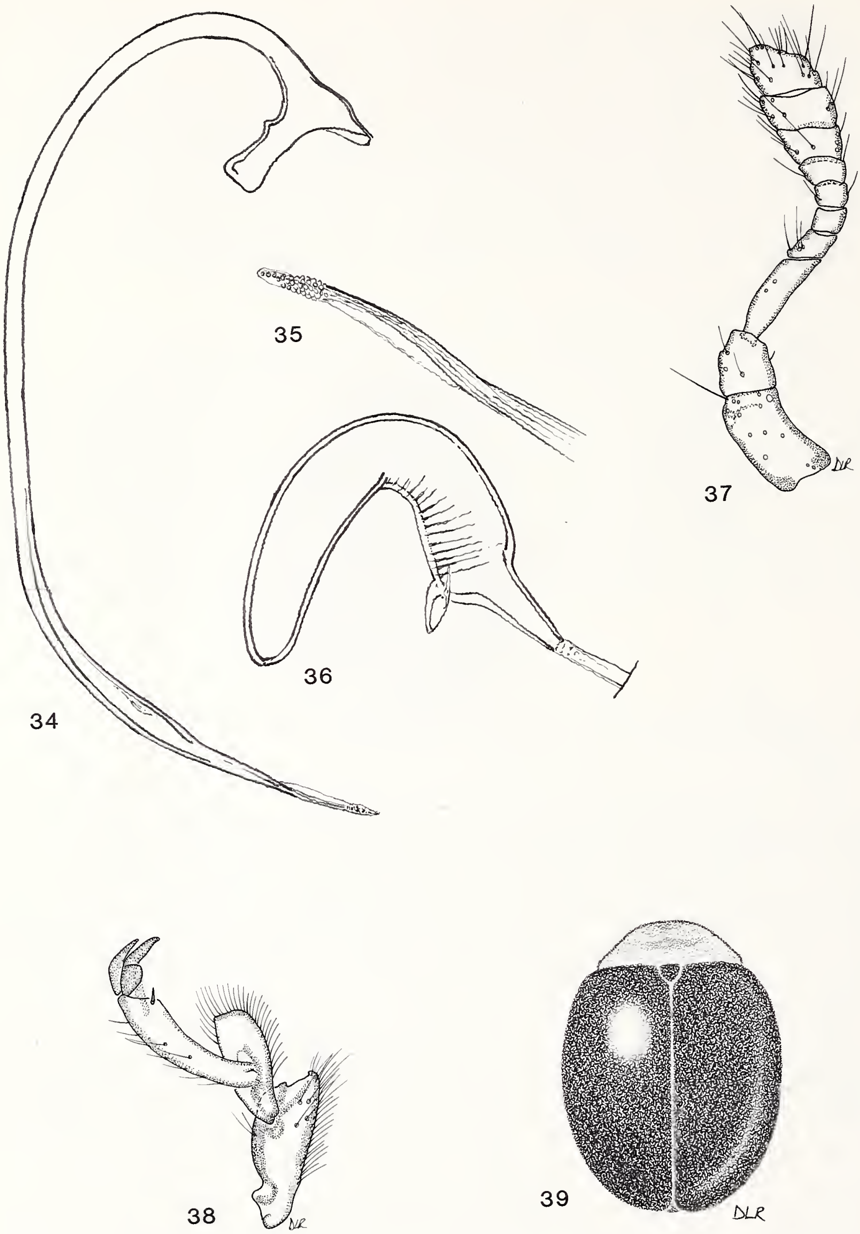
Decadiomus Chapin, 1933:96; Blackwelder, 1945:445. Type-species: *Scymnus* (*Diomus*) *bahamicus* Casey, by original designation.

Small to minute Scymnini. Antenna short, 10-segmented, segments 8–10 forming distinct club (Fig. 37). Clypeus broadly rounded. Pronotum narrower at base than elytra at shoulders. Elytron with epipleura moderately wide at base, strongly narrowed apically. First abdominal sternum with postcoxal line joining hind margin of sternum. Leg with trimerous tarsus, claw toothed at base (Fig. 38). Male genitalia with basal lobe asymmetrical; sipho long, slender. Female genitalia with genital plates short, rounded, or truncate apically; sperm duct elongate, convoluted, infundibulum lacking.

This is a neotropical genus with 5 previously described species. *Decadiomus* is closely related to *Diomus* but has 10-segmented antennae and true 3-segmented tarsi rather than the 11-segmented antennae and 3- or 4-segmented tarsi of *Diomus.* In addition the larvae appear to be different, but this must be tested by examination of larvae of many species. All previously described species are known from the Caribbean islands and the Bahamas. One species is established on Bermuda. The only available host record for any member of this genus is that of *D. pictus* (Casey) feeding on *Icerya purchasi* Maskell in Puerto Rico (Chapin, 1933).

Decadiomus hughesi Gordon and Hilburn, new species

Description. Male, length 1.50 mm, width 1.20 mm. Form oval, widest at middle of elytron (Fig. 39). Color black except pronotum reddish yellow with transverse,



Figs. 34–39. *Diomus terminatus, Decadiomus hughesi.* 34. 35. *Diomus terminatus,* sipho of male genitalia. 36. *Diomus terminatus,* female spermathecal capsule. 37. *Decadiomus hughesi,* antenna. 38. *Decadiomus hughesi,* tarsus. 39. *Decadiomus hughesi,* habitus.

black basal spot anterior to scutellum; head, prosternum, leg and apical abdominal sternum reddish yellow. Punctation on head fine, punctures separated by one to 3 times a diameter; pronotal punctures slightly coarser than on head, separated by a diameter or less; elytron with punctures equal in size to pronotal punctures, separated by about a diameter. Dorsal pubescence yellowish white. First abdominal sternum with basal, crescent-shaped patch of fine setae on each side. Genitalia as in Figures 40, 41.

Female. Similar to male except pronotum dark brown with narrow apical border and lateral ¼ reddish yellow. Genitalia as in Figure 42.

Variation. Length 1.15 to 1.60 mm, width 0.80 to 1.30 mm. The male pronotum is often entirely reddish yellow, lacking the basal black spot; the median black area of the female pronotum is subject to some variation in size.

Type material. Holotype; Bermuda, Smiths Parish, Aquarium, 29-V-87, D. J. Hilburn, on *Pittosporum* (deposited in United States National Museum). Allotype; same data as holotype. Paratypes, Bermuda: 14, same data as holotype; 1, Hamilton Parish, Stelly Bay, 25-V-87, D. J. Hilburn, on sunbather; 1, Paget Parish, 4-VII-87, J. Hendrickson; 1, Paget Parish, Beverly Farm, 28-V-87, D. J. Hilburn; 5, Paget Parish, Bot. Garden, 30-V-87, D. J. Hilburn, on *Cycas revoluta*; 1, Paget Parish, Bot. Garden, 12-VIII-87, D. J. Hilburn, with *Coccus viridis*; 1, Paget Parish, St. Pauls Church, 26-V-87, D. J. Hilburn, on *Cycas revoluta*; 3, Paget Parish, St. Pauls Church, 14-VIII-87, R. Gordon; 1, St. Georges, Ferry Reach, 6-VIII-87, D. J. Hilburn; 8, St. Georges, Airport Ferry Reach, 11-VIII-87, R. Gordon; 1, Smiths Parish, Aquarium, 30-IV-87, D. J. Hilburn; 1, Smiths Parish, Aquarium, 25-VI-87, D. J. Hilburn; 6, Smiths Parish, Penhurst Park and Fort Scaur, 21-VIII-87, P. Marsh; 1, Smiths Parish, Spittal pond, 24-VI-87, D. J. Hilburn; 1, Southampton Parish, Barnes Corner, 29-VI-87, J. Hendrickson, on *Juniperus bermudiana*; 1, Warwick Parish, Uplands, 6-VII-87, J. Hendrickson.

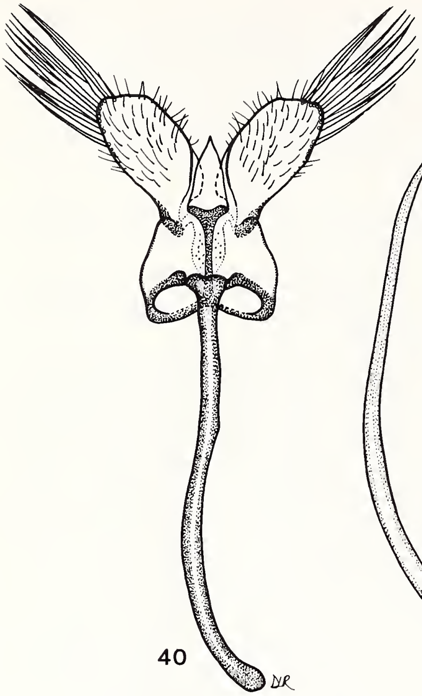
Bermuda distribution. Island wide.

Bermuda temporal distribution. Adults present year round.

Discussion. The black elytra of this species of *Decadiomus* are unique within the genus; previously described species have the elytra yellow with a pattern of dark spots.

Decadiomus hughesi was almost certainly introduced in 1951 as a "*Scymnus* sp." for control of cedar scale. Three species of "*Scymnus*" are listed by Bennett et al. (1985), one each from Portugal, Trinidad, and Jamaica, but only the latter two are possible as places of origin. The species from Jamaica is listed as a mealybug predator, therefore we suspect it is the species we describe here since *D. hughesi* definitely preys on mealybugs. Many specimens, including the immature stages, have been collected feeding on the long-tailed mealybug, *Pseudococcus longispinus* (Targioni-Tozzetti), on *Cycas revoluta* (Thunberg). *Decadiomus hughesi* has the following recorded adult host range on Bermuda: *P. longispinus* on *C. revoluta, Icerya purchasi* Maskell on *Pittosporum tobira* (Thunberg), *Coccus viridis* (Green) on *Brassaia actinophylla* Endlicher, and *Carulaspis minima* (Targioni-Tozzetti) on *Juniperus bermudiana* L. The recorded larval hosts are: *P. longispinus* on *C. revoluta* and *Pseudaulacaspis pentagona* (Targioni-Tozzetti) on *Nerium oleander* L.

We name this species for I. W. Hughes in recognition of his long involvement with biological control on Bermuda.



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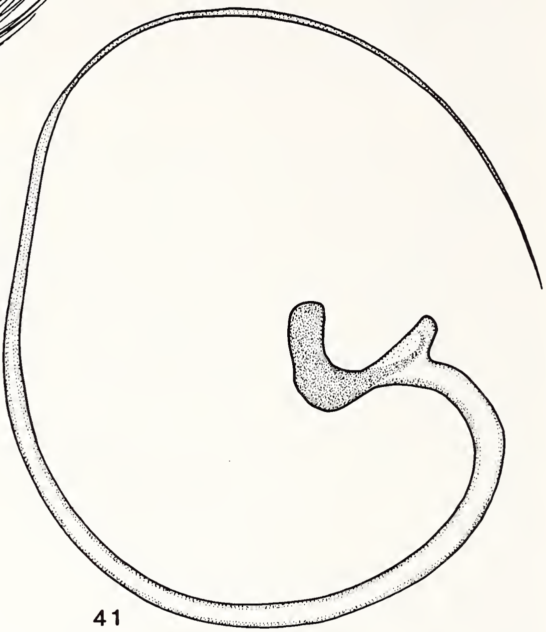

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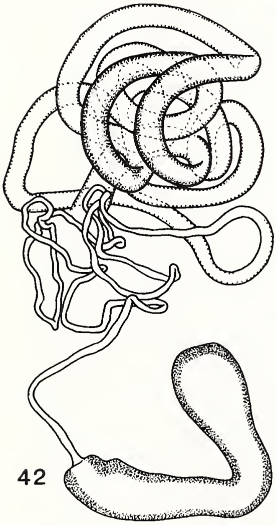

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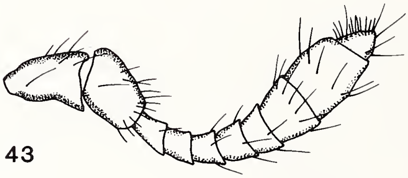

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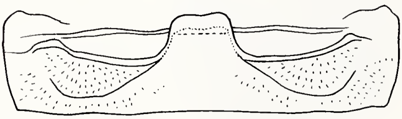

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Figs. 40–44. *Decadiomus hughesi, Exochomus* spp. 40. 41. *Decadiomus hughesi,* male genitalia. 42. *Decadiomus hughesi,* female genitalia. 43. *Exochomus* sp., antenna. 44. *Exochomus* sp., 1st abdominal sternum.

Exochomus Redtenbacher

Exochomus Redtenbacher, 1843:11; Mulsant, 1850:476; Casey, 1899:106; Gordon, 1985:621. Type-species: *Coccinella 4-pustulata* L., by subsequent designation of Korschefsky, 1932.

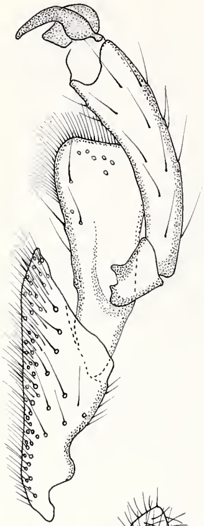
Chilocorini with form broadly oval to almost round; upper surface glabrous or pubescent. Clypeus expanded laterally, shelflike, partially dividing eye. Antenna 10-segmented; last 3 segments forming a slender fusiform club, 10th segment embedded in 9th (Fig. 43). Terminal segment of maxillary palpus subsecuriform, apex strongly oblique. Prosternal lobe narrow, truncate at apex, anterior coxae nearly contiguous. Pronotum finely margined across base, lateral margin slightly reflexed. Elytral margin strongly ridged, epipleuron not foveolate for reception of femoral apices. Abdomen with 6 visible sterna in male, 5 in female. Postcoxal line complete or not extending more than ½ distance to hind margin of sternum (Fig. 44) or reaching hind margin. Leg with robust femora, tibia slender, tarsal claw with subquadrate basal tooth (Fig. 45). Male genitalia with basal lobe symmetrical. Female genitalia with long sperm duct; infundibulum present.

Exochomus is found in most parts of the world with approximately 16 species occurring in the Western Hemisphere. One species is established on Bermuda. Host data indicate that scales are the primary hosts, but some species feed on aphids. Specific host data are as follows. Aphids: *Aphis gossypii* Glover, *Aphis pomi* Degeer, *Cinara fresai* Blanchard, *Eriosoma lanigerum* (Hausmann), *Toxoptera aurantii* (Boyer de Fonscolombe). Scales: *Aonidiella aurantii* (Maskell), *Aonidiella taxus* Leonard; *Asterolecanium coffeae* Newstead, *Asterolecanium miliaris* (Boisduval), *Asterolecanium bambusae* (Boisduval), *Ceroplastes rusci* (L.), *Ceroplastes sinensis* Del Guercio, *Chionaspis furfura* (Fitch), *Chionaspis minor* Maskell, *Chionaspis salicis* (L.), *Chrysomphalus dictyospermi* (Morgan), *Chrysomphalus aonidum* (L.), *Coccus viridis* (Green), *Cryptococcus fagisuga* Lindinger, *Dactylopius opuntiae* (Cockerell), *Eulecanium tiliae* (L.), *Filippia oleae* (Costa), *Hemiberlesia lataniae* (Signoret), *Ischnaspis longirostris* (Signoret), *Lepidosaphes beckii* (Newman), *Lepidosaphes gloverii* (Packard), *Parthenolecanium corni* (Bouche), *Parlatoria camelliae* Comstock, *Parlatoria oleae* (Colvee), *Pinnaspis buxi* (Bouche), *Planococcus citri* (Risso), *Planococcus lilacinus* (Cockerell), *Pollinia pollini* (Costa), *Pseudaulacaspis pentagona* (Targioni-Tozzetti), *Pseudoparlatoria ostreata* Cockerell, *Pulvinaria floccifera* (Westwood), *Quadraspidiotus marani* Zahradnik, *Quadraspidiotus ostreaeformis* (Curtis), *Saissetia oleae* (Olivier), *Situlaspis yuccae* (Cockerell), *Sphaerolecanium prunastri* (Boyer de Fonscolombe), *Toumeyella liriodendri* (Gmelin), *Unaspis citri* (Comstock), *Unaspis yanonensis* (Kuwana).

Exochomus jamaicensis Sicard

Exochomus jamaicensis Sicard, 1922:351; Korschefsky, 1932:263.

Diagnosis. Length 3.10 to 3.70 mm, width 2.80 to 3.10 mm. Form oval, convex. Color black except anterior pronotal angle very narrowly yellow; elytron red or yellowish red with large, black spot behind scutellum narrowly connected along suture to an irregularly transverse black fascia in apical ½ (Fig. 46). Head and pronotum



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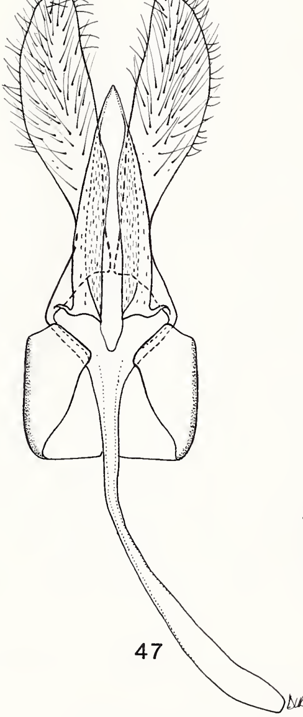

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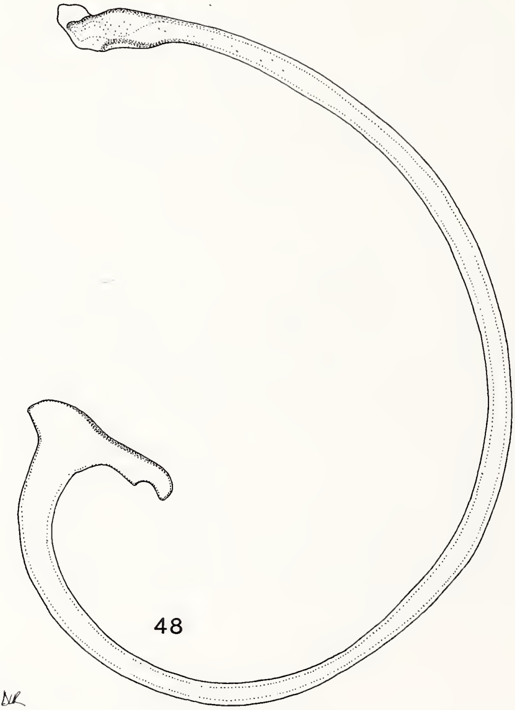

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Figs. 45–48. *Exochomus jamaicensis.* 45. tarsus. 46. habitus. 47. 48. male genitalia.

alutaceous, elytron shining. Male genitalia as in Figures 47, 48. Female spermathecal capsule as in Figure 49.

World distribution. Jamaica.

Bermuda distribution. Island wide.

Bermuda temporal distribution. Adults present year round.

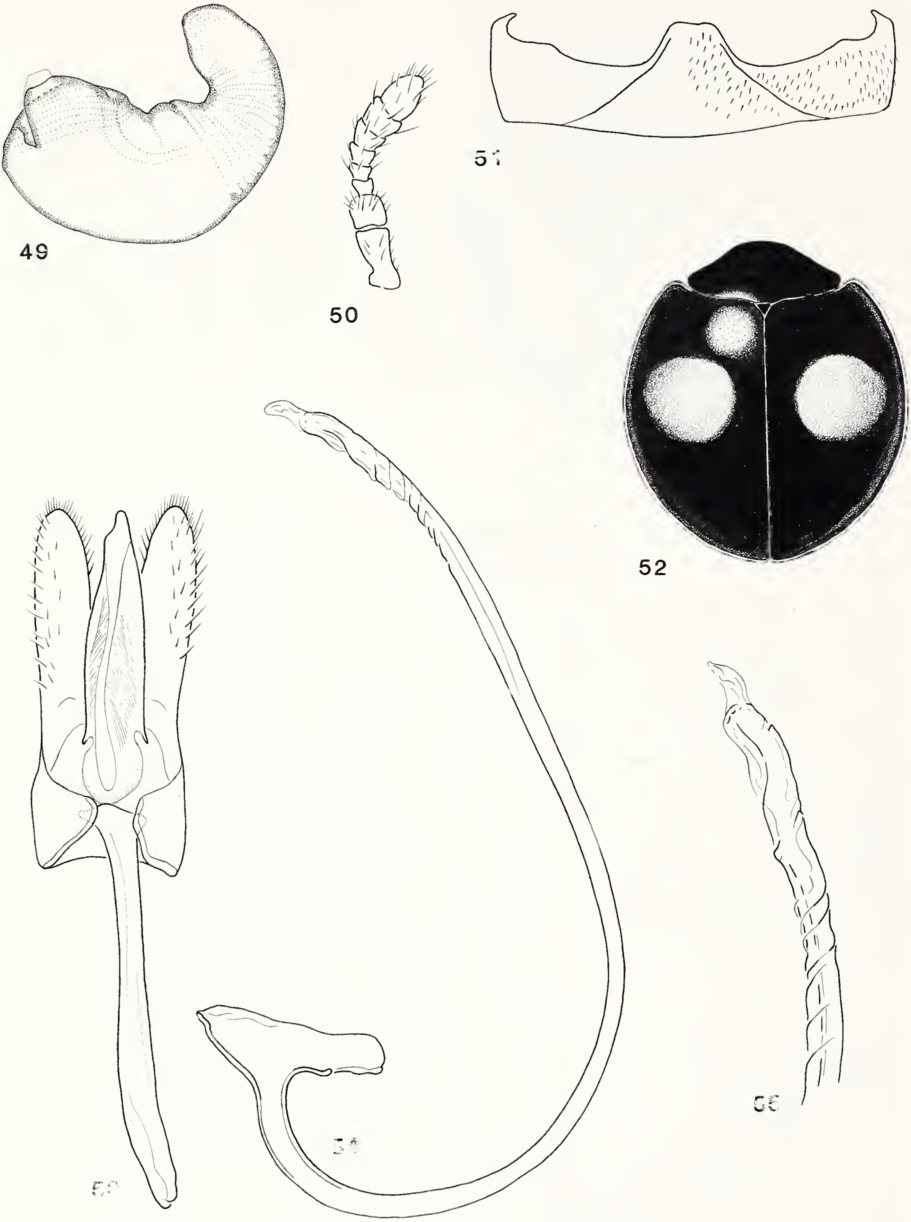
Discussion. The dorsal color pattern resembles only that of *Rodolia cardinalis,* however, the latter species is dorsally pubescent and lacks the divided eyes of *E. jamaicensis.* This species is distributed over the entire island and is the most visible of the Bermuda coccinellids because it is both very brightly colored and extremely active. The most common prey is aphids, but it will feed on scale insects as well, at least under laboratory conditions. It was originally introduced from Jamaica to control cedar scale but is rarely found on Bermuda cedar, and if so, it is usually associated with the juniper aphid, *Cinara fresai* Blanchard. It has also been recorded feeding on *Aphis gossypii* Glover.

Genus *Chilocorus* Leach

Chilocorus Leach, *in* Brewster, 1815:116; Mulsant, 1850:452; Korschefsky, 1932: 237; Gordon, 1985:641. Type-species: *Coccinella cacti* L., by monotypy.
Chilochorus Hope, 1840:157 (misspelling).

Chilocorini with form broadly oval, convex, dorsal surface glabrous. Clypeus expanded laterally, shelflike, partially dividing eye. Antenna 8-segmented, club 4-segmented, fusiform (Fig. 50). Apical segment of maxillary palpus with lateral margins nearly parallel, apical margin strongly oblique. Prosternal lobe flat, wide. Elytral margin not reflexed, finely ridged; epipleuron descending externally, shallowly foveolate for reception of femoral apices. Abdomen with 6 visible sterna in male, 5 in female. Postcoxal line incomplete (Fig. 51), merging with posterior margin of abdominal sternum. Leg with stout femora; tibia with external, triangular tooth at basal third; tarsal claw with small, quadrate tooth at base. Male genitalia with basal lobe slightly asymmetrical; trabes slender, longer than phallobase; sipho stout, twisted near apex. Female genitalia with spermathecal capsule large, without differentiation into nodulus and ramus, cornu short, bent, with falciform appendix at apex; infundibulum absent.

Chilocorus occurs worldwide with species in both temperate and tropical regions. One species is established on Bermuda. There are a number of specific host records available for members of *Chilocorus*; most are scale insects, but at least some species accept aphids as prey. These host records are listed below. Adelgid: *Adelges picea* (Ratzeburg). Aphids: *Acythrosiphon solani* (Kaltenbach), *Anoecia corni* (F.), *Aphis cytisorum* Hartig, *Aphis donacis* Passerini, *Chromaphis juglandicola* (Kaltenbach), *Eriosoma lanigerum* (Hausmann), *Macrosiphum avenae* (F.), *Monellia californica* Essig, *Monellia caryae* (Monell), *Monelia caryella* (Fitch), *Myzus malisuctus* Matsumura, *Phorodon humuli* (Schrank), *Rhopalomyzus lonicerae* (Siebold), *Rhopalosiphus padi* (L.), *Schizaphis graminum* (Rondani), *Schizaphis piricola* (Matsumura), *Toxoptera citricidus* (Kirkaldy). Scales: *Africaspis chionaspiformis* (Newstead), *Antonina bambusae* (Maskell), *Aonidia lauri* (Bouche), *Aonidiella aurantii* (Maskell), *Aonidiella citrina* (Coquillett), *Aonidiella taxus* Leonardi, *Aonidomytilus albus* (Cockerell), *Aspidiotus nerii* Bouche, *Asterolecanium coffeae* Newstead, *Asterolecanium*



Figs. 49–55. *Exochomus jamaicensis, Chilocorus cacti.* 49. *Exochomus jamaicensis,* female spermathecal capsule. 50. *Chilocorus cacti,* antenna. 51. *Chilocorus cacti,* 1st abdominal sternum. 52. *Chilocorus cacti,* habitus. 53–55. *Chilocorus cacti,* male genitalia.

phoenicis Rao, *Asterolecanium pustulans* (Cockerell), *Aulacaspis difficilis* (Cockerell), *Aulacaspis rosae* (Bouche), *Aulacaspis tubercularis* (Newstead), *Ceroplastes destructor* Newstead, *Ceroplastes floridensis* Comstock, *Ceroplastes japonicus* Green, *Ceroplastes rubens* Maskell, *Ceroplastes rusci* (L.), *Ceroplastes sinensis* Del Guercio, *Ceroplastes zonatus* Newstead, *Chionaspis salicis* (L.), *Chrysomphalus aonidum* (L.), *Chrysomphalus dictyospermi* (Morgan), *Coccus africanus* (Newstead), *Coccus colemani* Kannan, *Coccus hesperidum* L., *Coccus longulus* (Douglas), *Coccus viridis* (Green), *Comstockiella sabalis* (Comstock), *Cryptes baccatus* (Maskell), *Cryptoccus fagisuga* Lindinger, *Drosicha corpulenta* (Kuwana), *Dysmicoccus brevipes* (Cockerell), *Duplachionaspis saccharifolii* (Zehntner), *Ehrhornia cupressi* (Ehrhorn), *Ericerus pela* Chavannes, *Eriococcus casuarinae* (Maskell), *Eriococcus coriaceus* Maskell, *Eriococcus ironsidei* Williams, *Eriococcus leptospermi* Maskell, *Eulecanium kunoensis* Kuwana, *Eulecanium tiliae* (L.), *Filippia oleae* Costa, *Fiorinia theae* (Green), *Gossyparia casuarinae* Maskell, *Gossyparia spuria* (Modeer), *Hemiberlesia lataniae* (Signoret), *Hemiberlesia rapax* (Comstock), *Icerya purchasi* Maskell, *Inchoaspis dentilobis* (Newstead), *Inglisia conchiformis* Newstead, *Ischnaspis longirostris* (Signoret), *Kermes ilicis* (L.), *Kermes miyasakii* Kuwana, *Kermes nakagawae* Kuwana, *Lepidosaphes afganensis* Borschsenius, *Lepidosaphes beckii* (Newman), *Lepidosaphes conchiformis* (Gmelin), *Lepidosaphes gloverii* (Packard), *Lepidosaphes olivina* Leonardi, *Lepidosaphes ulmi* (L.), *Leucaspis* sp., *Lineaspis striata* (Newstead), *Mesolecanium nigrofasciatum* (Pergande), *Miscanthaspis tegalensis* (Zehntner), *Monophebulus* sp., *Nelaspis humilis* (Brain), *Nipaecoccus aurilanatus* (Maskell), *Nipaecoccus filamentosus* (Cockerell), *Nipaecoccus nipae* (Maskell), *Paralecanium frenchii* (Maskell), *Parlatoria blanchardi* (Targioni-Tozzetti), *Parlatoria oleae* (Colvee), *Parlatoria pergandii* Comstock, *Parlatoria proteus* (Curtis), *Parlatoria ziziphi* Lucas, *Parthenolecanium corni* Bouche, *Parthenolecanium persicae* (F.), *Parthenolecanium quercifex* (Fitch), *Phenacaspis grandilobis* (Maskell), *Phenacoccus solani* Ferris, *Pinnaspis strachani* (Cooley), *Planococcus citri* (Risso), *Planococcus kenyae* (LePelley), *Planococcus lilacinus* (Cockerell), *Pollinia pollini* (Costa), *Protopulvinaria mangiferae* (Green), *Pseudococcus longispinus* (Targioni-Tozzetti), *Pseudaonidia duplex* (Cockerell), *Pseudaonidia paeoniae* (Cockerell), *Pseudoparlatoria ostreata* (Cockerell), *Pulvinaria aurantii* (Cockerell), *Pulvinaria maxima* Green, *Pulvinaria okitsuensis* Kuwana, *Pulvinaria psidii* Maskell, *Quadraspidiotus ostreaeformis* (Curtis), *Saissetia coffeae* (Walker), *Saissetia oleae* (Olivier), *Unaspis yanonenis* (Kuwana).

Chilocorus cacti (L.)

Coccinella cacti L., 1767:584.
Chilocorus cacti: Mulsant, 1850:459; Korschefsky, 1932:237; Gordon, 1985:646.
Chilocorus confusor Casey, 1899:105; Leng, 1908:36 (synonymy).
Chilocorus cacti confusor: Drea, 1956:76.

Diagnosis. Length 4.00 to 6.20 mm, width 3.60 to 5.20 mm. Form oval, convex. Color black except large transverse red spot on elytron (Fig. 52), mesosternum, metasternum, and abdomen yellow or red. Dorsal surface smooth, polished, punctures fine, distinct. Male genitalia as in Figures 53–55. Female genitalia as in Figure 56.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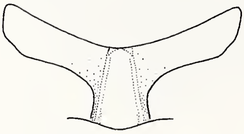
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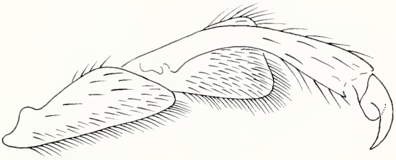
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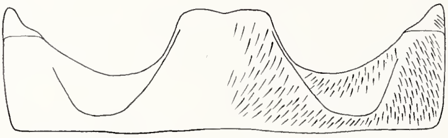
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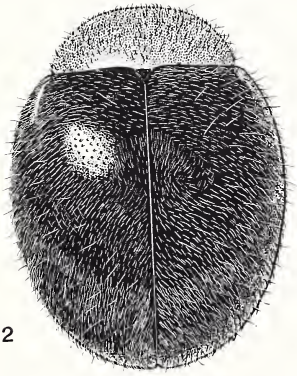
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Figs. 56–62. *Chilocorus cacti, Rhyzobius lophanthae.* 56. *Chilocorus cacti,* female genitalia. 57. *Rhyzobius lophanthae,* antenna. 58. *Rhyzobius lophanthae,* maxillary palpus. 59. *Rhyzobius lophanthae,* prosternum. 60. *Rhyzobius lophanthae,* tarsus. 61. *Rhyzobius lophanthae,* 1st abdominal sternum. 62. *Rhyzobius lophanthae,* habitus.

World distribution. Northern South America, Central America, Mexico, and southern United States.

Bermuda distribution. Island wide, but patchy.

Bermuda temporal distribution. Adults present October through May.

Discussion. The red or yellow ventral surface (except prosternum) will separate *C. cacti* from other Western Hemisphere species of *Chilocorus.* This species was originally introduced into Bermuda in 1948 for control of cedar scale, but has become established on the palmetto scale, *Comstockiella sabalis* (Comstock).

Genus *Rhyzobius* Stephens

Rhyzobius Stephens, 1829:239; Pope, 1981:22; Gordon, 1985:659. Type-species: *Nitidula litura* F., by monotypy.

Rhizobius Stephens, 1832:373 (error); Leng, 1920:214 Korschefsky, 1931:88; Blackwelder, 1945:443.

Rhizobius Agassiz, 1846:325 (unjustified emendation).

Lindorus Casey, 1899:161; Leng, 1920:214; Blackwelder, 1945:443; Pope, 1981:22. Type-species: *Scymnus lophanthae* Blaisdell, by monotypy.

Rhizobiellus Oke, 1951:21 (unnecessary replacement name for *Rhizobius* Agassiz, 1846 not Burmeister, 1835).

Coccidulini with form elongate or oval; dorsal pubescence composed of dense, decumbent hairs with sparse, erect hairs intermixed. Antenna long, slender, 11-segmented, club serrate (Fig. 57). Head partly concealed beneath pronotum; eye moderately coarsely faceted; apical segment of maxillary palpus securiform (Fig. 58). Prosternum with carinae widely separated, usually not joined apically (Fig. 59). Epipleuron narrow, not descending externally. Tarsus cryptotetramerous; tarsal claw not toothed, slightly angulate at base (Fig. 60), or appendiculate at least on hind leg. Postcoxal line on first abdominal sternum complete, as in *Pullus* (Fig. 61).

The partly concealed head and dual type of pubescence distinguish *Rhyzobius* from the genera of Western Hemisphere Coccidulini which it superficially resembles. The species that has been widely established in other parts of the Western Hemisphere also occurs on Bermuda. Species of *Rhyzobius* (at least the Australian species) are apparently scale feeders on *Aonidiella aurantii* (Maskell), *Chrysomphalus dictyospermi* (Morgan), *Coccus hesperidum* L., *Fiorinia theae* Green, *Planococcus citri* (Risso), *Pseudaulacaspis pentagona* (Targioni-Tozzetti), *Pseudococcus acaciae* (Maskell), *Pseudococcus calceolariae* (Maskell), *Pseudococcus maritimus* (Ehrhorn), *Quadraspidiotus perniciosus* (Comstock), and *Saissetia oleae* (Olivier). The European *Rhyzobius litura* (F.) has been recorded as feeding on the aphids *Dactynotus cirsii* (L.), *Dactynotus jaceae* (L.), and *Macrosiphum avenae* (F.).

Rhyzobius lophanthae (Blaisdell)

Scymnus lophanthae Blaisdell, 1892:51.

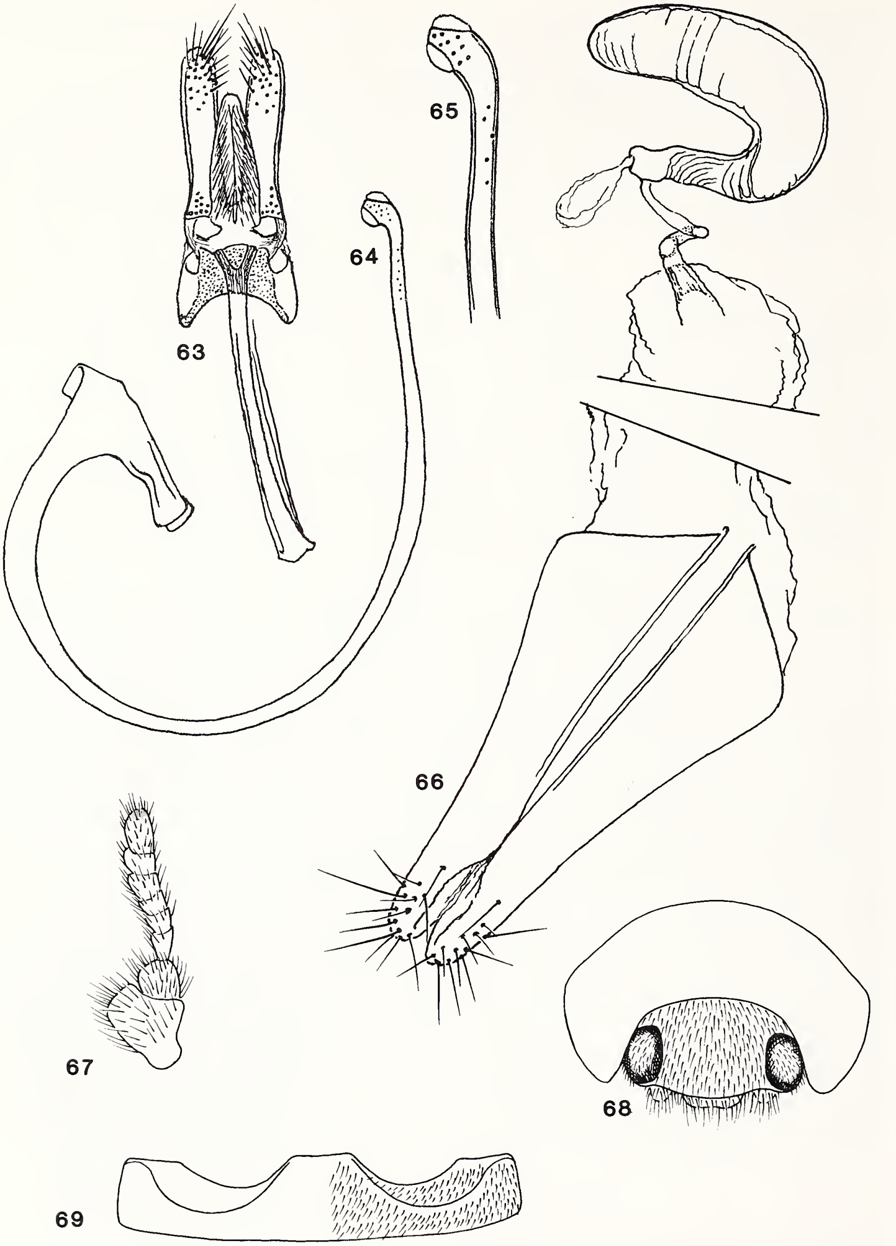
Rhizobius lophanthae: Horn, 1895:112.

Lindorus lophanthae: Casey, 1899:162; Korschefsky, 1931:86.

Lindorus lophantae: Leng, 1920:214 (misspelling).

Rhizobius toowoombae Blackburn, 1892:254; Korschefsky, 1931:86 (synonymy).

Rhyzobius lophanthae: Pope, 1981:22; Gordon, 1985:660.



Figs. 63–69. *Rhyzobius lophanthae, Rodolia cardinalis.* 63–65. *Rhyzobius lophanthae,* male genitalia. 66. *Rhyzobius lophanthae,* female genitalia. 67. *Rodolia cardinalis,* antenna. 68. *Rodolia cardinalis,* head. 69. *Rodolia cardinalis,* 1st abdominal sternum.

Diagnosis. Length 1.70 to 2.85 mm, width 1.35 to 2.00 mm. Form elongate, oval (Fig. 62). Color; pronotum light reddish brown, elytron dark reddish brown with faint, green metallic tint. Dorsal pubescence composed of dense, short, decumbent setae with long, sparse, erect setae intermixed. Male genitalia as in Figures 63–65. Female genitalia as in Figure 66.

World distribution. Native to Australia, introduced into many parts of the world; established in southern United States from Maryland to Florida, west to California.

Bermuda distribution. Island wide.

Bermuda temporal distribution. Adults present September through June.

Discussion. The metallic dorsal sheen and intermixed long and short pubescence will distinguish *R. lophanthae* from other Bermuda coccinellids. This species was introduced into Bermuda for control of cedar scale in 1947, 1948, and 1951, and has become well established and abundant on that host; at certain times of the year it is the commonest coccinellid on the island. For many years this species was known as *Lindorus lophanthae* but was assigned to *Rhyzobius* by Pope (1981).

Genus *Rodolia* Mulsant

Rodolia Mulsant, 1850:902; Korschefsky, 1931:98; Blackwelder, 1945:443; Gordon, 1972b:25; Gordon, 1985:665. Type-species: *Rodolia ruficollis* Mulsant, by subsequent designation of Crotch, 1874.
Rodolia (*Macronovius*) Weise, 1885:63.

Noviini with 8-segmented antenna as in Figure 67. Labrum flat or concave, anterior margin usually feebly emarginate (Fig. 68). Postcoxal line on first sternum complete (Fig. 69); 6th sternum of male with strong apical emargination.

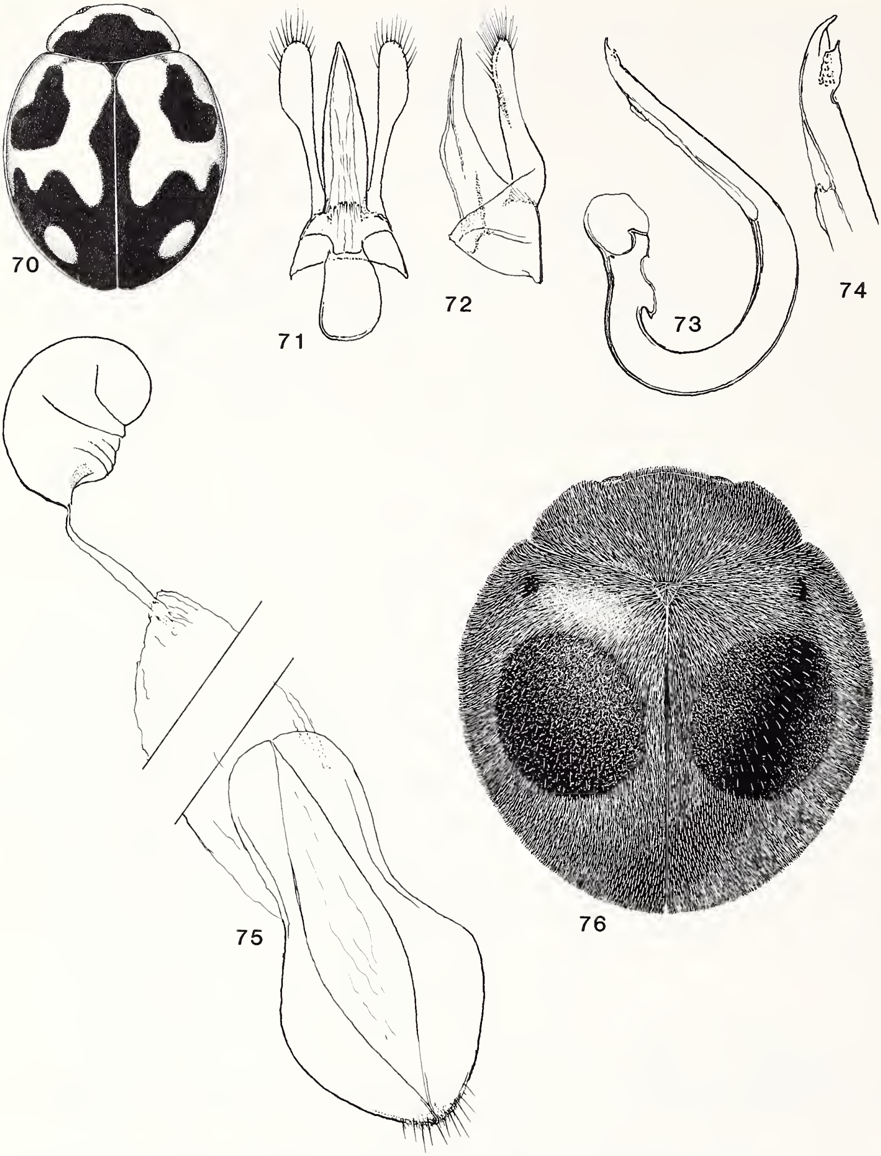
Rodolia cardinalis, the only species of *Rodolia* occurring in the Western Hemisphere, was introduced into California from Australia in 1888 for control of the cottonycushion scale, *Icerya purchasi* Maskell. It has since been introduced and become established in many parts of the world including Bermuda. Species of *Rodolia* prey primarily on scales of the genus *Icerya.* Recorded hosts include *Icerya purchasi* Maskell, *Icerya seychellarum* (Westwood), *Pseudococcus* sp., and *Pseudaulacaspis pentagona* (Targioni-Tozzetti).

Rodolia cardinalis (Mulsant)

Vedalia cardinalis Mulsant, 1850:906.
Novius cardinalis: Crotch, 1874:283.
Rodolia cardinalis: Weise, 1905:200; Korschefsky, 1931:99; Blackwelder, 1945:443; Gordon, 1972b:25; Gordon, 1985:666.

Diagnosis. Length 2.65 to 4.18 mm, width 2.00 to 3.33 mm. Form elongate, elytron nearly parallel sided, widest at middle. Color predominantly red; basal area of pronotum and head black; meso- and metasternum, femur and median area of basal 2 abdominal sterna piceous; elytron with black maculation (Fig. 70). Male genitalia as in Figures 71–74. Female genitalia as in Figure 75.

World distribution. Native to Australia, introduced into many parts of the world; established in the United States in California and Florida and scattered areas of the southern United States.



Figs. 70–76. *Rodolia cardinalis, Azya orbigera.* 70. *Rodolia cardinalis,* habitus. 71–74. *Rodolia cardinalis,* male genitalia. 75. *Rodolia cardinalis,* female genitalia. 76. *Azya orbigera,* habitus.

Bermuda distribution. Island wide, but patchy.

Bermuda temporal distribution. Adults present January through May.

Discussion. The dorsal color pattern and pubescence will distinguish *R. cardinalis* from other species of Bermuda Coccinellidae. This species was introduced into Bermuda in 1902 for control of the cottonycushion scale, *Icerya purchasi* (Maskell). It became established but is found only in some places on the island and only where cottonycushion scale occurs. *Pittosporum* is the most common host infested with this scale.

Genus *Azya* Mulsant

Azya Mulsant, 1850:928; Korschefsky, 1932:230; Gordon, 1980:155; Gordon, 1985: 674. Type-species: *Azya luteipes* Mulsant, by subsequent designation of Crotch, 1874.

Azyini with length ranging from 2.90 to 4.40 mm. Form oval. Dorsal surface black, often with metallic luster, male head yellow; dorsal pubescence dense, appressed, short or long, usually white with spot on elytron composed of brown hairs. Venter usually black or piceous except leg and abdomen yellow. Antenna 11-segmented. Epipleuron foveate for reception of femoral apices. Prosternum lobed anteriorly, partially concealing mouthparts, deeply excavated at side for reception of antenna; intercoxal lobe elevated, narrow, bicarinate or medially ridged. Anterior tibia with dually rounded external border. Male genitalia with paramere slender; apex of sipho slender, with ventral flap before apex. Female genitalia with cornu of spermathecal capsule broader than nodulus; genital plate extremely elongate, triangular.

Azya is native to the Western Hemisphere south of the United States, and one species, *A. orbigera,* has been introduced into many parts of the world, including Bermuda, for biological control purposes. Specific host records for this scale feeding genus are as follows: *Asterolecanium bambusae* (Boisduval), *Asterolecanium miliaris* (Boisduval), *Aulacaspis tubercularis* (Newstead), *Coccus viridis* (Green), *Dysmicoccus brevipes* (Cockerell), *Ferrisia virgata* (Cockerell), *Lecanium* sp., *Lecanium viride* Green, *Parasaissetia nigra* (Nietner), *Pseudococcus* sp., *Saissetia coffeae* (Walker), *Saissetia oleae* (Olivier), and *Selenaspidius* sp.

Azya orbigera orbigera Mulsant

Azya orbigera Mulsant, 1850:930; Korschefsky, 1932:230.
Azya orbigera orbigera: Gordon, 1980:157; Gordon, 1985:676.
Azya luteipes: Blackwelder, 1945:451; Woodruff and Sailer, 1977:1 (not *luteipes* Mulsant, 1850).

Diagnosis. Length 2.90 to 4.25 mm, width 2.50 to 3.45 mm. Form oval. Dorsum greenish black; head of male yellow; each elytron with round discal spot (Fig. 76). Venter black except leg and abdomen yellow. Male genitalia as in Figures 77–79.

World distribution. Native to South America, introduced into many parts of the world; established in the United States only in Florida.

Bermuda distribution. Devonshire Parish; Paget Parish; Smiths Parish; Pembroke Parish. Distribution very patchy.

Bermuda temporal distribution. Adults present year round but most abundant in the warmer months.

Discussion. The presence of a round, dark spot on each elytron and the dually rounded external border of the anterior tibia distinguish *Azya orbigera* from other Bermuda coccinellids. This species was introduced into Bermuda in 1956 and 1957 for control of the green shield scale, *Pulvinaria psidii* Maskell. It became established and is locally found feeding on a variety of scales including green scale, *Coccus viridis* (Green), oleander pit scale, *Asterolecanium pustulans* (Cockerell), and nigra scale, *Parasaissetia nigra* (Nietner).

Genus *Naemia* Mulsant

Naemia Mulsant, 1850:30; Crotch, 1874:92; Brown and de Ruette, 1962:644; Gordon, 1985:693. Type-species: *Coccinella seriata* Melsheimer by subsequent designation of Crotch, 1874.

Coccinellini with length 4.00 to 6.70 mm. Form elongate, somewhat flattened, femur visible beyond lateral margin of elytron. Dorsal color yellow with strong, variable, black maculae. Apex of clypeal margin broadly emarginate, anterolateral angle produced forward. Base of pronotum finely margined. Lateral margin of elytron feebly reflexed; epipleuron nearly flat, sloping downward slightly internally. Intercoxal process of prosternum narrow, feebly convex, lacking carinae but with fine lateral ridge. Metasternum with postcoxal line. Middle and hind tibia each with 2 spurs. Tarsal claw widened basally, not toothed (Fig. 80). Postcoxal line on abdomen lacking. Male genitalia symmetrical. Female genitalia with small infundibulum; coxal plate elongate, stylus distinct.

Naemia is a New World genus containing a single species occurring in eastern North America and from southern California south to Colombia. This species is established on Bermuda. Members of *Naemia* are supposedly aphid predators, but no specific host data are available.

Naemia seriata seriata (Melsheimer)

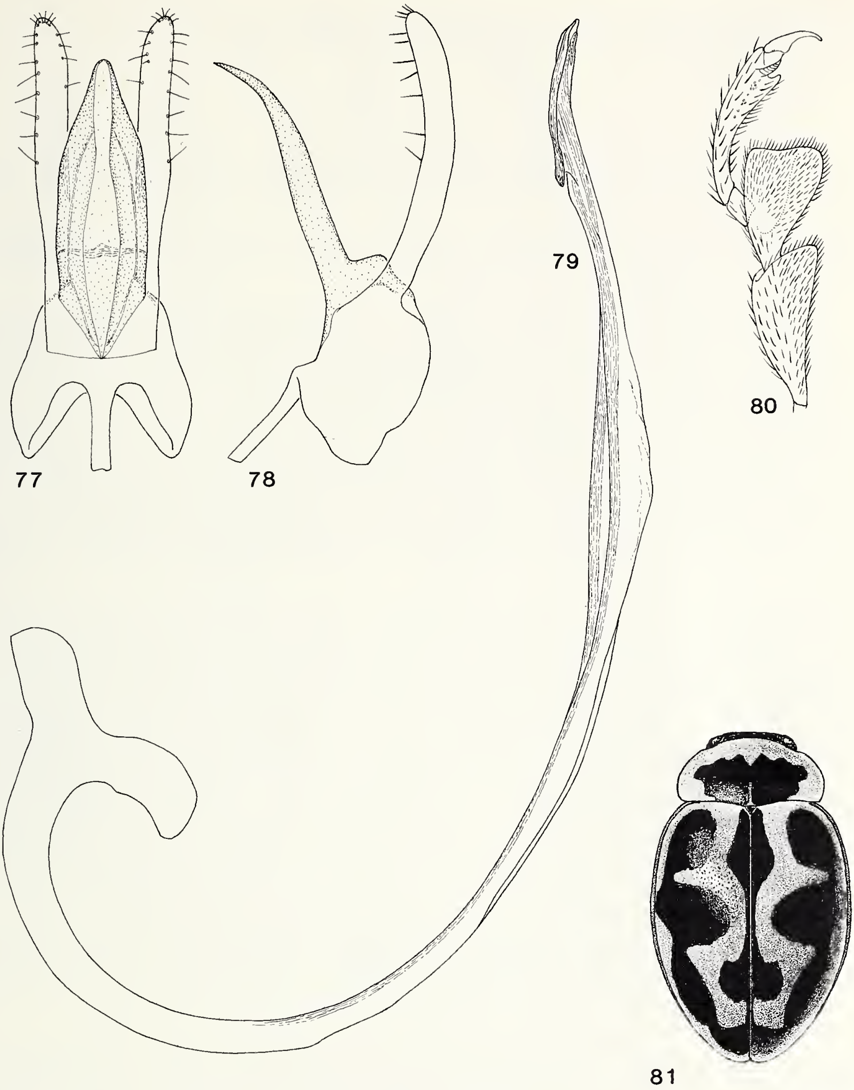
Coccinella seriata Melsheimer, 1847:177.
Anisosticta seriata: LeConte, 1852:130; Crotch, 1873:369; Leng, 1903:37.
Naemia seriata: Mulsant 1866:21; Crotch, 1874:92; Gorham, 1891:152; Casey, 1899:76; Leng, 1920:215; Korschefsky, 1932:317; Timberlake, 1943:9.
Naemia seriata seriata: Timberlake, 1943:46; J. Chapin, 1974:56; Gordon, 1985:694.
Megilla fuscilabris decepta Blatchley, 1914:64.
Ceratomegilla fuscilabris a. *decepta*: Leng, 1920:215.
Ceratomegilla maculata ab. *decepta*: Korschefsky, 1932:313.
Naemia seriata decepta: Timberlake, 1943:9, 46.

Diagnosis. Length 4.00 to 6.70 mm, width 2.50 to 3.10 mm. Head black; pronotum typically yellow with an irregular, black, central macula (Fig. 81), but many southern United States specimens have macula broken into ill-defined spots; elytron yellow with 6 black spots more or less fused in northern specimens (typical form). Ventral surface including leg black except prosternum and lateral abdominal margin yellow. Male genitalia as in Figures 82–85. Female genitalia as in Figure 86.

World distribution. North America; Atlantic and Gulf coasts, Rhode Island to south Texas.

Bermuda distribution. Camden Marsh; Spittal Pond, Smiths Parish.

Bermuda temporal distribution. Unknown.



Figs. 77–81. *Azya orbigera, Naemia seriata.* 77–79. *Azya orbigera,* male genitalia. 80. *Naemia seriata,* tarsus. 81. *Naemia seriata,* habitus.

Discussion. The pink or pinkish yellow dorsal surface with bold black maculae distinguishes *N. s. seriata* from other Bermuda Coccinellidae. This species was not intentionally introduced onto the island but is probably a wind blown immigrant from coastal United States. Adult specimens were collected at Camden Marsh (now filled in) in 1955, a larval specimen was collected at Spittal Pond in June, 1987, and one adult was collected at Spittal Pond in 1987. Population density is apparently low, given the difficulty experienced in finding specimens; it probably occurs only in damp, marshy localities as is often the case on the mainland.

Genus *Cycloneda* Crotch

Cycloneda Crotch, 1871:6; Casey, 1899:84; Korschefsky, 1932:282; Gordon, 1985: 819. Type-species: *Coccinella sanguinea* L., by subsequent designation of Crotch, 1874.

Daulis Mulsant, 1850:296 (not *Daulis* Erichson, 1842). Type-species: not designated.

Coccinella (*Cycloneda*): Leng, 1903:202.

Coccinellini with length 3.0 to 9.0 mm; form rounded, convex. Elytron pale, immaculate; pronotum black with pale markings. Apex of clypeus truncate, anterolateral angle produced forward. Lateral margin of elytron feebly explanate; epipleuron obliquely descending externally. Intercoxal process of prosternum narrow, ridged medially, lateral ridges obsolete. Apical margin of mesosternum truncate or barely perceptibly emarginate. Apex of middle and hind tibia each with 2 spurs. Tarsal claw with large, subquadrate basal tooth (Fig. 87). Postcoxal line incomplete, of *Diomus* type, without oblique dividing line (Fig. 88). Male genitalia symmetrical. Female genitalia with infundibulum; coxal plate irregularly elongate with distinct apical stylus.

Cycloneda is a New World genus with more than 50 names presently included. Most of these are neotropical with 3 species occurring north of Mexico. Because many species may have been erroneously placed in *Cycloneda,* we have based the description above on the North American species, which are closely allied to the type species. One native North American species is established on Bermuda. Members of *Cycloneda* are primarily aphid predators with specific host records as follows: *Acyrthosiphon dirhodum* (Walker), *Acyrthosiphon pisum* (Harris), *Aphis gossypii* Glover, *Aphis nerii* Boyer de Fonscolombe, *Aphis pomi* Degeer, *Aphis viburni* Scopoli, *Brevicoryne brassicae* (L.), *Carolinaia cyperi* Ainslie, *Chapitophorus eleagni* (Del Guercio), *Eriosoma lanigerum* (Hausmann), *Hyadaphis erysimi* (Kaltenbach), *Macrosiphum avenae* (F.), *Macrosiphum euphorbiae* (Thomas), *Myzus cerasi* (F.), *Myzus persicae* (Sulzer), *Nearctaphis crataegifoliae* (Fitch), *Periphyllus negundinis* (Thomas), *Phorodon humuli* (Schrank), *Rhopalosiphum maidis* (Fitch), *Sipha flava* (Forbes), *Sipha maydis* Passerini, *Toxoptera aurantii* (Boyer de Fonscolombe).

Cycloneda munda (Say)

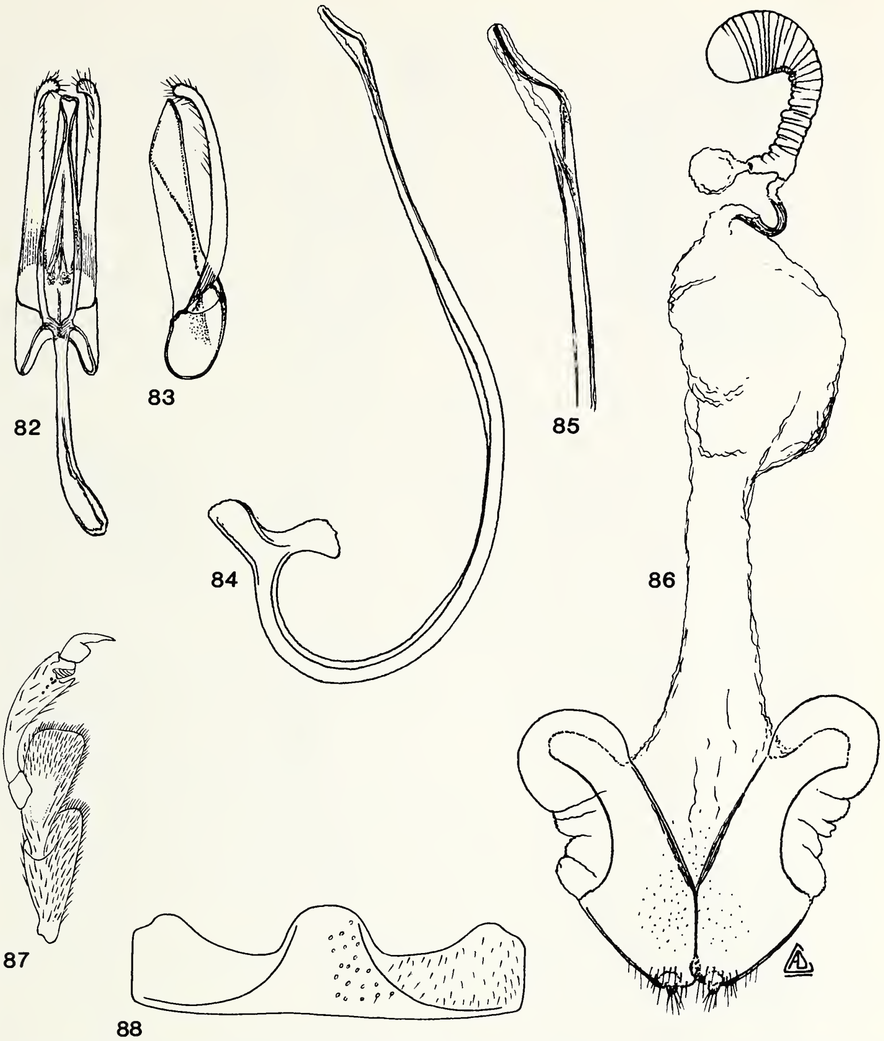
Coccinella munda Say, 1835:202.

Daulis munda: Mulsant, 1850:324.

Cycloneda munda: Crotch, 1871:6; Casey, 1899:93; Korschefsky, 1932:284; Gordon, 1985:824.

Coccinella (*Cycloneda*) *sanguinea* var. *munda*: Leng, 1903:203.

Diagnosis. Length 3.70 to 5.70 mm, width 3.10 to 4.20 mm. Pronotum mostly black with lateral pale spot not completely enclosed by black area, or with separate black spot laterally (Fig. 89); elytron reddish yellow. Male genitalia as in Figures 90–93. Female genitalia as in Figure 94.



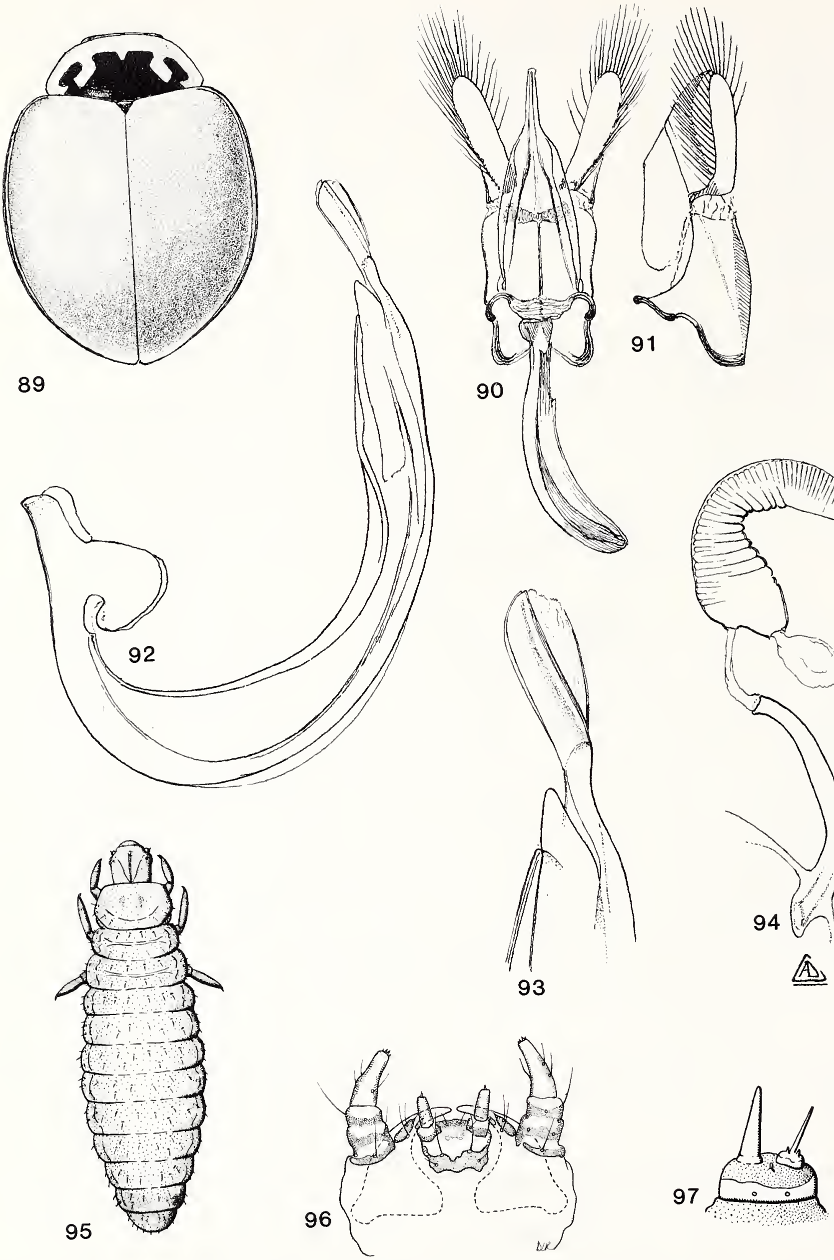
Figs. 82–88. *Naemia seriata, Cycloneda* spp. 82–85. *Naemia seriata,* male genitalia. 86. *Naemia seriata,* female genitalia. 87. *Cycloneda* sp., tarsus. 88. *Cycloneda* sp., 1st abdominal sternum.

World distribution. North America; New England to Montana, south to Texas and Georgia.

Bermuda distribution. Ferry Reach, St. George's Parish.

Bermuda temporal distribution. Adults present June through August.

Discussion. The entirely reddish yellow elytra and pronotal color pattern are unique among Bermuda Coccinellidae. This aphid feeding species was first recorded from Bermuda by Ogilvie (1928) and was probably not intentionally introduced. It is now found at only one locality on the island.



Figs. 89–97. *Cycloneda munda,* larval illustrations. 89. *Cycloneda munda,* habitus. 90–93. *Cycloneda munda,* male genitalia. 94. *Cycloneda munda,* female genitalia. 95. *Microweisea misella,* habitus. 96. *Microweisea suturalis,* mouthparts. 97. *Microweisea* sp., antenna.

IMMATURE STAGES OF BERMUDA COCCINELLIDAE

The larvae of 11 of the 14 species occurring on Bermuda have been field collected on the island, and the larvae of 2 remaining species are in the USNM collection; only the immature stages of *S.* (*P.*) *creperus* are unavailable for inclusion in the following key. As we do not have reliably determined larval specimens of any representative of *Scymnus* (*Pullus*), the larva of *Scymnus* (*P.*) *creperus* will key to *Scymnus* (*S.*) *floralis* since larval differences between the subgenera, if they exist, are still unknown. The larvae of *Microweisea suturalis, Decadiomus hughesi, Exochomus jamaicensis, Scymnus* (*S.*) *floralis,* and *Naemia seriata seriata* are described for the first time. Specimens studied are deposited in the USNM and Bermuda Department of Agriculture collections.

KEY TO LARVAE OF BERMUDA COCCINELLIDAE

1. Abdomen dorsolaterally with longitudinal series of 2 or 3 prominent, circular intersegmental pores; pores strongly sclerotized, darkly pigmented (Fig. 111) 2

– Abdomen without dorsolateral series of circular, strongly sclerotized pores; when pores present, elliptical to subcircular, weakly sclerotized (Fig. 100) 3

2(1). Apex of mandible simple; pronotum without senti .. *Exochomus jamaicensis* Sicard

– Apex of mandible bidentate (Fig. 112); pronotum with senti (Fig. 111) .... *Chilocorus cacti* (L.)

3(1). Length 2.0 mm or less; pronotum with 2 elongate pigmented areas; mandible without retinaculum (Fig. 98) .... *Microweisea suturalis* Schwarz

– Length 2.0 mm or more; pronotum not as described above; mandible with retinaculum 4

4(3). Mandible apically bidentate 5

– Mandible apically simple 8

5(4). Epicranial sutures distinct; mesothoracic and metathoracic terga each with 2 sclerites (Fig. 118) or with structures other than verrucae 6

– Epicranial sutures indistinct but evident posteriorly; mesothoracic and metathoracic terga with prominent verrucae (Fig. 108); abdominal tergae 1–8 with similar verrucae .... *Cryptolaemus montrouzieri* Mulsant

6(5). Tergal sclerites and strumae with small chalazae bearing gomphosetae (Fig. 113); abdomen with sharply defined dorsal light area extending from terga one through 3 (Fig. 113) .... *Rhyzobius lophanthae* (Blaisdell)

– Tergal sclerites and other structures without chalazae or gomphosetae; abdomen without sharply defined dorsal light area 7

7(6). Tibiotarsal claw simple, without basal tooth or rectangular base (Fig. 117) .... *Naemia seriata seriata* (Melsheimer)

– Tibiotarsal claw with basal tooth or rectangular base (Fig. 120) .... *Cycloneda munda* (Say)

8(4). Cardinal, submental, mental areas not fused into single composite structure, area membranous or nearly so (Fig. 99) 9

– Cardine, stipes, submental and mental areas fused into a solid sclerotized, pigmented structure with anterior extension on each side (Fig. 114) .... *Rodolia cardinalis* (Mulsant)

9(8). Hind margin of 9th abdominal sclerite with 2 pairs of strong, short, pointed setae (Fig. 107) .... *Clitostethus arcuatus* (Rossi)

– Hind margin of 9th abdominal sclerite without strong, pointed setae 10

10(9). Abdominal terga with membranous or non-sclerotized strumae each bearing 2 chalazae with bases extremely small, setae subequal, short, apically truncate (Fig. 115) .... *Azya orbigera* Mulsant

– Abdominal terga otherwise, or if membranous, strumae or verrucae with collar setae present, setae distinct and long 11

11(10). Maxillary palpus 3-segmented, with segments of palpus and palpifer distinct, sharply defined; abdominal terga without intersegmental pores .... *Scymnus* (*Scymnus*) *floralis* Mulsant

– Maxillary palpus 2-segmented, palpifer and basal segment of palpus weakly sclerotized, often indistinct and poorly defined; abdomen dorsolaterally on each side with elliptical intersegmental pores (Fig. 109) 12

12(11). Mesopleura and metapleura with poorly defined anterior and posterior lobes; pleura of abdominal segments 1–8 slightly protuberant (Fig. 101) .... *Decadiomus hughesi,* n. sp.

– Mesopleura and metapleura with sharply defined anterior and posterior lobes; pleura of abdominal segments 1–8 distinctly protuberant (Fig. 109) .... *Diomus terminatus* (Say)

Microweisea suturalis (Schwarz)

Larval references: Boving, 1917:631; Gage, 1920:42.

Description, 4th (last) instar. Body elongate, fusiform, widest across 3rd abdominal segment; length 2.0 mm. Head elongate, parallel sided (Fig. 95), distinctly longer than broad; darkly pigmented dorsally and laterally, with sparse, long setae dorsally; ventral surface moderately pigmented, with narrow, pale strip ventrolaterally; epicranial suture pale, distinct, epicranial stem lacking. Clypeal area deeply hollowed out medially, lateral projection heavily sclerotized. Labrum lying inside hollowed out clypeal area, somewhat triangular apically, armed with 2 pairs of setae, basal pair much longer, more robust than anterior pair. Mandible falcate, simply pointed at apex, lacking receptaculum (Fig. 98). Cardo and stipes of maxilla fused, palpifer distinct; maxillary palpus composed of 3 articles, 3rd article curved inward, narrowed toward apex, with terminal sensillae; basal 2 articles pigmented in basal ½ (Fig. 96). Labial palpus composed of 2 articles, 2nd article elongate, rectangular, 3 times as long as basal segment, with 1 large and 1 small apical sensilla. Antenna of 1 short article, broader than long, pigmented in apical ½, bearing an elongate sensilla and 1 short sensilla (Fig. 97). Dorsum and pleuron of thoracic and abdominal segments densely covered with minute, pointed spicules intermixed with sparse, long, wide based setae, presenting a uniform gray appearance. Prothorax oval, rounded at sides, with 2 pigmented sclerites on each side of middle (Fig. 95). Meso- and metathorax without pigmented sclerites. Sternal areas of all thoracic segments glabrous; sternal areas of abdominal segments with minute spicules less dense than on terga. Thoracic and abdominal spicules small, round. Femur and tibiotarsus subequal in length; femur bearing 3 long setae, tibiotarsus bearing 4 short setae; apex of tibiotarsus with 2 long, paddle-like tenent hairs and appendiculate claw. Abdominal segment 10 cylindrical, directed caudo-ventrad; rectum evaginated to form sucking disc.

Larvae of species of *Microweisea* are very simple in structure, lacking the complicated thoracic and abdominal ornamentation of most other genera of Coccinellidae. The elongate, darkly pigmented head, pigmented prothoracic sclerites, and hollowed out clypeal area are unique to this genus, at least until the immature stages of other genera of the tribe Microweisini are described. The only other described

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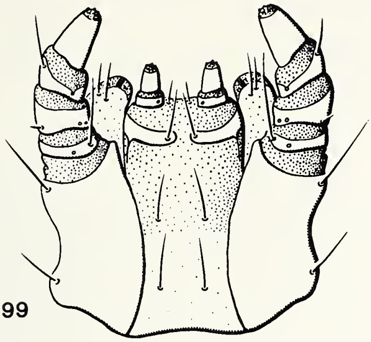

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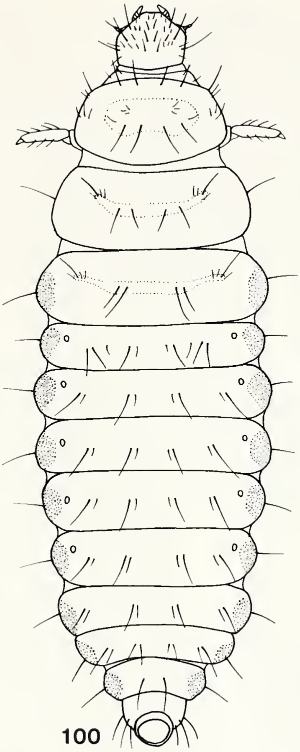

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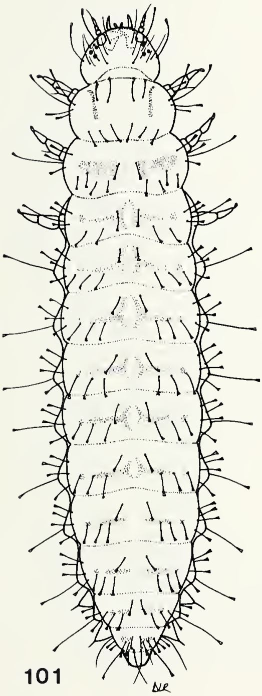

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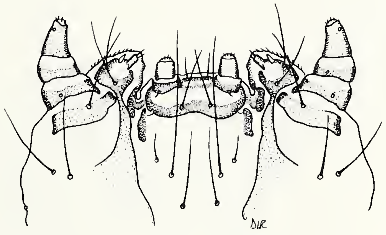

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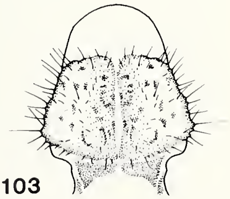

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Figs. 98–103. Larval illustrations. 98. *Microweisea* sp., mandible. 99. *Scymnus* sp., mouthparts. 100. *Scymnus* (*S.*) *floralis*, habitus. 101. *Decadiomus hughesi*, habitus. 102. *Exochomus jamaicensis*, mouthparts. 103. *Exochomus jamaicensis*, pronotum.

larva of this genus is that of *M. misella* (LeConte) (Gage, 1920), and comparison of the larvae of both species indicates that *M. suturalis* differs in having the 2nd segment of the labial palpus 3 times as long as the basal segment and in having a greater number of the long, wide based setae on the tergum of all thoracic and abdominal segments. The larva of *M. misella* has the 2nd article of the labial palpus only about ½ longer than the basal segment and the tergal setae less numerous. In addition, the pigmented prothoracic sclerites are much larger and more distinct in *M. suturalis* than in *M. misella*. The larvae described above were collected at Admiralty House, Pembroke Parish, 14-VIII-87, by R. Gordon, on *Juniperus bermudiana* infested with cedar scale. Voucher specimens are deposited in the USNM collection.

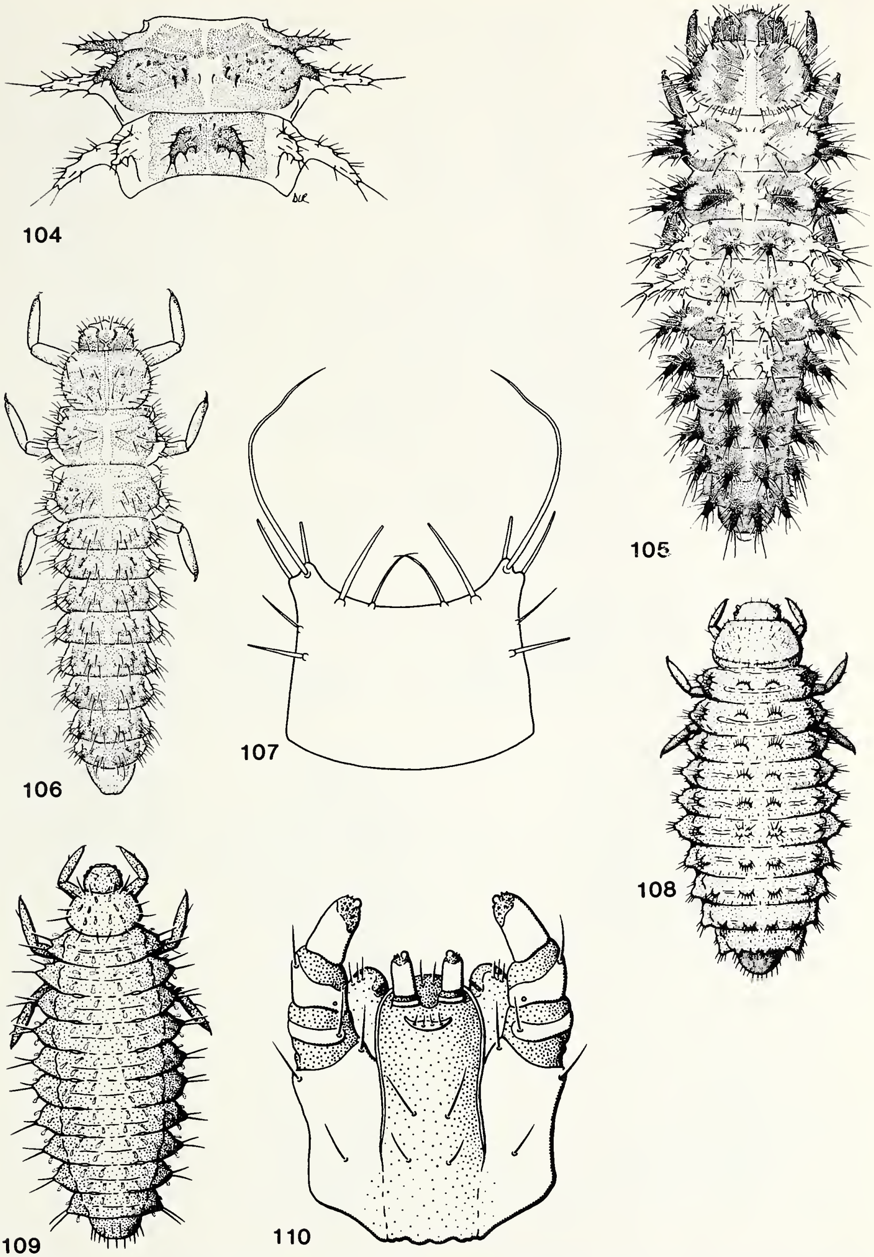
Scymnus (*Scymnus*) *floralis* (F.)

Description, 4th (last) instar. Body elliptical, widest across metathorax, length 3.75 mm (Fig. 100). Head subcordate; epicranial suture lacking; lightly pigmented behind each group of ocelli and medially posterior to labrum. Antenna 3-segmented, 1st and 2nd segments broader than long, with several apical, sensory processes. Mandible apically simple, retinaculum present. Maxillary palpus 3-segmented, 3rd segment longer than either segments 1 or 2, sclerotized; palpifer distinct. Labial palpus 2-segmented, 1st segment short, broader than long, 2nd segment elongate, conical; palpiger distinct (Fig. 99). Pronotum transverse, rectangular; median area with weakly pigmented sclerite feebly divided longitudinally, 5 setae present on each side of sclerite, 2 large setae basally near midpoint, 1 small seta medially near midpoint, 1 small seta at anterolateral corner, 1 small seta laterally at middle; apical margin of pronotum with 4 long, prominent setae; 1 large seta and several small setae on each lateral margin of pronotum. Meso- and metanotum each with 2 indistinct, dorsal sclerites, 1 on each side, each sclerite armed with 2 long setae near midline and 1 small lateral seta; each anterolateral angle with clump of 1 large and 2 smaller setae. Meso- and metapleuron each lacking anterior lobe; posterior lobe rounded, with 1 large seta at middle and several small setae. Abdominal segments 1–8 with 1 large and 1 small seta at lateral margin, 1 large and 2 small setae arranged in transverse row dorsally on each side of middle; each dorsal pleural lobe with setal pattern as on metapleuron; each ventral pleural lobe lightly pigmented, with 2 long and several short setae. Ninth abdominal segment transverse, distinctly pigmented, apical margin with 8 long setae. Apex of tibiotarsus with 2 long, clavate setae; claw curved, nearly simple, but with small, rectangulaar, basal projection.

Two species in 2 subgenera of *Scymnus* occur on Bermuda. The larva of *S.* (*Pullus*) *creperus* has not been discovered, therefore no comparative statements can be made. When alive, the larva of *S.* (*Scymnus*) *floralis* is covered with a white, waxy coat; when preserved, the wax dissolves and the larva is yellowish white. The larval specimens described above were collected at the Botanical Gardens, Paget Parish, 2-XI-87, by D. Hilburn, on hibiscus infested with aphids. Voucher specimens are deposited in the USNM collection.

Decadiomus hughesi Gordon and Hilburn

Description, 4th (last) instar. Body elliptical, widest across 2nd abdominal segment, length 2.40 mm (Fig. 101). Head transversely subrectangular with both extremely



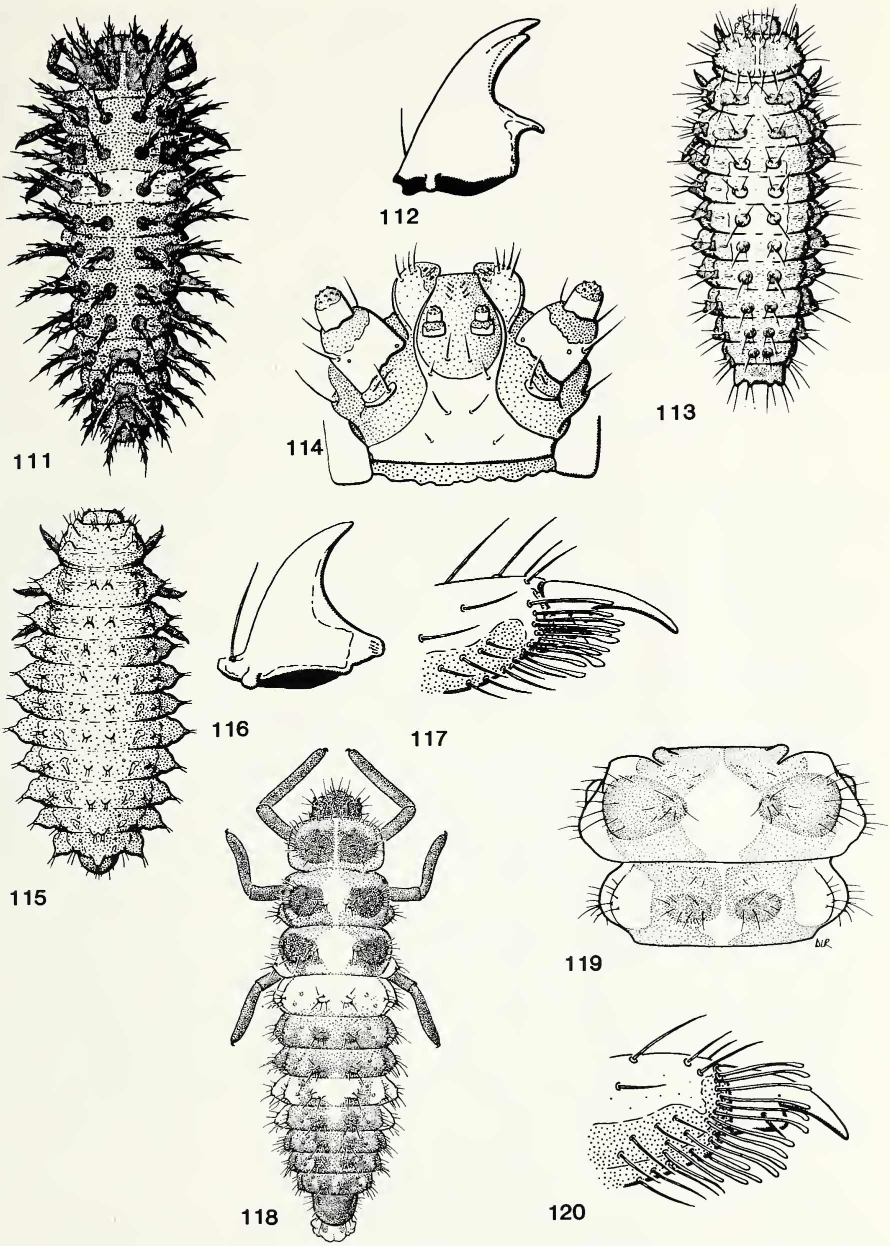
Figs. 104–110. Larval illustrations. 104. *Exochomus jamaicensis,* metanotum, 1st abdominal segment. 105. *Exochomus marginipennis,* habitus. 106. *Naemia seriata,* habitus. 107. *Clitostethus arcuatus,* terminal abdominal segment. 108. *Cryptolaemus montrouzieri,* habitus. 109. *Diomus roseicollis,* habitus. 110. *Diomus roseicollis,* mouthparts.

long and extremely short setae present dorsally; epicranial suture lacking. Antenna 2-segmented, 2nd segment very small, with 1 apical sensilla; basal segment with 1 short, robust sensilla and scattered setae. Mandible apically simple, retinaculum present. Maxillary palpus 2-segmented, 2nd segment longer than 1st, palpifer present, distinct. Labial palpus 2-segmented, 2nd segment 3 to 4 times as long as 1st, palpiger faintly evident. Pronotum with weak, indistinct sclerite on each side, with tiny asperities and widely spaced, clublike feather setae intermixed with slender feather setae. Mesonotum and metanotum each with 2 weak, indistinct sclerites, 1 on each side, with tiny asperities, short setae, sparse chalazae, and clublike feather setae. Mesopleuron and metapleuron each with poorly defined anterior and posterior lobes, lobes with elongate feather setae. Abdominal segments 1–8 with asperities and scattered, clublike setae; pleuron slightly protuberant, terminating in low, weakly sclerotized verruca with 3 or 4 elongate feather setae. Ninth abdominal segment semicircular, asperate, with 2 lateral feather setae and 6 long, median setae at apex. Leg with femur robust, tibiotarsus slender with sparse, long, terminal setae; claw curved, simple, without appendiculate base.

No larval descriptions of *Decadiomus* species have been published, however, we compared the larva of this species with that of *Decadiomus pictus* Chapin and found that the dorsal asperities are much more dense and the feather setae much less dense in *D. hughesi* than in *D. pictus.* When alive, the larva of *D. hughesi* is pale green in color, when preserved it is pale yellowish or pinkish white, almost transparent. The larval specimens described above were collected at Admiralty House, Pembroke Parish, 14-VIII-87, by R. Gordon, on *Cycas revoluta* infested with the mealybug, *Pseudococcus longispinus.* Voucher specimens are deposited in the USNM collection.

Exochomus jamaicensis Sicard

Description, 4th (last) instar. Body elongate oval, widest across metathorax; length 7.0 mm. Dorsal pigmentation composed of minute spicules forming individual patterns on different body segments. Head slightly elongate, lateral margins straight, somewhat narrowed apically; occipital margin nearly straight; darkly pigmented dorsally and laterally; epicranial sutures present, faintly indicated, epicranial stem lacking. Labrum deflexed anteriorly, with numerous long and short dorsal setae. Mandible apically simple, internally grooved, retinaculum present. Maxilla with fused cardo and stipes, distinct palpifer; palpus 3-segmented, 3rd segment narrow, longer than 2nd, bearing short sensory papillae (Fig. 102). Labial palpus 2-segmented, apical segment longer and narrower than basal segment (Fig. 102). Antenna of 1 segment, bearing 1 long sensillum and several short setae. Pronotum with large sclerite on each side, outer ½ pale, inner ½ pigmented, dorsal and lateral margins fringed with chalazae (Fig. 103). Mesonotum with sclerite on each side, each with 2 short, unequal senti on lateral margin; anterior and posterior mesopleural lobes each with large sentus nearly equal in size. Metanotum with sclerite on each side, each with 1 large sentus on lateral margin; anterior and posterior metaplerual lobes each with senti nearly equal in size; anterior metapleural sentus unpigmented, posterior sentus (Fig. 104). Abdominal segments 1–8 each with 6 senti (Fig. 106), dorsal senti of segment 8 longer than on other segments, all senti except mesopleural senti of segments 1 and 5–8 pigmented; 9th segment apically semicircular. Abdominal segments 1–8 each



Figs. 111–120. Larval illustrations. 111. *Chilocorus stigma,* habitus. 112. *Chilocorus* sp., mandible. 113. *Rhyzobius lophanthae,* habitus. 114. *Rodolia cardinalis,* mouthparts. 115. *Azya* sp., habitus. 116. *Azya* sp., mandible. 117. *Hippodamia* sp., tibiotarsal claw. 118. *Cycloneda* sp., habitus. 119. *Cycloneda munda,* metanotum, 1st abdominal segment. 120. *Coccinella* sp., tibiotarsal claw.

with 2 dorsal intersegmental pores, 1 on each side. Leg pigmented, tibiotarsus with dense, apical tactile setae, claw strongly appendiculate.

No description of a Western Hemisphere *Exochomus* has been published, but we have compared the larva of *E. jamaicensis* with that of *E. marginipennis* from Florida and found some significant differences. The larva of *E. jamaicensis* lacks a pronotal sentus, has 2 senti on the lateral margin of the mesonotum, 1 sentus on the lateral margin of the metanotum, and the senti on the anterior and posterior mesopleural lobes are equal in size. In contrast, *E. marginipennis* has 1 lateral pronotal sentus, 3 senti on the lateral margin of the mesonotum, 2 senti on the lateral margin of the metanotum, and the sentus on the anterior mesopleural lobe is smaller than the sentus on the posterior lobe. The larval specimens described above were collected at Admiralty House, Pembroke Parish, 26-V-87, by D. J. Hilburn, on *Pittosporum.* Voucher specimens are deposited in the USNM collection.

Naemia seriata seriata (Melsheimer)

Description, 4th (last) instar. Body fusiform, widest across metathorax (Fig. 106), length 8.5 mm. Head strongly sclerotized, basal ½ pigmented; epicranial arms distinct, epicranial stem very short. Antenna 2-segmented. Labrum subrectangular, pigmented on lateral margin. Mandible bidentate, with retinaculum. Maxillary palpus 3-segmented, palpifer distinct. Labial palpus 2-segmented. Pronotum with large sclerite divided by narrow median area, asperate, with setae and chalazae, setae of chalazae long, black. Mesonotum and metanotum with suboval, asperate struma on each side; mesonotum with 13 chalazae on each struma, metanotum with 12 chalazae on each struma. Abdominal segments 1–8 each with dorsal, dorsolateral, and lateral strumae; all strumae asperate; dorsal and dorsolateral strumae each with 4 prominent chalazae, 2 anterior, 2 posterior; lateral struma asperate, with 2 chalazae and several prominent setae. Ninth abdominal segment conical, longer than broad, setiferous dorsally and laterally. Ventral surface of thoracic segments sparsely asperate, each segment with paired strumae between legs, each struma with 2 long setae. Ventral surface of abdominal segments 1–3 sparsely asperate, with 4 strumae, each struma bearing a single seta, setae progressively longer and coarser from segment 1 to segment 8. Leg long, tibiotarsus with membranous, setiferous sole; claw simple, base lacking tooth.

The larva of this species is most similar to the larva of *Coleomgilla maculata* (Degeer) from the North American mainland, but has 4 chalazae on each dorsal and dorsolateral abdominal sterum rather than 3 as in *C. maculata.* The preceding description is based on a single larva collected at Spittal Pond, Smiths Parish, 24-VI-87, by J. Hendrickson. This voucher specimen is deposited in the Bermuda Department of Agriculture collection.

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TAXONOMIC NAMES PROPOSED IN THE INSECT ORDER HETEROPTERA BY JOSÉ CANDIDO DE MELO CARVALHO FROM JANUARY 1985 TO JANUARY 1989, WITH TYPE DEPOSITORIES

José C. M. Carvalho and Richard C. Froeschner
Museu Nacional de História Natural, Quinta da Boa Vista,
Rio de Janeiro, Brazil, and
United States National Museum of Natural History,
Washington, D.C. 20560 U.S.A.

Abstract.—A list of taxonomic names of Heteroptera proposed by J. C. M. Carvalho alone or in coauthorship from January 1985 to January 1989 is presented. Included are 72 genera, and 480 species and subspecies. For each name the original reference is cited, and for holotypes the present depository is given.

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This is the second list of Carvalho contributions to heteropterology and encompasses the period from January 1984 to January 1989. The first list containing 254 genera and 1,260 species was published in the Journal of the New York Entomological Society, 95:121–224 (1987). The style of presentation used there is followed here in recording the original citations for 72 genera and for 480 species and subspecies with their type localities and the institutional depository of their holotypes.

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LIST OF NAMES PROPOSED

Family Colobathristidae
Genus-Group Name

Parathristes Carvalho & Henry, 1986
  Bol. Mus. Goeldi, Zool. 2(2):86.

Species-Group Name

Parathristes carajaensis Carvalho & Henry, 1986
    Bol. Mus. Goeldi, Zool. (2)2:88, figs. 1–3; H ♂, Pará, Brazil, Serra Norte (Carajás), Estr. Manganês, 21.V.1984, T. Pimental; MPEG.

Family Miridae

Genus-Group Names

Adhyalochloria Carvalho & Ferreira, 1987
    Expertientiae 29(10):144 (1986).
Adparaproba Carvalho, 1987
    Rev. Brasil. Biol. 47(4):574.
Allommatela Carvalho & Ferreira, 1987
    Experientiae 29(10):147 (1986).
Araucanomiris Carvalho, 1986
    Jour. N.Y. Ent. Soc. 94(2):206.
Atahualpacoris Carvalho, 1985
    Rev. Brasil. Biol. 45(4):547.
Biobiocoris Carvalho, 1985
    Rev. Brasil. Biol. 45(3):253.
Boliviomiris Carvalho, 1987
    Rev. Brasil. Biol. 47(4):593.
Bomberia Carvalho, 1987
    Rev. Brasil. Biol. 47(1–2):177.
Brailovskysta Carvalho, 1988
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Carpinteroa Carvalho, 1988
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Caruarina Carvalho, 1985
    Rev. Brasil. Biol. 45(3):254.
Chileria Carvalho, 1985
    Rev. Brasil. Biol. 45(3):291.
Colimacoris Schaffner & Carvalho, 1985
    Proc. Ent. Soc. Wash. 87(2):308.
Comefulvius Carvalho & Carpintero, 1985
    An. Acad. Brasil. Ci. 57(4):509.
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  An. Acad. Brasil. Ci. 59(4):393 (1987).
Fortunacoris Carvalho, 1985
  Rev. Brasil. Biol. 45(4):656.
Froeschneriella Carvalho, 1986
  Jour. N.Y. Ent. Soc. 94(2):206.
Gressitticoris Carvalho, 1985
  Rev. Brasil. Biol. 45(4):460.
Gressittmiris Carvalho, 1988
  Rev. Brasil. Ent. 32(2):217.
Guaicurua Carvalho, 1987
  Rev. Brasil. Biol. 47(4):594.
Guapimirinus Carvalho, 1985
  Rev. Brasil. Biol. 45(3):260.
Guaranimiris Carvalho, 1988
  An. Acad. Brasil. Ci. 59(4):408 (1987).
Gulacylapus Carvalho, 1986
  Ann. Soc. Ent. France (n.s.) 22(2):215.
  Note: Carvalho, 1987, Ann. Soc. Ent. France (n.s.) 23:112, noted the type-species should read *Gulacylapus carayoni,* not "*Gulafulvius*" *carayoni.*
Ialibua Carvalho, 1986
  Rev. Brasil. Ent. 30(2):393.
Iguazucoris Carvalho & Carpintero, 1985
  An. Acad. Brasil. Ci. 57(4):507.
Jimia Carvalho, 1987
  Rev. Brasil. Biol. 47(1–2):179.
Karimuicoris Carvalho, 1985
  Rev. Brasil. Biol. 45(4):462.
  Note: Two spellings were used in the original proposal: the above and "*Karamuicoris*" in the species combination. Because the genus is named after the locality "Karimui," the spelling "*Karimuicoris*" is here designated the correct one.
Karubacoris Carvalho, 1985
  Rev. Brasil. Biol. 45(4):461.
Kraussella Carvalho, 1987
  Rev. Brasil. Biol. 47(1–2):180.
Kraussmiris Carvalho, 1987
  An. Acad. Brasil. Ci. 58(3):489 (1986).
Lincolnia Eyles & Carvalho, 1988
  New Zeal. Jour. Zool. 15(2):339.

Linharesmiris Carvalho, 1986
    Rev. Brasil. Biol. 46(1):43.
Marinonicoris Carvalho, 1988
    Rev. Brasil. Biol. 48(4):877.
Mercedesina Carvalho, 1988
    Rev. Brasil. Biol. 48(2):344 [new name for *Limonia* Carvalho, 1985, Rev. Brasil. Biol. 44(3):267 (1984)].
Meridatibius Carvalho, 1985
    Rev. Brasil. Biol. 45(4):575.
Morobea Carvalho, 1987
    Rev. Brasil. Biol. 47(1–2):181.
Morobemiris Carvalho, 1985
    Rev. Brasil. Biol. 45(4):463.
Morocisca Carvalho, 1987
    An. Acad. Brasil. Ci. 58(3):492 (1986).
Mourecoris Carvalho, 1988
    Rev. Brasil. Biol. 48(4):881.
Neoloxops Carvalho, 1987
    Rev. Brasil. Biol. 47(1–2):182.
Nuevoleonia Schaffner & Carvalho, 1985
    Jour. Kans. Ent. Soc. 58(2):228.
Osornocoris Carvalho, 1985
    Rev. Brasil. Biol. 45(3):284.
Papaveronia Carvalho, 1985
    Rev. Brasil. Biol. 45(3):287.
Papuacoris Carvalho, 1985
    Rev. Brasil. Biol. 45(4):465.
Paraguayna Carvalho, 1986
    Jour. N.Y. Ent. Soc. 94(2):213.
Paranatylus Carvalho, 1988
    Rev. Brasil. Biol. 48(4):884.
Perumiris Carvalho, 1987
    Rev. Brasil. Biol. 47(1–2):226.
Prepopsisca Carvalho, 1988
    An. Acad. Brasil. Ci. 59(3):253 (1987).
Prolygus Carvalho, 1987
    Rev. Brasil. Biol. 47(1–2):137.
Rondonella Carvalho, 1985
    Rev. Brasil. Biol. 45(3):294.
Roppisca Carvalho, 1988
    Rev. Brasil. Biol. 48(4):867.
Seabracoris Carvalho, 1988
    An. Acad. Brasil. Ci. 59(4):395.
Seychellesius Carvalho, 1988
    Rev. Brasil. Ent. 32(1):99.
Sinopia Carvalho, 1988
    Rev. Brasil. Biol. 48(4):868.

Thomascoris Carvalho, 1985
Rev. Brasil. Biol. 45(4):586.
Tigremiris Carvalho, 1985
Rev. Brasil. Biol. 45(3):297.
Tucuruisca Carvalho, 1987
Acta Amazon. 16–17:589.
Urapura Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):184.
Vanettia Carvalho & Ferreira, 1987
Experientiae 29(10):177 (1986).
Vissosamiris Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):233.
Warrisia Carvalho, 1987
An. Acad. Brasil. Ci. 58(3):493 (1986).
Waucoris Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):156.
Wauella Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):184.
Wumea Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):186.

Species Group-Names

Adneella agripinoi Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):79, figs. 1–2; H ♀, Brasil, Serra Norte (Carajás), região do manganês, 27.IV.1985, H. Andrade; MN.
Adeneella panamensis Carvalho & Schaffner, 1985
Fol. Ent. Mex. 64:4, figs. 1–4; H ♂, Panama, Cerro Campana, 800 m, Dist. Chame, 22 Feb. 1975, H. D. Engleman; P ♀; NMNH.
Adparaproba boliviana Carvalho, 1987
Rev. Brasil. Biol. 47(4):574, figs. 1–3; H ♀, Cochabamba, Bolívia, Germain, col. Noualhier; P ♂; NMNH.
Adparaproba carioca Carvalho, 1987
Rev. Brasil. Biol. 47(4):576, figs. 4–7; H ♂, Represa Rio Grande, Rio de Janeiro, Brasil, F. M. Oliveira; 22♂♂, 9 ♀♀; MN.
Adparaproba dispersa Carvalho, 1987
Rev. Brasil. Biol. 47(4):577, figs. 8–10; H ♀ Casa Nova, Pernambuco, Brasil, V.74, J. C. M. Carvalho col.; P 1♂, 2♀♀; MN.
Adparaproba gabrieli Carvalho, 1987
Rev. Brasil. Biol. 47(4):577, figs. 11–14; H ♂, Cataguazes, Minas Gerais, Brasil, IX.85, Gabriel Simoes de Andrade; 11♂♂, 7♀♀; MN.
Adparaproba itatiaiana Carvalho, 1987
Rev. Brasil. Biol. 47(4):579, figs. 15–18; H ♂, Brasil, Rio de Janeiro, Parque Nacional, Itatiaia, I.1978, Carvalho & Schaffner; P ♀; MN.
Adparaproba larensis Carvalho, 1988
Rev. Brasil. Biol. 48(4):884, figs. 34–39; H ♂, Venezuela, Lara, 1 km N Sanare, December 28, 1985, P. Kovarik & R. Jones; P ♂ ♀; NMNH.

Adparaproba novateutonia Carvalho, 1987
Rev. Brasil. Biol. 47(4):581, figs. 19–23; H ♀, Brasilien, Nova Teutonia, V.1945, Fritz Plaumann; P 2♂♂, 4♀♀; MN.

Adparaproba piranga Carvalho, 1987
Rev. Brasil. Biol. 47(4):583, figs. 24–27; H ♀, Ponte Nova, MG (Minas Gerais), Brasil, 29.VII.57, J. Becker; P 1♂, 2♀♀; MN.

Adparaproba venezuelana Carvalho, 1988
Rev. Brasil. Biol. 48(4):874, figs. 1–4; H ♀, Venezuela, Lara, 8 km N Cubrio, 1,000 m, scrub forest, December 27, 1985, P. Kovarik & R. Jones; P 1♀; NMNH.

Adpiasus ecuadorianus Carvalho & Carpintero, 1986
An. Acad. Brasil. Ci. 58(2):291, figs. 1–4; H ♂, Quevedo, Ecuador, V.78, Fritz; CC.

Adxenetus matogrossensis Carvalho, 1988
Rev. Brasil. Biol. 48(4):858, figs. 1–5; H ♂, Sinop, Mato Grosso, Brasil, Rio Teles Pires, IX.74, Alvarenga & Roppa; P 14♂♂, 7♀♀; MN.

Allommatela rugosa Carvalho & Ferreira, 1987
Experientiae 29(10):148, figs. 6–10(1986); H ♂, Viçosa, MG. Brasil, 9.XII.82, P. S. Fiuza Ferreira; P 3♂♂; MN.

Allommatus carajasensis Carvalho, 1988
Rev. Brasil. Biol. 48(4):859, figs. 6–12; H ♂; Brasil, Pará, Serra Norte, 3-Alfa, 26–29.X.1984, armadilha luminosa; MN.

Allomatus saltensis Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):608, figs. 1–6; H ♂, Sumalao, Salta, Argentina, XI.84, Diego L. Carpintero; P 2♀♀; CC.

Amapacylapus nigricapitis Carvalho, 1987
Acta Amazon. 16–17:591, figs. 7–9; H ♂, Brasil, Rondonia, Ji-Paraná, 12.XI.1983, equipe J. R. Arias; P 1♂; MN.

Amapacylapus rondoniensis Carvalho, 1987
Acta Amazon. 16–17:590, figs. 3–6; H ♂, Brasil. Rondonia, Ji-Paraná, Gleba G., XI.1983, equipe J. Arias; P 4♀♀; MN.

Antias bonaerensis Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):609, figs. 7–10; H ♂, Glew, Provincia Buenos Aires, Argentina, 1982, Diego L. Carpintero; CC.

Atahualpacoris columbiensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):551, figs. 11–14; H ♂, Colômbia, Purace, Cauca, X.68, Borys Malkin; P 2♂♂, 3♀♀; NMNH.

Atahualpacoris impunctatus Carvalho, 1985
Rev. Brasil. Biol. 45(4):555, figs. 24–27; H ♂, Venezuela, Pass on Pacific-Atlantic divide 8–9,000 ft., Estado Trujillo, IX.15.57, E. I. Schlinger & E. S. Ross; P ♂; CAS.

Atahualpacoris incaicus Carvalho, 1985
Rev. Brasil. Biol. 45(4):553, figs. 15–18; H ♂, Carpish, Peru, 2,800 m, Dept. Huanuco, October 1984, J. Woytkowski; P 3♂♂, 12♀♀; NMNH.

Atahualpacoris lojaensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):548, figs. 1–5; H ♂, Rio Tinajillas, 3,100 m, III, 1965, Ecuador, L. F. Peña; P 3♀♀; NMNH.

Atahualpacoris tamboensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):549, figs. 6–10; H ♀, Ecuador, N El Tambo, 2,900 m, II.65, L. F. Peña; P 1♂, 1♀; NMNH.

Atahualpacoris venezuelensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):553, figs. 19–23; H ♂, Venezuela, D. F. 14 km Tovar, 28–29 Feb. 1976, C. M. & O. S. Flint, Jr.; NMNH.

Biobiocoris setosus Carvalho, 1985
Rev. Brasil. Biol. 45(3):253, figs. 1–5; H ♂, EL Abanico, BioBio, Chile, XII.30.50, Ross & Michelbacher; P 11♂♂, 18♀♀; CAS.

Bilirania borneensis Carvalho, 1986
Ann. Soc. Ent. France (N.S.) 22(2):217, figs. 9–17, H ♀, Sandakan, Borneo, Baker; P 2♀♀, 1♂; NMNH.

Bispinocoris ottoensis Carvalho, 1988
Rev. Brasil. Ent. 32(2):215, figs. 1–4 H ♂, New Guinea, NE, Mt. Otto, 2,200 m, June 24, 1955, J. L. Gressitt. P ♀; BPBM.

Boliviomiris antenalis Carvalho, 1987
Rev. Brasil. Biol. 47(4):594, figs. 1–3; H ♀, Bolivien, Prov. Sara., Steinbach S.; NMNH.

Bomberia foliacea Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):178, figs. 1–5; H ♂, New Guinea, Neth. Vogelkop, Bomberi, 700–900 m, VI.16′58, J. L. Gressitt; BPBM.

Cafayatina altigena Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):611, figs. 11–12; H ♀, Cafayate, Salta, Argentina, XI.84, Diego L. Carpintero; P 2♀♀; CC.

Calocorisca altiplana Carvalho, 1986
Rev. Brasil. Biol. 46(1):58, figs. 1–5; H ♂, Carpish, Peru, 2,800 m, Dept. Huanuco, October 1947, J. Woytkowski; P 32♂♂, 55♀♀; NMNH.
Note: Genus name misspelled *Calocorista.*

Calocorisca araguana Carvalho, 1986
Rev. Brasil. Biol. 46(1):59, figs. 4–7; H ♂, Venezuela, Aragua, Rancho Grande, July 5, 1968, J. Maldonado C.; P 57♂♂, 53♀♀; NMNH.
Note: Genus name misspelled *Calocorista.*

Calocorisca brasiliensis Carvalho, 1986
Rev. Brasil. Biol. 46(1):60, figs. 8–11; H ♀, Parque Nacional da Serra dos Orgãos, Teresópolis, Brasil, 1,500–1,700 m, 14–22.4.1947, Wygodzinsky; P 4♂♂, 13♀♀; MN.

Calocorisca callangana Carvalho, 1986
Rev. Brasil. Biol. 46(1):61, figs. 12–16; H ♀, Peru, Callanga, 1,300 m, Province Paucartambo, Dept. Cuzco, II.12.1953, J. Woytkowski; P 2♂♂, 5♀♀; NMNH.

Calocorisca cuzcoana Carvalho, 1986
Rev. Brasil. Biol. 46(1):65, figs. 21–14; H ♂, Peru, Dept. Cuzco, Valley of River C Conispata, XI.16.1951, F. Woytkowski; P 3♂♂, 14♀♀; NMNH.

Calocorisca fortuna Carvalho, 1986
Rev. Brasil. Biol. 46(1):65, figs. 25–28; H ♀, Panamá, lt Fortuna, V.79, H. Wolda; P 1♂, 5♀♀; NMNH.

Calocorisca longirostris Carvalho, 1986
 Rev. Brasil. Biol. 46(1):69, figs. 29–31; H ♀, Panama, Chiriqui District, Renacimiento, Santa Clara, 4,000 ft, 28–29.V.76, Engleman & Thurman, P ♀; NMNH.

Calocorisca minima Carvalho, 1986
 Rev. Brasil. Biol. 46(1):70, figs. 32–37; H ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 3.VI.1971, L. J. Joly T.; P 10♂♂, 18♀♀; NMNH.

Calocorista spp.—Misspelling for *Calocorisca,* see that generic name.

Carpinteroa balena Carvalho, 1988
 An. Acad. Brasil. Ci. 59(4):403, fig. 1 (1987); H ♀, Belen, Catamarca, Republica Argentina, 27.I.1960, Tomsic & Willink; MLP.

Carpinteroa sanluisensis Carvalho, 1988
 An. Acad. Brasil. Ci. 59(4):404, figs. 2–5, (1987); H ♂, S. Elena, San Luis, Argentina, Carpintero, XI.76; P ♂; MLP.

Carpinteroa tacuila Carvalho, 1988
 An. Acad. Brasil. Ci. 59(4):407, figs. 9–12 (1987), H ♂, República Argentina, Salta, Tacuil, 23.I.1968, A. Willink & A. Teran; P 0; MIP.

Caruarina rubronotata Carvalho, 1985
 Rev. Brasil. Biol. 45(3):256, figs. 6–11; H ♂, Caruaru, Pernambuco, Brasil, IV.1972, M. Alvarenga; P 2♂♂; (ex-JCMC) MN.

Ceratocapsus barensis Carvalho & Fontes, 1986
 Acta Amazon. 15(1–2):235, figs. 1–3 (1985); H ♂, Brasil, Amazonas, P. Laranjeiras, 8–14.VII.81, Arias; INPA.

Ceratocapsus batistai Carvalho & Fontes, 1986
 Acta Amazon. 15(1–2):236, figs. 4–7 (1985); H ♂, Brasil, Amazonas, P. Laranjeiras, 8–14.VII.81, Arias; P ♂; INPA.

Ceratocapsus esavianus Carvalho & Ferreira, 1987
 Experientiae 29(10):149, figs. 11–14 (1986); H ♂, Viçosa, MG., Brasil, 13.IV.82, P. S. Fiuza Ferreira; MN.

Ceratocapsus kerri Carvalho & Fontes, 1986
 Acta Amazon. 15(1–2):237, figs. 11–13 (1985); H ♂, Brasil, Amazonas, P. Laranjeiras, 8–14.VII.81., Arias; INPA.

Ceratocapsus liliae Carvalho & Ferreira, 1987
 Experientiae 29(10):151, figs. 15–19 (1986); H ♂, Viçosa, MG., Brasil, 18.XI.82, P. S. Fiuza Ferreira; MN.

Ceratocapsus manauara Carvalho & Fontes, 1986
 Acta Amazon. 15(1–2):236, figs. 8–10 (1985); H ♂, Brasil, Amazonas, P. Laranjeiras, 8–14.VII.81, Arias; P ♂; INPA.

Ceratocapsus missionensis Carvalho & Carpintero, 1986
 Rev. Brasil. Biol. 46(3):612, figs. 13–17; H ♀, Parque Nacional de Iguaçu, Provincia Missiones, Argentina, X.80, Diego L. Carpintero; P ♂ e ♀; CC.

Ceratocapsus peruanus Carvalho, 1985
 Rev. Brasil. Biol. 45(3):256, figs. 12–15; H ♂, Peru, Monzon Valley, Tingo Maria, IX.23-1954, E. I. Schlinger & E. S. Ross; P 3♂♂, 6♀♀; CAS.

Ceratocapsus plaumanni Carvalho, 1985
 Rev. Brasil. Biol. 45(3):258, figs. 16–18; H ♂, Brasil, Nova Teutonia, Santa Catarina, novembro, Fritz Plaumann; (ex-JCMC) MN.

Ceratocapsus vissosensis Carvalho & Ferreira, 1987
Experientiae 29(10):151, figs. 20–24 (1986); H ♂, Viçosa, MG., Brasil, 9.III.83, P. S. Fiuza Ferreira; P 9♂♂, 4♀♀; MN.

Chileria araucana Carvalho, 1985
Rev. Brasil. Biol. 45(3):291, figs. 122–125; H ♂, Salta de Pilmaiquen, Osorno, Chile, I.21.1951, Ross & Michelbacher; P 6♂♂, 4♀♀; CAS.

Chiloxionotus columbiensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):265, figs. 1–4 (1987); H ♂, Colombia, Perijá Sierra, B. Malkins, VII.68; NMNH.

Chiloxionotus corcovadensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):267, fig. 5 (1987); H ♀, Corcovado, Guanabara (Rio de Janeiro), Brasil, 9.X.1967, Alvarenga & Seabra; P 2♀♀; MN.

Chiloxionotus guanabarinus Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):268, fig. 6 (1987); H ♀, Corcovado, GB (Guanabara), Brasil, 6.X.1967, Moure & Seabra; MN.

Chiloxionotus iratiensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):268, fig. 7 (1987); H ♀, Irati, Estado do Paraná, Brasil, X.61, Zajciv col.; MN.

Chiloxionotus marianus Carvalho, 1988
Rev. Brasil. Biol. 48(2):352, figs. 3–5; H ♀, Missiones, Argentina, Dept. Concepc., Santa Maria, M. J. Viana; P ♂ ♀; M LP.

Chiloxionotus monnei Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):269, fig. 8; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m. Encruzilhada, Bahia, Brasil, XI.72, Seabra & Roppa; MN.

Chiloxionotus nigrosulphureus Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):270, figs. 9–12 (1987), H ♂, Encruzilhada, Bahia, Brasil, Roppa & Seabra; MN.

Chiloxionotus paineiranus Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):270, figs. 13–14 (1987), H ♀, Corcovado, G.B. (Guanabara), Brasil, Alvarenga & Seabra, XI.62; MN.

Chiloxionotus rodoniensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):654, figs. 1–4; H ♂, Nova Fernandopolis, Barra dos Bugres, Mato Grosso, Brasil, X.84, Roppa; P 22♂♂, 6♀♀; MN.

Chrysodasia boyacana Carvalho, 1986
Rev. Brasil. Biol. 46(1):219, fig. 25; H ♀, Colombia, Boyaca, 12 km N Tunja, 13 July 1982, Clark & Cave; P 2♂♂, 3♀♀; NMNH.

Chrysodasia bucaramanga Carvalho, 1986
Rev. Brasil. Biol. 46(1):219, figs. 6–9; H ♀, Colombia, Sant., 27 km E Bucaramanga, 10 July 1982, Clark & Cave; P 2♂♂, 1♀; NMNH.

Chrysodasia caracensis Carvalho, 1986
Rev. Brasil. Biol. 46(1):220, fig. 10; H ♀, Serra do Caraça, Minas Gerais, Brasil, F. M. Oliveira, II. 1970; MN.

Chrysodasia chiriquina Carvalho, 1986
Rev. Brasil. Biol. 46(1):221, figs. 11–14; H ♀, Panamá, Chiriqui Dist., Renacimiento, Santa Clara, 4,000 ft. 28–29.V.76, Engleman & Thurman; P 1♀ 6♀♀; NMNH.

Chrysodasia colimensis Carvalho, 1986
Rev. Brasil. Biol. 46(1):222, figs. 15–18; H ♀, Mexico, Colima, 10 mi NE Comala, July 7–19, 1983, Kovarik, Harrison, Schaffner, P 1♂, 3♀♀; NMNH.

Chrysodasia zuruchuchuensis Carvalho, 1986
Rev. Brasil. Biol. 46(1):227, figs. 31–34; H ♀, Ecuador, Lago Zurucuchu, 11 mi W Cuenca, 16.II.1955, E. I. Schlinger & E. S. Ross; P 2♀♀; CAS.

Colimacoris occidentalis Schaffner & Carvalho, 1985
Proc. Ent. Soc. Wash. 87(2):310, figs. 1–4; H ♂, Mexico, Jalisco, Nevado de Colima Road, 7 mi W hwy-junct. (near Atenquique), August 5, 1978, Plitt & Schaffner; P 18♂♂, 10♀♀; UNAM.

Comefulvius chingonus Carvalho & Carpintero, 1985
An. Acad. Brasil. Ci. 57(4):510, figs. 6–7; H ♂, La Serranita, Cordoba, Argentina, II.1981, Diego L. Carpintero; CC.

Coridromius minusculus Carvalho, 1987
Rev. Bras. Ent. 31(1):62, figs. 1–2; H ♂, New Guinea, Neth. Boden, 1,000 m, 11 km SE Oberfaren. VII.1959, T. C. Maa; BPBM.

Coridromius neoguineanus Carvalho, 1987
Rev. Brasil. Ent. 31(1):63, figs. 3–7; H ♂, New Guinea, Papua, Minj W Highlands, 14.8.13.1959, T. C. Maa; P 32 ♂ ♀; BPBM.

Coridormius nigrus Carvalho, 1987
Rev. Brasil. Ent. 31(1):64, figs. 8–9; H ♂, New Guinea, Edie Creek, Wau, 1,700 m, 2.IV.1966, J. L. Gressitt; BPBM.

Coridromius punctatus Carvalho, 1987
Rev. Brasil. Ent. 31(1):65, figs. 10–13; H ♀, New Guinea, NE, Mt. Kaindi, 2,300 m, 31.XII.1964, J. Sedlacek; P ♂; BPBM.

Craoliella tucuruiensis Carvalho, 1988
Bol. Mus. Goeldi, Zool. 4(1):10, figs. 1–2; H ♀, Tucurui, Estado do Pará, Brasil, 1.'79, M. Alvarenga; MN.

Cylapinus minusculus Carvalho, 1987
Acta Amazon. 16–17:592, figs. 10–13; H ♂, Brasil, Rondonia, Ji-Paraná, II, 1983 equipe J. R. Arias; MN.

Cylapus brasiliensis Carvalho, 1987
Acta Amazon. 16–17:593, figs. 14–18; H ♂, Nova União, Ouro Preto, Rondonia, Brasil, XI.83, Bento col.; P 6♂♂, 5♀♀; MN.

Cyrtocapsus columbiensis Carvalho, 1987
Bol. Mus. Goeldi, Zool. 3(2):235, fig. 1; H ♀, Pivijay (Mag.), Colombia, en fabaceae, agosto 1985, A. Madrigal; P 14♀♀ 2♂♂; MEFLG.

Cyrtocapsus paraensis Carvalho, 1987
Bol. Mus. Goeldi, Zool. 3(2): 237, figs. 2–5; H ♂, Pará, Brasil, V. 86, A. Mafra; P 2♀♀; MN.

Cyrtotylus ricardoi Carvalho, 1988
Rev. Brasil. Biol. 48(4):875, figs. 5–6; H ♀; Magé, Rio de Janeiro, Brasil, Ricardo Iglesias Rios col., 1968: MN.

Dagbertus amapaensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):81, figs. 8–11; H ♂, Azemar, Brasil, Amapá, 10.9.1961, H. Diniz de Oliveira; MN.

Dagbertus carabobensis Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):232, figs. 19–22; H ♂, Venezuela, Carabobo, Pateremo Beach, July 11, 1986, J. Maldonado; P 3♀♀; NMNH.

Dagbertus emboabanus Carvalho, 1985
Rev. Brasil. Biol. 45(4):654, fig. 5; H ♀, Brasil, Minas Gerais, Carmo do Rio Claro, janeiro, 1978, Carvalho & Schaffner; P ♀, MN.

Dagbertus froeschneri Carvalho, 1985
Rev. Brasil. Biol. 45(4):682, figs. 46–49; H ♀, Colombia, 1 mi W Villeta, Cundinamarca, 860 m, III.15.55, E. I. Schlinger & E. S. Ross; P ♂; CAS.

Dagbertus peruanus Carvalho, 1985
Rev. Brasil. Biol. 45(4):684, figs., 50–53; H ♂, Peru, 15 mi E Trujillo, 500 m, La Libertad, I.16.1955, E. I. Schlinger & E. S. Ross; P 2♂♂, 3♀♀; CAS.

Dagbertus salvadorensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):685, figs. 54–56; H ♂, El Salvador, Quezaltepeque, 500 m, VI.19.63, D. Q. Cavagnaro & M. E. Martin; P ♂ ♀; CAS.

Deraeocoris finisterrensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):451, figs. 10–14; H ♂, New Guinea, NE, Main Finisterre Range nr. Freiberg Pass (N), 2,550 m, X.1–21.1956, W. W. Brandt; P 79♂♂, 14♀♀; BPBM.

Deraeocoris gagnei Carvalho, 1985
Rev. Brasil. Biol. 45(4):453, figs. 15–18; H ♂, New Guinea, NE, Mt. Talibu, 2,300–2,560 m, 8–14.IV.1968, J. L. Gressitt; P 4♂♂, 1♀ BPBM.

Deraeocoris gorokensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):454, figs. 19–22; H ♂, New Guinea, NE, Karimui, South of Goroka, 1,000 m, 6.VI.1961, J. L. Gressitt; P 4♂♂, 8♀♀; BPBM.

Deraeocoris gressitti Carvalho, 1985
Rev. Brasil. Biol. 45(4):455, figs. 23–26; H ♂, New Guinea, Neth., Swart Val. W. Fork, 1,300–1,350 m, 17.IX.1958, J. L. Gressitt; P 3♂♂, 9♀♀; BPBM.

Deraeocoris kaitakiensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):456, figs. 27–31; H ♂, Kaitaki, 1,500 m, New Guinea, Oct.–Nov. 1938; Pemberton; P 1♂, 2♀♀; BPBM.

Deraeocoris membranalis Carvalho, 1985
Rev. Brasil. Biol. 45(4):456, figs. 32–35; H ♂, above Kegelsugl, New Guinea, NE, Mt. Wilhelm, 3,060 m, July 4, 1955. J. L. Gressitt; P 5♂♂, 15♀♀; BPBM.

Deraeocoris morobensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):457, figs. 36–39; H ♂, New Guinea, NE, Morobe District, Mindik, 1,200–1,600 m, XI.68, N. L. H. Krauss; P 6♂♂, 11♀♀; BPBM.

Deraeocoris wauensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):458, figs. 40–45; H ♂, New Guinea, NE, Wau, 1,100–1,200 m, VI.1968, N. L. H. Krauss; P 42♂♂, 63♀♀; BPBM.

Derophthalma azteca Carvalho, 1985
Rev. Brasil. Biol. 45(4):492; H ♂, Mexico, Chiapas, 4, 4 mi N Bochil, 17.VIII.67, H. R. Burke & J. Hafernik; P 1♂, 3♀♀; NMNH.
Note: Proposed as a "n.sp." for the misidentified *Derophthalma irrorata* of Carvalho and Gomes (not Lethierry), 1980, Experientiae 26:116, figs. 39, 61, 82.

Derophthalma jamaicensis Carvalho, 1985

Rev. Brasil. Biol. 45(4):492; H ♀, Mandeville, Jamaica; MZU.

Note: Proposed as a "n.sp." as a replacement name for the preoccupied *Cyrtocapsidea irrorata* Reuter, 1907, Ofv. Finska Vet. Soc. Forh. 49:9, now in *Derophthalma.*

Dicyphus peruanus Carvalho & Meléndez, 1986

Bol. Mus. Goeldi, Zool. 2(2):94, figs. 1–4; H ♂, Peru, Amazonas, Colpa, 15.XII.1984, E. Meléndez; P ♂ ♀; CELM.

Dimifacoris fasciatus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):178, figs. 7–10; H ♂, New Guinea, NE. Moife, 2,100 m, 15 km NW Okapa, Oct. 7–14.1959, P 2 ♂ ♀; BPBM.

Eccritotarus bocainensis Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):303, figs. 1–5; H ♀, Bocaina, S. Paulo, Brasil, XI.1970, M. Alvarenga; P ♂; (ex-JCMC) MN.

Eccritotarsus brotaensis Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):304, fig. 6; H ♀, Brotas, S. Paulo, Brazil, 25.VIII.1932, Aristoteles Silva; (ex-JCMC) MN.

Eccritotarsus callanganus Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):305, fig. 7; H ♂, Callanga, Peru, P ♂; NMNH.

Eccritotarsus chanchamayanus Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):306, fig. 8; H ♀, Chanchamayo (Peru), 24.VI.67, K. Ravin col. U.A. 2289-68; NMNH.

Eccritotatsus cinctus Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):307, figs. 9–14; H ♂, Panama, Chiriqui, Fortuna, 1,050 m, Henk Wolda; P 2♂♂; NMNH.

Eccritotarsus cochabambensis Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):308, fig. 15; H ♂, Cochabamba, Bolivia, '64, Borys Malkin; NMNH.

Eccritotarsus corcovadensis Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):309, fig. 16; H ♀, Corcovado, Guanabara, Brasil, X.75, C. A. Campos Seabra (ex-JCMC) MN.

Eccritotarsus curtipilis Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):310, fig. 17; H ♂, Colombia, Cundinamarca, Finca Bela Vista nr. Sasaima, 12.IV.1965, P. R. Craig; NMNH.

Eccritotarsus englemani Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):311, figs. 18–21; H ♂, Panamá, Bocas d.T. Corriente Grande, 100 m, April 2–8.1980, Henk Wolda; NMNH.

Eccritotarsus ingenioensis Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):312, figs. 22–26; H ♂, Ingenio (Peru), 27.7.70, C. Korytkowski; P 2♂♂; NMNH.

Eccritotarsus jaliscoensis Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):313, figs. 27–31; H ♂, México, Jalisco, 14 mi S Autlan, August 13, 1978, Plitt & Schaffner; P ♂ 2 ♀; NMNM.

Eccritotarsus machupichanus Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):315, figs. 32–35; H ♂, Machupichu, Peru, VI.1964, B. Malkin; P 4♂♂, 4♀♀; NMNH.

Eccritotarsus mapirinus Carvalho & Schaffner, 1986

An. Acad. Brasil. Ci. 58(2):316, fig. 36; H ♀, Bolivia, Mapiri; NMNH.

Eccritotarsus mexicanus Carvalho & Schaffner, 1986
An. Acad. Brasil. Ci. 58(2):317, fig. 37; H ♂, Mexico, Coahuila, 3 mi S Saltillo, Jan. 2, 1969, D. Jirovec; P ♂; NMNH.

Eccritotarsus montanus Carvalho & Schaffner, 1986
An. Acad. Brasil. Ci. 58(2):318, figs. 38–42; H ♂, S. Bacaina, 1,650 m, S. J. Barreiro, SP. Brazil, I.1969, M. Alvarenga; P 15♂♂, 10♀♀; (ex-JCMC) MN.

Eccritotarsus oaxacaenus Carvalho & Schaffner, 1986
An. Acad. Brasil. Ci. 58(2):319, figs. 43–46; H ♂, Mexico, Oaxaca, 3 mi N Candelaria Loxicha, July 19, 1974, Clark, Murray, Ashe, Schaffner, P 2 ♂ ♀ NMNH.

Eccritotarsus panamensis Carvalho & Schaffner, 1986
An. Acad. Brasil. Ci. 58(2):321, figs. 47–50; H ♂, Panama, Chiriqui, Fortuna, 1,050 m, 15.VII.1979, Henk Wolda; NMNH.

Eccritotarsus pictusoides Carvalho & Schaffner, 1986
An. Acad. Brasil. Ci. 58(2):322, figs. 51–54; H ♂, Mexico, Chiapas, 12 mi N Ocozocoautla, July 8, 1971, Clark, Murray, Hart, Schaffner; P 17♂♂, 43♀♀; NMNH.

Eccritotarsus pilosoides Carvalho & Schaffner, 1986
An. Acad. Brasil. Ci. 58(2):323, fig. 55; H ♀, Marcapata, Peru; NMNH.

Eccritotarsus pomacochanus Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):473, fig. 56; H ♀, Pomacochas (Peru), 25.7.70, C. Korytkowski, 31.7.70; P ♀; NMNH.

Eccritotarsus quinquomilianus Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):474, fig. 57; H ♀, Peru, Quincomil, Sept. 1962, L. E. Peña; P ♀; NMNH.

Eccritotarsus restrepus Carvalho, 1988
Rev. Brasil. Biol. 48(2):334, figs. 1–4; H ♂, Colombia, Restrepo, (Valle), em *Lantana camara,* junio, 1985, A. Madrigal; P 4♂♂, 2♀♀; MEFLG.

Eccritotarsus saranus Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):475, figs. 58–62; H ♂, Bolivien, Prov. Sara, Steinbach; NMNH.

Eccritotarsus sonorensis Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):476, fig. 63; H ♂, Aguamarina, Alamos, Sonora, México, 1.IX.51, F. Pacheco; NMNH.

Eccritotarsus tandapianus Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):477, figs. 64–67; H ♀, Ecuador, Casar, Troncal, VI.20.1981, 1,300 ft., C. V. Manley; P ♂ 3 ♀; NMNH.

Eccritotarsus tingoensis Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):478, fig. 68; H ♀, Peru, Monson Valley, Tingo Maria, X.19.54, E. I. Schlinger & E. S. Ross; NMNH.

Eccritotarsus tingomarianus Carvalho, 1985
Rev. Brasil. Biol. 45(4):572, figs. 1–3; H ♂, Peru, Tingo Maria, June 30, 1948, E. J. Hambleton; P 2♂♂, 3♀♀; NMNH.

Eccritotarsus tresrianus Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):479, figs., 69–73; H ♂. Gatun Lake, Panamá, XI.5.31, Tres Rios Plantation, T. O. Zachokke; NMNH.

Eccritotarsus tucumanus Carvalho & Schaffner, 1987

An. Acad. Brasil. Ci. 58(3):480, figs. 74–77; H ♂, La Angostura, Tucuman, Argentina, 2,000 m, II.53, JCMC; P 3♂♂, 1♀; IML.

Eccritotarsus woldai Carvalho & Schaffner, 1987
An. Acad. Brasil. Ci. 58(3):481, figs. 78–82; H ♀, Panamá, Bocas de T., Corriente Grande, 100 m, April 2–8, 1980, Henk Wolda; P ♂ ♀; NMNH.

Englemania peruana Carvalho, 1985
Rev. Brasil. Zool. 3(4):169, fig. 1; H ♂, Peru, Monzon Valley, Tingo Maria, X.21.1954, E. I. Schlinger & E. R. Ross; CAS.

Esavia vissosensis Carvalho & Ferreira, 1987
Experientiae 29(10):181, figs. 78–82 (1986); H ♀, Viçosa, MG., Brasil, 20.I.82, P. S. Fiuza Ferreira; P 4♂♂, 1♀; MN.

Euchilocoris andinus Carvalho, 1986
Rev. Brasil. Biol. 46(1):261, fig. 5; H ♀, Venezuela, D. F. Hacienda El limon, Guacatal, 1,500 m, 22.VII.1971, L. J. Joly T.; P ♀; NMNH.

Euchilocoris bolivarianus Carvalho, 1985
Rev. Brasil. Zool. 3(4):172, figs. 4–7; H ♀, Limbo, Bolivia, Chapare, 2,000 m, XI.79, Prosen; P 1♂, 2♀♀; NMNH.

Euchilocoris boyacanus Carvalho, 1986
Rev. Brasil. Biol. 46(1):262, fig. 6; H ♀, Colombia, Boyaca, 11 km NW Arcabuco, 13 July 1982, Clark & Cave; NMNH.

Euchilocoris ecuadorensis Carvalho, 1986
Rev. Brasil. Biol. 46(1):262, fig. 7; H ♀, Santa Inez, Ecuador, R. Haensch; NMNH.

Euchilocoris rufinasoides Carvalho, 1986
Rev. Brasil. Biol. 46(1):266, figs. 16–19; H ♀, Panamá, Chiriqui, Dist. Renacimiento, Sta Clara, 20–27.V.77; P 2♂♂, 1♀; NMNH.

Euchilocoris sulinus Carvalho, 1986
Rev. Brasil. Biol. 46(1):269, figs. 21–27; H ♂, Panamá, Brasil, Staviarski, 4.50; P ♂; (ex. JCMC) MN.

Euchilocoris venezuelanus Carvalho, 1986
Rev. Brasil. Biol. 46(1):270, figs. 28–31; H ♂, Venezuela, D. F., Hacienda El Limon, Guacatal, 1,500 m, 22.VII.1971, L. J. Joly T.; P ♂ 2 ♀; NMNH.

Eurotas reinhardti Carvalho, 1988
Rev. Brasil. Biol. 48(4):876, figs. 7–10; H ♂ Lagoa Santa, Minas Gerais, Brasil, Reinhardt; MZUC.

Eurychilella peruana Carvalho, 1985
Rev. Brasil. Biol. 45(4):572, figs. 4–8; H ♂, Peru, Tingo Maria, June 30, 1948, E. J. Hambleton; P ♂ ♀; NMNH.

Eurylomata picturata sulina Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):396, figs. 6–12 (1987); H ♂, Argentina, Provincia Santa Cruz, Puerto Bandera, Lago Argentino, T. Cekalovic; P ♂ ♀; MLP.

Eustictus amazonicus Carvalho, 1988
Bol. Mus. Goeldi, Zool. 4(1):12, fig. 3; H ♂, Estirao do Equador, Estado do Amazonas, Brasil, VIII.'79, M. Alvarenga; MN.

Eustictus guaraniensis Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):612, figs. 18–20; H ♀, Parque Nacional de Iguacu, Provincia Missiones, Argentina, X.80, Diego L. Carpintero; P ♂; CC.

Eustictus incaicus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):225, figs. 1–4; H ♂, Peru, 40 km N Ciclayo, Lambaieque, I.17.1955, E. I. Schlinger & E. R. Ross; P ♂; CAS.

Falconia antioquiana Carvalho, 1987

Rev. Brasil. Biol. 47(4):600, figs. 4–7; H ♂, Antioquia, Colombia, VIII.5.1977, L. Urueta & Higuerilla; P 33 ♂♂ and ♀♀; NMNH.

Falconia callangana Carvalho, 1987

Rev. Brasil. Biol. 47(4):603, figs. 12–15; H ♂, Callanga, Peru; NMNH.

Falconia coroicana Carvalho, 1987

Rev. Brasil. Biol. 47(4):603, fig. 16; H ♂, Coroico, Bolivia, Staudinger & Bang-Haas; NMNH.

Falconia elongata Carvalho, 1987

Rev. Brasil. Biol. 47(4):605, figs. 20–22; H ♂, Nova Teutonia, Santa Catarina, Brasil, April, 1971, Fritz Plaumann; P 2♂♂, 3♀♀; MN.

Falconia guaraniana Carvalho, 1987

Rev. Brasil. Biol. 47(4):606, figs. 23–26; H ♂, São Paulo, Jabaquara, 12.V.1940, O. Monte; P 2♂♂, 4♀♀; NM.

Falconia incaica Carvalho, 1987

Rev. Brasil. Biol. 47(4):608, figs. 27–30; H ♂, Quito, Ecuador, 3.IV.74, Engleman col., P 7♂♂, 4♀♀; NMNH.

Falconia nigra Carvalho, 1987

Rev. Brasil. Biol. 47(4):609, figs. 32–35; H ♂, Peru, Loreto, 15 km E Iquitos, 16 February 1984, W. E. Clark; P 1♂, 6♀♀; NMNH.

Falconia parauara Carvalho, 1987

Rev. Brasil. Biol. 47(4):610; fig. 36; H ♀ Jacareacanga, Pará, Brasil, VI.1970, R. R. Barbosa; P 4♀♀; NM.

Falconia schaffneri Carvalho, 1987

Rev. Brasil. Biol. 47(4):611, fig. 38; H ♀, Venezuela, Merida, 35 km N Barinitas, 1,400 m, December 31, 1985, P. Kovarik, R. Jones; P 2♀♀; NMNH.

Falconia teutoniana Carvalho, 1987

Rev. Brasil. Biol. 47(4):612; figs. 39–41; H ♂, Nova Teutonia, Santa Catarina, Brasil, May 1968, Fritz Plaumann; P 3♂♂, 8♀♀; NM.

Falconiodes costaricensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):260, figs. 19–22; H ♀, Costa Rica, San José, 1911–1912, H. Schmidt; P 2♂♂; (ex-JCMC) NMNH.

Falconisca vissosensis Carvalho & Ferreira, 1987

Experientiae 29(10);155, figs. 25–28 (1986); H ♂, Viçosa, MG. Brasil, 25.II.82, P. S. Fiuza Ferreira; P ♂; NM.

Florus englemani Schaffner & Carvalho, 1985

Proc. Ent. Soc. Wash. 87(2):311, figs. 5–9; H ♂, Panama, Chiriqui, Fortuna, 1,050 m, 2.IV.1978, Henk Wolda; P ♂; NMNH.

Fontesius bentoanus Carvalho, 1988

An. Acad. Brasil. Ci. 59(4):394, figs. 1–4 (1987); H ♂, Porto Uniao, Ouro Preto, Rondônia, Brasil, XII. 1983, Bento col.; P ♂; MN.

Fontesius jujuiensis Carvalho, 1988

An. Acad. Brasil. Ci. 59(4):395; fig. 5; (1987); H ♀, Peritas, Tileana, Jujuy, República Argentina, 1.954, Prosen; MLP.

Fortunacoris castaneus Carvalho, 1985

Rev. Brasil. Biol. 45(4):656, figs. 6–9; H ♀, Fortuna, Panama, 1976, H. Wolda; P 2♂♂, 4♀♀; NMNH.

Froeschneriella elsiae Carvalho, 1986
Jour. N.Y. Ent. Soc. 94(2):208, figs. 1–4; H ♀, Ecuador, 2 mi N Santa Rosa, El Oro, 10 m, 1.24.55, E. I. Schlinger & E. S. Ross; CAS.

Fulvius minimus Carvalho, 1988
Rev. Brasil. Biol. 48(4):880, figs. 20–27; H ♀, Estirão do Equador, AM (Amazonas), Brasil, X.79, Alvarenga; P 3♂♂, 2♀♀; MN.

Gaveanus carajasensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):83, fig. 12; H ♀, Brasil, Pará, Serra Norte (Carajás), Serraris, 20.IX.1985; MN.

Gaveanus renatoi Carvalho, 1988
Rev. Brasil. Biol. 48(2):338, figs. 10–14; H ♂, Reserva Florestal Compamhia Vale do Rio Doce, Linhares, Espirito Santo, XII.1986, J. C. M. Carvalho; P ♂ 2 ♀; MN.

Gressitticoris sedlaceki Carvalho, 1985
Rev. Brasil. Biol. 45(4):460, figs. 46–49; H ♂, New Guinea, NE, Wau, 1,200 m, 24.3.1969, J. Sedlacek; P 3♂♂, 9♀♀; BPBM.

Gressittmiris gressitti Carvalho, 1988
Rev. Brasil. Ent. 32(2):217, figs. 5–7, H ♂, New Guinea, NE. Swart Valley, Karubaka, 1,400 m, XI.6.1958, J. L. Gressitt; BPBM.

Guapimirinus alboscutellatus Carvalho, 1985
Rev. Brasil. Biol. 45(3):261, fig. 23; H ♀, Guapimirim, Estado do Rio de Janeiro, Brasil, 11, 1944, Wygodzinsky; (ex-JCMC) MN.

Guaranimiris punctatus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):409, figs. 13–20 (1987); H ♂, Paraguai, Fiebrig; NMNH.
Note: The species name was spelled two ways in the original proposal: "*punctactus*" [printer's error] in the species heading and "*punctatus*" elsewhere. The latter spelling was the proper one.

Gulacylapus carayoni Carvalho, 1986
Ann. Soc. Ent. France, (N.S.) 22(2):216, figs. 1–8; H ♀, Sandakan, Borneo, Baker col.; P ♂ ♀; NMNH.

Hadronemella subandina Carvalho, 1985
Rev. Brasil. Biol. 45(3):263, figs. 29–30; H ♀, Republica Argentina, Salta, Piedra de Molino, 3,700 m, 30.I.1968, Golbach; P 2♀♀; (ex-JCMA) MLP.

Henicocnemis carmelitanus Carvalho 1985
Rev. Brasil. Biol. 45(4):670, figs. 1–5; H ♂, Brasil, Minas Gerais, Carmo do Rio Claro, janeiro, 1978, Carvalho & Schaffner; P 8♂♂, 10♀♀; MN.

Heinicocnemis castaneus Carvalho, 1985
Rev. Brasil. Biol. 45(4):670, figs. 6–9; H ♀, Brasilien, Nova Teutonia, 29.9.1938, Fritz Plaumann; P ♂ ♀; MN.

Henicocnemis fasciatus Carvalho, 1985
Rev. Brasil. Biol. 45(4):672, figs. 10–11; H ♀, Santa Catarina, Luederwaldt; MN.

Henicocnemis guttulosus Carvalho, 1985
Rev. Brasil. Biol. 45(4):673, figs. 12–13; H ♀, La Florida, Peru, 6.5.67, D. Ojeda; NMNH.

Horcias carajasensis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):229, fig. 15; H ♂, Serra dos Carajás, (Estrada do Manganes), Estado do Pará, Brasil, Jan. 1986, JCMC; MN.

Horciasisca tiquiensis Carvalho, 1985

Rev. Brasil. Biol. 45(4):657, figs. 10–13; H ♀, Tiquié (rio), Amazonas, Brasil, J. C. M. Carvalho, 1949; P ♂ ♀; MN.

Horciasinus unicolor Carvalho & Carpintero, 1986

Rev. Brasil. Biol. 46(3):614, figs. 21–24; H ♂, Benevidez, Provincia Buenos Aires, Argentina, I.1974; P ♂ 2 ♀; CC.

Hyaliodes iguazuensis Carvalho & Carpintero, 1986

Rev. Brasil. Biol. 46(3):615, figs. 25–30; H ♂, Parque Nacional de Iguaçu, Argentina, C.80, Diego L. Carpintero; P 6♂♂, 5♀♀; CC.

Hyalochloria aliformis Carvalho, 1985

Rev. Brasil. Biol. 45(3):263, fig. 31; H ♂, Ouro Preto, Rondonia, XI.1983, Olmiro Roppa; MN.

Hyalochloria antilleana Carvalho, 1985

Rev. Brasil. Biol. 45(3):264, fig. 32; H ♀, Saba, The Botton, 10.12.1956, R. H. Cobben; P 1♀; NMNH.

Hyalochloria araripensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):265, fig. 33; H ♀, Barbalha, Ceará, Brasil, V.1969, M. Alvarenga; (ex-JCMC) MN.

Hyalochloria inermis Carvalho, 1985

Rev. Brasil. Biol. 45(3):265, figs. 34–37; H ♂, Parque Nacional Serra dos Orgãos, Teresópolis, 1,000 m, Brasil; (ex. JCMC) MN.

Hyalochloria itatiaiensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):267, fig. 38; H ♂, Itatiaia, Brasil, 1,100 m, Dalcy & Travassos, 8.I.50; (ex-UCMC) MN.

Hyalochloria rondoniensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):267, figs. 39–44; H ♂, Ouro Preto, Rondonia, Brasil, XI.1983, Roppa; P 1♂, 3♀♀ (ex-JCMA) MN.

Ialibua brandti Carvalho, 1986

Rev. Brasil. Ent. 30(2):394, figs. 1–5; H ♂, New Ireland, Schleinitz Mts. Lelet Plateau, Oct. 1959, W. W. Brandt; BPBM.

Ialibua gressitti Carvalho, 1986

Rev. Brasil. Ent. 30(2):394, figs. 6–9, H ♂, Ialibu, New Guinea, NE, 2,600 m, Gressitt-Maa, 8–14.IV.1968; P 8♂♂, 11♀♀; BPBM.

Ialibua maai Carvalho, 1986

Rev. Brasil. Ent. 30(2):397, figs. 10–13; H ♂, New Guinea, Papua, Anga Gorge, E Mendi, X.14.1958, J. L. Gressitt; P 5♂♂, 13♀♀; BPBM.

Ialibua nigriclava Carvalho, 1986

Rev. Brasil. Ent. 30(2):398, figs. 14–17; H ♂, New Guinea, NE, Morobe District, Arabuka, 1,500–2.000 m, 7.I.1968, J. & M. Sedlacek; BPBM.

Ialibua rubrovenosa Carvalho, 1986

Rev. Brasil. Ent. 30(2):400, figs. 18–21; H ♂, New Guinea, SE, Mt. Giluwe, 2,500–2,750 m, 30.V.1963, J. Sedlacek; P ♀; BPBM.

Ialibua sedlaceki Carvalho, 1986

Rev. Brasil. Ent. 30(2):401, 22–25; H ♂, New Guinea, NE, Wau, Morobe District, 1,200 m, 10.V.1963, J. Sedlacek; P 19♂♂, 30♀♀; BPBM.

Ialibua unicolor Carvalho, 1986
Rev. Brasil. Biol. 30(2):403, figs. 26–29; H ♂, New Guinea, Papua, Anga Gorge, E. Mendi, X.14.1958, J. L. Gressitt; P 15♂♂ 17♀♀; BPBM.

Ialibua viridicollis Carvalho, 1986
Rev. Brasil. Ent. 30(2):404, figs. 30–33; H ♀, New Guinea, Neth. Vogelkop, Bomberi, 700–900 m, VI.6.1959, T. C. Maa; BPBM.

Iguazucoris tibialis Carvalho & Carpintero, 1985
An. Acad. Brasil. Ci. 57(4):508, figs. 1–5; H ♂, Parque Nacional Iguazu, Missiones, Argentina, X.1980, Diego L. Carpintero; P ♂; CC.

Ilnacora arnaudi Carvalho, 1986
Jour. N.Y. Ent. Soc. 94(2):215, figs. 17–21; H ♂, Mexico, Chihuahua, 37 mi S Hidalgo de Parral, VIII.21.60, P. H. Arnaud Jr., E. S. Ross, D. C. Rentz; P 2♂♂, 5♀♀; CAS.

Jimia bimaculata Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):179, figs. 11–14; H ♂, New Guinea, NE, Tsenga, 1,200 m, Upper Jimmi Valley, July 13, 1955, J. L. Gressitt; BPBM.

Jobertus gabrieli Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):230, figs. 16–17; H ♀, Cataguazes, Minas Gerais, Brasil, IV.1985, Gabriel S. Andrade; P ♂ ♀; MN.

Karimuicoris pronotalis Carvalho, 1985
Rev. Brasil. Biol. 45(4):463, figs. 55–58; H ♂, New Guinea, NE, Karimui, 4.VI.1961, J. L. & M. Gressitt; BPBM.

Karubacoris translucidus Carvalho, 1985
Rev. Brasil. Biol. 45(4):462, fig. 50–54; H ♀, New Guinea, Neth, Swart Val., Karubaka, 1,450 m, 12.VI.1958, J. L. Gressitt; P 2♂♂, 3♀♀; BPBM.

Krainacoris tucuruiensis Carvalho, 1988
Bol. Mus. Goeldi, Zool. 4(1):14, figs. 4A–D; H ♂, Tucurui, Estado do Pará, Brasil, I. '79, M. Alvarenga; MN.

Kraussella albomaculata Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):180, figs. 15–18; H ♂, New Guinea, NE, Wau, 1,200–1,500 m, VII.1968, W. L. H. Krauss; P 5♂♂, 1♀; BPBM.

Kraussmiris nigris Carvalho, 1987
An. Acad. Brasil. Ci. 58(3):489, figs. 1–4 (1986); H ♂, New Guinea, NE, Morobe District, Mindik, 1,200–1,600 m, IX.1968, N. L. H. Krauss; P 41♂♂, 78♀♀; BPBM.

Laemocoridea brasiliensis Carvalho, 1988
Bol. Mus. Goeldi, Zool. 4(1):79, figs. 13–17; H ♂, Brasil, Nova Teutonia, Santa Catarina, March & April, 1973, Fritz Plaumann; P 4♂♂; MN.

Lepidoxenetus nigroscutellatus Carvalho, 1988
Rev. Brasil. Biol. 48(4):860, figs. 13–17; ♂, Diamantino, Fazenda São João, Mato Grosso, Brasil, km 20 Br 163, Roppa; P 3♂♂; MN.

Limonia costarica Carvalho, 1985
Rev. Brasil. Biol. 45(4):573, figs. 9–12; H ♂, Costa Rica, Provincia Heredia, La Selva Biological Station, Aug. 1983, George Schatz; P ♂; NMNH.

Lincolnia leucernina Eyles & Carvalho, 1988
New Zealand Jour. Zool. 15(2):339, figs. 1–5; H ♂ Kyeburn, Co, Maniototo Country, 12 Feb 1970, R. Macfarlane, on flowering lucerne. A ♀ P 25 ♂♂, 19♀♀; NZAC.

Linharesmiris viridis Carvalho, 1986
Rev. Brasil. Biol. 46(1):44, figs. 1–4; H ♂, Linhares, Espirito Santo, Brasil, IX.1972, Roppa & Alvarenga; P ♂; MN.

Lundiella panamensis Schaffner & Carvalho, 1985
Proc. Ent. Soc. Wash. 87(2):313, figs. 10–13; H ♂, Panama, Bocas d.T., Corriente Grande, 100 m, March 18–23, 1980, Henk Wolda; P 11♂♂; MNNH.

Macrolophus hexaradiatus Carvalho & Carpintero, 1986
An. Acad. Brasil. Ci. 58(2):292, figs. 5–8; H ♂, T. F. A. Venezuela, VII.79; P 2♂♂; CC.

Marinonicoris myrmecoides Carvalho, 1988
Rev. Brasil. Biol. 48(4):878, figs. 16–19; H ♂, Têlemaco Borba, Paraná, Reserva Samuel Klabin, 2.XI.1986, Lev. Ent. ProfauPar. lampada; P 3♂♂; MN.

Melanotrichus argentinus Carvalho, 1985
Rev. Brasil. Biol. 45(3):271, figs. 45 48; H ♂, Salta, Argentina, 12.1.1951, Wygodzinsky; P 1♂; MLP.

Melanotrichus bicolor Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):618, figs. 31–34; H ♂; R. de Lerma, Salta, Argentina, XI.84, Diego L. Carpintero; P 2♂♂, 2♀♀; CC.

Melanotrichus bonaerensis Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):618, figs. 35–38; H ♂; San Justo, Provincia Buenos Aires, Argentina, Diego L. Carpintero; P 35♂♂, 39♀♀; CC.

Melanotrichus minensis Carvalho, 1985
Rev. Brasil. Biol. 45(3):271, figs. 49–52; H ♂, Parque Estadual do Rio Doce, MG (Minas Gerais), Brasil, M. A. Vulcano & F. Pereira, P 1♂; MN.

Melanotrichus missionensis Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):619, figs. 39–42; H ♂, Parque Nacional de Iguaçu, Provincia Missiones, Argentina, X.80, Diego L. Carpintero; P 11♂♂, 1♀; CC.

Melanotrichus saltensis Carvalho, 1985
Rev. Brasil. Biol. 45(3):272, figs. 53–56; H ♀, Gran Salta, Argentina, Wygodzinsky, XI.1948; P 2♂♂; (ex-JCMA) MLP.

Meridatibius meridanus Carvalho, 1985
Rev. Brasil. Biol. 45(4):576, figs. 13-18; H ♂, Venezuela, Merida, E. Apartadores nr. Mitisus, 24.II.69, Duckworth & Dietz; P 3♀♀; NMNH.

Mexicomiris texanus Carvalho, 1986
Ann. Soc. Ent. France (N.S.) 22(2):217, figs. 18–22; H ♂, Ft. Sam Houston, "Texas" [=Bexar] Co., Texas, 6.IV.1953, B. J. Adelson; P 2♂♂, 1♀; NMNH.

Mimoncopeltus chaparensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):259, figs. 1–4 (1987); H ♂, Bolivia, Departamento de Cochabamba, Provincia Chapare-Limbo, 2,000 m, III.53, Prosen; P ♂ (ex-JCMA) NMNH.

Mimoncopeltus itacoaiensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(3):261 (1987); H ♂, Rio Itacoai, Estado do Amazonas, Brasil, V.1950, J. C. M. Carvalho; MN.
Note: This description is based, in part, on information published by Carvalho, 1953 Rev. Brasil. Biol., 13(1):83, fig. 12, under the misidentification *M. lycoideus* (Reuter).

Mimoncopeltus leonardoi Carvalho, 1988

An. Acad. Brasil. Ci. 59(3):261, figs. 5–8 (1987); H ♂, Corcovado, Rio de Janeiro, Brasil, XI.1957, M. Alvarenga; P ♂ 2 ♀; MN.

Mimoncopeltus tijucanus Carvalho, 1988

An. Acad. Brasil. Ci. 59(3):262, figs. 9–12 (1987); H ♀, Floresta da Tijuca, Guanabara, Brasil, 1.1971, C. A. Campos Seabra; P ♂; MN.

Minasmiris argentinus Carvalho, 1985

Rev. Brasil. Zool. 3(4):164, figs. 9–13, 15; H ♂, Tucuman, Argentina, XII.49, Wygodzinsky; P 1♂, 2♀♀; MLP.

Minasmiris peruanus Carvalho, 1985

Rev. Brasil. Zool. 3(4):161, figs. 1–4, 16; H ♂, Machupichu, Peru, VI.64, Borys Malkin; P 3♂♂, 6♀♀; NMNH.

Minasmiris maldonadoi Carvalho, 1985

Rev. Brasil. Zool. 3(4):163, figs. 5–8, 14; H ♂, Colombia, La Vega, 1,200 m, Cundinamarca, Mar. 1965, J. A. Ramos; P 1♂, 1♀; NMNH.

Monalonion bicolor Carvalho & Costa, 1988

Rev. Brasil. Biol. 48(4):893, figs. 1–5; H ♂, Piedras Negras, Costa Rica, Collection Schild-Burgdorf; NMNH.

Monalonion paraensis Carvalho, 1985

Rev. Brasil. Biol. 45(4):658, figs. 14–17; H ♂, Brasil, Pará, Benevides, 408 km 06, 23.VII.1980, E. L. Oliveira; P ♀; MN.

Monalonion velezangeli Carvalho & Costa, 1988

Rev. Brasil. Biol. 48(4):894, figs. 6–10; H ♂, Jardin (Ant.), em fruto de abacate, mayo, 1987, J. Velilla; P 2♂♂, 4♀♀; MEFLG.

Morobea longipes Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):181, figs. 19–22 M H ♂, New Guinea, NE, Morobe District, nr. Kaindi, 2,350 m, 9.XI.1979, W. C. Gagné; BPBM.

Morobemiris giluwensis Carvalho, 1985

Rev. Brasil. Biol. 45(4):464, figs. 59–62; H ♀, New Guinea, NE, Morobe District, Lake Trist, 1,600 m, 21–26.XI.1966, G. A. Samuelson; P 3♂♂, 1♀; BPBM.

Moroca chuavea Carvalho, 1987

Rev. Brasil. Biol. 46(4):759, figs. 1–4 (1986); H ♂, New Guinea, Chuave, 1,600–2,000 m, 8–14.IX.1968, J. L. Gressitt & T. C. Maa; P ♂ 2 ♀; BPBM.

Moroca elongata Carvalho, 1987

Rev. Brasil. Biol. 46(4):760, figs. 5–8 (1986); H ♂, New Guinea, NE, L. Aunde, VIII.68, R. Rice; P 17♂♂, 14♀♀; BPBM.

Moroca fasciata Carvalho, 1987

Rev. Brasil. Biol. 46(4):761, figs. 9–12 (1986); H ♂, New Guinea, NE, Wau, Morobe District, 1,200 m, 21.VII.1961, J. Sedlacek; P 7♂♂, 3♀♀; BPBM.

Moroca giluwensis Carvalho, 1987

Rev. Brasil. Biol. 46(4):762, figs. 13–16 (1986); H ♂, New Guinea, Papua, Mt. Giluwe, 3,700 m, 27.V.1961, J. L. & M. Gressitt; P 6♂♂, 3♀♀; BPBM.

Moroca karubaka Carvalho, 1987

Rev. Brasil. Biol. 46(4):762, figs. 17–19 (1986); H ♂; New Guinea, NE, Swart Valley, Karubaka, 1,400 m, XI.21.1955, J. L. Gressitt; P ♂; BPBM.

Moroca lutescens Carvalho, 1987

Rev. Brasil. Biol. 46(4):765, figs. 25–28 (1986); H ♂, New Guinea, NE, N. Slope Mt. Strong, 2,600–3,000 m, 8–10.I.1968, J. & M. Sedlacek; P 9♂♂, 18♀♀; BPBM.

Moroca morobensis Carvalho, 1987

Rev. Brasil. Biol. 46(4):766, figs. 29–32 (1986); H ♂, New Guinea, NE, Wau, Morobe District, 1,200 m, 10.V.1963, J. Sedlacek; P 4♂♂, 7♀♀; BPBM.

Moroca nigriclava Carvalho, 1987

Rev. Brasil. Biol. 46(4):767, figs. 33–36 (1986); H ♂, New Guinea, NW. Vogelkop, Sururai, SW Lake Anggi, Giji, 2.000–2.100 m, 4–5.VIII.1963; P 18♂♂, 15♀♀; BPBM.

Moroca ottoana Carvalho, 1987

Rev. Brasil. Biol. 46(4):768, figs. 37–40 (1986); H ♂, New Guinea, NE, Mt. Otto, 12,200 m, June 24, 1955, J. L. Gressitt; P 2♂♂, 7♀♀; BPBM.

Moroca rubescens Carvalho, 1987

Rev. Brasil. Biol. 46(4):769, fig. 41 (1986); H ♀, New Guinea, Neth., Guega, W of Swart Val., 1,200 m, Nov. 15, 1958, J. L. Gressitt; P ♀; BPBM.

Moroca simillima Carvalho, 1987

Rev. Brasil. Biol. 46(4):769, figs. 42–45 (1986); H ♂, New Guinea, NE, Miramar, Gobayaba, Asaro V. 2,000 m, June 29, 1955, J. L. Gressitt; P ♂ 4 ♀; BPBM.

Moroca trilineata Carvalho, 1987

Rev. Brasil. Biol. 46(4):770, figs. 46–49 (1986); H ♂, New Guinea, Morobe District, Wau, 12.IX.1972, G. G. E. Scudder; P 7♂♂, 19♀♀; BPBM.

Moroca unicolor Carvalho, 1987

Rev. Brasil. Biol. 46(4):771, figs. 50–53 (1986); H ♂, New Guinea, Neth. Wisselmeren, Enaratodi, 1,800 m, Aug. 6, 1965, J. L. Gressitt; P 5♂♂, 2♀♀; BPBM.

Moroca verticillata Carvalho, 1987

Rev. Brasil. Biol. 46(4):773, figs. 54–58 (1986); H ♂, New Guinea, NE, Elliptamin Valley, 1,200–1,350 m, July 1–15, 1959, W. W. Brandt; P 8♂♂, 16♀♀; BPBM.

Moroca watuta Carvalho, 1987

Rev. Brasil. Biol. 46(4):774, figs. 59–62 (1986); H ♂, New Guinea, NE, U. Watut, 1,300–1,600 m, 1.V.1963, J. L. Gressitt; P ♂ ♀; BPBM.

Moroca wauensis Carvalho, 1987

Rev. Brasil. Biol. 46(4):774, figs. 63–67 (1986); H ♂, New Guinea, NE, Wau, Morobe District, 3,600 m, 11.IX.1971, on *Pipturus* C. Gagné; P 43♂♂, 27♀♀; BPBM.

Morocisa pilosa Carvalho, 1987

An. Acad. Brasil. Ci. 58(3):492, figs. 6–9 (1986); H ♂; New Guinea, NE, Wau, Morobe District, 1,050 m, 16.X.1961, J. Sedlacek; P 4♂♂, 4♀♀; BPBM.

Mourecoris lutescens Carvalho, 1988

Rev. Brasil. Biol. 48(4):881, fig. 28; H ♀, Ponta Grossa, Vila Vehla, Paraná, Brasil, 14.X.1972, Pe. Jesus S. Moure; P 3♀♀; MN.

Myrmecozelotes catamarcanus Carvalho, 1988

Rev. Brasil. Biol. 48(2):345, figs. 35–40; H ♂, Catamarca (Argentina), El Rodeo, I.59, 1,500 m, R. Golbach; MLP.

Note: The species name was spelled as above on the figure caption, and was spelled "*catamarcus*" in the abstract and the species heading. The above spelling is here adopted as the correct one.

Nanniresthenia cordobensis Carvalho & Carpintero, 1987

Rev. Bras. Zool. 4(1):20, figs. 5–9; H ♂, Calamuchita, Córdoba, Argentina, I.78; CC.

Nanniresthenia penai Carvalho & Carpintero, 1987
Rev. Bras. Zool. 4(1):19, figs. 1–4; H ♂, San Vicente, Coquimbo, Chile, 900 m, X.83, Peña col.; P 21♂♂, 14♀♀; CC.
Neella oaxana Carvalo & Carpintero, 1985
Fol. Ent. Mex. 64:11, fig. 13; H ♀, Mexico, Oaxaca, 14 mi N Miahuatlan, July 16, 1974, Clark, Murray, Ashe, Schaffner; P 16♀♀; UNAM.
Neella pallescens Carvalho & Schaffner, 1985
Fol. Ent. Mex. 64:7, figs. 5–8; H ♂, Oaxaca, 12 mi W Tehuantepec, July 11, 1971, Clark, Murray, Hart, Schaffner; P 247♂♂, 102♀♀; UNAM.
Neella rondonia Carvalho, 1985
Rev. Brasil. Biol. 45(4):661, fig. 18; H ♂, Brasil, Rondonia, Ji Paraná, 8.11.1983, J. Arias; P ♂; MN.
Neella veracruzana Carvalho & Schaffner, 1985
Fol. Ent. Mex. 64:10, figs. 9–12; H ♀, Mexico, Vera Cruz, 36 mi S Acayucan, July 5, 1971, Clark, Murray, Hart, Schaffner; P ♂; UNAM.
Neocapsus zopilotes Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):228, figs. 11–14; H ♂, Venta de Zopilote, Guerrero, 2,800 ft., Oct., H. H. Smith, Distant Coll. 1811, 383; P 5♂♂; BMNH.
Neofurius chiriquiensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):579, figs. 23–27; H ♂, Panamá, Chiriqui Volcano, 30 km NW, 23 July 1976, Wayne E. Clark; NMNH.
Neofurius fasciatus Carvalho & Schaffner, 1985
Fol. Ent. Mex. 64:19, figs. 22–27; H ♂, Panama, Bocas d.T. Corriente Grande, 100 m, April 2–8, 1980, Henk Wolda; P 5♂♂; NMNH.
Neofurius hondurensis Carvalho & Schaffner, 1985
Fol. Ent. Mex. 64:21, fig. 28; H ♀, Honduras, C. A. Lake Yojoa, VIII.6.1978, Gary V. Manley; (ex-JCMC) NMNH.
Neofurius nicaraguensis Carvalho, 1987
Rev. Nica. Ent. 1:5, fig. 1; H ♂, Nicaragua, Zelaya, El Recreo, Oct. 1984; P 3♀♀; MEEB.
Neofurius quichuanus Carvalho, 1985
Rev. Brasil. Zool. 3(4):175, figs. 12–13; H ♂, Peru, Monzon Valley, Tingo Maria, X.26.1954, E. I. Schlinger & E. S. Ross; CAS.
Neofurius terezae Carvalho & Schaffner, 1985
Fol. Ent. Mex. 64:16, fig. 18–21; H ♂, Brazil, Parna Itatiaia, RJ, Janeiro, 1978, Carvalho & Schaffner; P 4♂♂, 4♀♀; MN.
Neoleucon panamensis Carvalho, 1988
Rev. Brasil. Ent. 32(2):175, figs. 1–5. H ♂, Panamá. Canal Zone, Colon, 2–14.VII.1979, on *Cordia alliodora* Cham.; P 24 ♂ ♀; BMNH.
Neoleucon sulinus Carvalho, 1985
Rev. Brasil. Biol. 45(4):662, figs. 24–27; H ♂, Brasil, Pará, Serra Norte, Estrada do Fofóca, 17.VIII.1984; P 9♂♂; MN.
Neoleucon tolemanensis Carvalho, 1988
Rev. Brasil. Ent. 32(2):177, fig. 6. H ♀, Toleman, Vera Paz, Champion; BMNH.
Neoloxops rubrosignatus Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):183, figs. 23–25; H ♂, New Guinea, NE, Morobe

District, Mt. Amingwiwa, 1,200–1,800 m, 10.IV.1970, J. L. Gressitt; P 2 ♂ ♀; BPBM.

Neoneella minuscula Carvalho, 1985
Rev. Brasil. Zool. 3(4):173, figs. 8–11; H ♂, Aguas Vermelhas, Minas Gerais, Brasil, XII-1983, M. Alvarenga; P ♂; (ex. JCMC) MN.

Neoneella uruguayensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):580, figs. 28–31; H ♂, Montevideo, Uruguay, Lab. Parasitologia, 2.17.44, Berry; NMNH.

Neosilia dollingi Carvalho, 1985
Rev. Brasil. Biol. 45(4):662, fig. 23; H ♀, Costa Rica, Turrialba, CATIE/IICA Research Station, 3–8.VII.1981, W. R. Dolling; P ♀; BMNH.

Neosilia oaxacana Carvalho & Schaffner, 1985
Fol. Ent. Mex. 64:23, figs. 29–33; H ♂, Mexico, Oaxaca, 5 mi S Candelaria Loxicha, July 18–19, 1974, Clark, Murray, Ashe, Schaffner; P 14♂♂, 54♀♀; UNAM.

Neostenotus albanus Carvalho, 1985
Rev. Brasil. Biol. 45(4):674, figs. 14–20; H ♂, Colombia, Albano, Cundinamarca, 10 September 1965, J. A. Ramos; P 2♂♂; NMNH.

Neostenotus araguanus Carvalho, 1985
Rev. Brasil. Biol. 45(4):675, figs. 21–24; H ♀, Venezuela, Aragua, Rancho Grande, 70 km NW Maracay, 1,100 m, M. H. Sweet; P 2♂♂; NMNH.

Neostenotus bracatinganus Carvalho, 1985
Rev. Brasil. Biol. 45(4):676, figs. 25–28; H ♂, Vicosa, Minas Gerais, Brasil, 15–28.V.84, Paulo Sérgio Ferreira, Fiuza F.; P 7♂♂, 9♀♀; MN.

Neostenotus caliensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):680, figs. 37–40; H ♂, Colombia, 6 mi W Calli Valle, III.20.55, 1,630 m, E. S. Schlinger & E. S. Ross; P ♂ ♀; CAS.

Neostenotus chipaqueanus Carvalho, 1985
Rev. Brasil. Biol. 45(4):677, figs. 32–35; H ♂, Colombia, Chipaque, Cundinamarca, 27 November 1965, J. A. Ramos; NMNH.

Neostenotus columbiensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):680, figs. 41–45; H ♂, Colombia, Cundinamarca, Finca Bela Vista nr. Sasaima, 24.IV.1965, F. R. Craig; P 3♂♂, 2♀♀; CAS.

Neostenotus mapirinus Carvalho, 1985
Rev. Brasil. Biol. 45(4):678, fig. 36; H ♀, Bolivia, Mapiri; NMNH.

Neostenotus nigroviridis Carvalho & Ferreira, 1987
Experientiae 29(10):157, figs. 29–32 (1986); H ♀, Viçosa, MG. Brasil, 22.XII.81, P. S. Fiuza Ferreira; P 3♂♂, 5♀♀; MN.

Notholopus amazonicus Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):83, fig. 13; H ♀, Brasil, Pará, Serra Norte (Carajás), Nl, Serraria, 18.I.1985, Mário Dias; P 2♀♀; MN.

Notholopus carajasensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):84, fig. 14; H ♀, Brasil, Pará, Serra Norte (Carajás), Fofóca, col. luz, 18.IX.1985, J. Dias; MN.

Notholopus roraimensis Carvalho & Carpintero, 1986
An. Acad. Brasil. Ci. 58(2):294, fig. 9; H ♀, Roramima, Brasil, I. 1962; P 2♀♀; MN.

Nototremates chiriquiensis Carvalho & Schaffner, 1985

Fol. Ent. Mex. 64:27, figs. 34–37; H ♀, Panama, Boca d.T. Corriente Grande, 100 m, April 2–8, 1980, Henk Wolda; P ♀; NMNH.

Nuevoleonia minuscula Schaffner & Carvalho, 1985

Jour. Kans. Ent. Soc. 58(2):229, figs. 1–4; H ♂, Mexico, Nuevo Leon, 18 mi. N La Escondida, July 4, 1974, Clark, Murray, Ashe, Schaffner; P 7♂♂, 7♀♀; NMNH.

Oncerometopus mexicanus Carvalho & Schaffner, 1987

Jour. N.Y. Ent. Soc. 96(1):47, figs. 24–28; H ♂, México, Zacatecas, 28 mi NE Sierra Viejo, April 17, 1977, 6,600 ft. Murray, Schaffner, Sweet; P ♂ ♀; NMNH.

Oncerometopus pueblensis Carvalho, 1988

An. Acad. Brasil. Ci. 59(4):397, figs. 13–16 (1987); H ♂, México, Puebla, 6 mi SW Techuacan, July 8–10, 1973, Mastro & Schaffner; P 2♂♂, 1♀; NMNH.

Orthotylus angeloi Carvalho, 1986

Rev. Brasil. Biol. 46(1):45 and 48, figs. 5–8; H ♂, Parque Estadual do Rio Doce, Minas Gerais, Brasil, M. A. Vulcano & F. Pereira; P 20♂♂, 37♀♀; MN.

Note: The printer transposed the type-data for this species to p. 48 after the discussion of *Orthotylus riodocensis.*

Orthotylus anjuanensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):274, figs. 57–60; H ♂, Argentina, Anjuana, Salta, N. S. Carlos, L. E. Peña; P 1 ♂; (ex-JCMC) MLP.

Orthotylus catariensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):274, figs. 61–65; H ♂, Brasil, Nova Teutonia, Santa Catarina, Fritz Plaumann; P 3♂♂, 2♀♀; MN.

Orthotylus chapadensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):274, figs. 66–69; H ♀, Chapada dos Guimarães, 19.1.1961, Brasil, Mt (Mato Gross), J. & B. Bechyné; P 1♂, 3♀♀; (ex-JCMC) MN.

Orthotylus cuneatus Carvalho, 1985

Rev. Brasil. Biol. 45(3):277, figs. 74–77; H ♂, Republica Argentina, Tigre, 4.43, Carvalho; 4 ♂♂, 7♀♀; (ex-JCMC) MLP.

Orthotylus cyanescens Carvalho & Ferreira, 1987

Experientiae 29(10):157, figs. 33–36 (1986); H ♂, Viçosa, MG. Brasil, 23.IX.81, P. S. Fiuza Ferreira; P ♂; MN.

Orthotylus esavianus Carvalho & Ferreira, 1987

Experientiae 29(10):160; figs. 37–40 (1986); H ♂, Viçosa, MG. Brasil, 20.I.82, P. S. Fiuza Ferreira; P 6♂♂, 5♀♀; MN.

Orthotylus matogrossensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):280, figs. 78–81; H ♀, Fazenda Ricardo, Franco, 7.3.1961, Brasil, Mato Grosso, J & B. Bechyné; P 1♂, 1♀; MN.

Orthotylus missionensis Carvalho, 1985

Rev. Brasil. Biol. 45(3):280, figs. 82–88; H ♂, Missiones, Argentina, Dept. Concepcion, Santa Maria, M. J. Viana; P 2♀♀; MLP.

Orthotylus mourei Carvalho, 1985

Rev. Brasil. Biol. 45(3):281, figs. 89–94; H ♂, Nova Teutonia, Santa Catarina, Brasil, Fritz Plaumann; XII-1944; P 1♂, 4♀♀; (ex-JCMC) MN.

Orthotylus nigroluteus Carvalho and Ferreira, 1987

Experientiae 29(10):162, figs. 41–45 (1986); H ♂, Viçosa, MG. Brasil, 26.I.83, P. S. Fiuza Ferreira; P 3♂♂, 1♀; MN.

Orthotylus ricardoi Carvalho, 1988

Rev. Brasil. Biol. 48(4):882; figs. 29–33; H ♂, Barra de Maricá, Rio de Janeiro, Brasil, 1986, Ricardo Iglesias; P 3♀♀; MN.

Orthotylus riodocensis Carvalho, 1986

Rev. Brasil. Biol. 46(1):46, figs. 10–14; H ♂, Parque Estadual do Rio Doce, Minas Gerais, Brasil, M. A. Vulcano & F. Pereira; P 3♀♀; MN.

Orthotylus roppai Carvalho, 1985

Rev. Brasil. Biol. 45(3):284, figs. 95–98; H ♂, Estrado Rio-Bahia, km 965, Encruzilhada, Divisa, 960 m, Bahia, Brasil, XI-1972, Seabra & Roppa; P 5♂♂; (ex-JCMC) MN.

Orthotylus seabrai Carvalho, 1985

Rev. Brasil. Biol. 45(3):284, figs. 99–103; H ♂, Encruzilhada, Divisa, 960 m, Bahia, Brasil, Seabra & Roppa; MN.

Orthotylus vanettii Carvalho & Ferreira, 1987

Experientiae 29(10):164, figs. 46–49 (1986); H ♂, Viçosa, MG. Brasil, 5.I.83, P. S. Fiuza Ferreira; P 3♂♂, 2♀♀; MN.

Osornocoris punctatus Carvalho, 1985

Rev. Brasil. Biol. 45(3):287, figs. 104–108; H ♂, 30 km W Purranque, Osorno, Chile, 1.16.51, Ross & Michelbacher; P 9♂♂, 4♀♀; CAS.

Pachymerocerista manauara Carvalho, 1985

Rev. Brasil. Biol. 45(4):663, fig. 28; H ♀, Manaus, Brasil, Amazonas, VI.1973, Roppa & Oliveira; MN.

Pachymerocerista nicaraguensis Carvalho, 1987

Rev. Nica. Ent. 1:5, figs. 2–5; H ♂, Nicaragua, Zelaya, El Recreo, Oct. 1984; P ♂ ♀; MEEB.

Pachyneurrhimenus castilloanus Carvalho, 1985

Rev. Brasil. Biol. 45(4):580, fig. 32; H ♂, Ecuador, Chimborazo, Naranjapata, Chilicay, 16 June 1955, R. Levi Castillo; P ♀; NMNH.

Papuacoris ottoensis Carvalho, 1985

Rev. Brasil. Biol. 45(4):466, figs. 68–71; H ♂, New Guinea, NE, Mt. Otto, 2,200 m, 23.VI.1955, J. L. Gressitt; 1♂, 4♀♀; BPBM.

Parafurius schuhi Carvalho, 1985

Rev. Brasil. Biol. 45(4):581, figs. 33–36; H ♂, Costa Rica, Provincia Heredia, La Selva Biological Station, August 1983, George Schartz; P 3♂♂, 6♀♀; NMNH.

Paranatylus albocuneatus Carvalho, 1988

Rev. Brasil. Biol. 48(4):884, figs. 40–43; H ♂, Vila Velha, Paraná, Brasil, 23.I.1986, Pe. Moure; P 7♂♂, 12♀♀; MN.

Paraproba binotata Carvalho & Ferreira, 1987

Experientiae 29(10):166, figs. 50–53 (1986); H ♀, Viçosa, MG. Brasil, 2.II.83, P. S. Fiuza Ferreira; P 2♂♂, 2♀♀; MN.

Paraproba brasiliana Carvalho & Ferreira, 1987

Experientiae 29(10):168, figs. 54–57 (1986); H ♂, Viçosa, MG. Brasil, 18.V.82, P. S. Fiuza Ferreira & Martins; P 46 ♂ and ♀; MN.

Paraproba burkei Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):87, figs. 5–10; H ♀, 5 mi W San Cristobal, Chis. México, VII.22.65, H. R. Burke, J. L. Meyer, J. C. Schaffner; P 7♂♂, 3♀♀; NMNH.

Paraproba clavonotata Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):91, figs. 16–19; H ♀, Costa Rica, Sao José, 8.3 mi N San Isidro del General, 30.VI.72, R. R. & M. R. Murray; P 6♂♂, 4♀♀; NMNH.

Paraproba costaricana Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):93, figs. 20–24; H ♂, Costa Rica, San José, 1911, H. Schmidt, 31-8-1911; NMNH.

Paraproba crotonica Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):93, figs. 25–28; H ♂, San Pedro de Montes de Oca, Costa Rica, Jan. 1937, C. H. Ballou; P ♀; NMNH.

Paraproba ecuatoriana Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):95, figs. 29–30; H ♀, Quito, Equador, X.62, JCMC; NMNH.

Paraproba insularis Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):101, figs. 45–49; H ♂, Socorro Id. 2,000 ft. May 8, 1925, H. H. Keifer; P 1♂, 1♀; CAS.

Paraproba jamaicana Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):102, figs. 50–53; H ♂, Jamaica, St. Andrews Parish, Content Gap, Pine Grove Hotel, 3,600 ft. 8–10.VIII.85, J. E. Eger; P 1♂, 3♀♀; NMNH.

Paraproba mexicana Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):102, figs. 54–61; H ♂, México, Guanajuato, 3 mi NE Santa Rosa, July 5, 1985; P 11♂♂, 21♀♀; NMNH.

Paraproba nigroscutellata Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):106, figs. 66–68; H ♀, San Geronimo, Guatemala, Champion; P 4♂♂, 6♀♀; BMNH.

Paraproba schaffneri Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):110, figs. 74–77; H ♂, México, Guerrero, 5.4 mi SW La Laguna, July 14, 1985, Jones & Schaffner; P 4♂♂, 7♀♀; NMNH.

Paraproba totolapana Carvalho, 1987

An. Acad. Brasil. Ci. 29(1–2):112, figs. 78–81; H ♂, México, Oaxaca, 2.1 mi NW Totolapan, July 11–17, 1981, Bogar, Schaffner, Friedlander; P 4♂♂, 8♀♀; NMNH.

Paraproba venezuelana Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):113, figs. 82–86; H ♂, Venezuela, Aragua, Colonia Tovar, December 27, 1985, P. Kovarik, R. Jones; P 7♂♂, 8♀♀; NMNH.

Paraproba veracruzana Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):114, figs. 87–90: H ♀. México, Veracruz, 3 mi NE Huatusco, July 22, 1985, Jones, Schaffner; P 1♂, 3♀♀; NMNH.

Paraproba virescens Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):116, fig. 91; H ♀, Costa Rica, San Ramon, Tres Rios, 10 August 1972, J. Maldonado; NMNH.

Paraproba viridipennis Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):116, figs. 92–95; H ♂, New Mexico, Otero Co., 4 mi E Cloudcloft, August 18, 1979, Delorae, McHugh, Schaffner; P 10♂♂, 10♀♀; NMNH.

Paraproba zacapoaxtla Carvalho, 1987

An. Acad. Brasil. Ci. 59(1–2):118; figs. 96–99; H ♂, México, Puebla, 3.7 mi S Zacapoaxtla, July 23, 1985, Jones & Schaffner; P 1♂, 6♀♀; NMNH.

Paraxenetus albonotatus Carvalho, 1988

Rev. Brasil. Biol. 48(4):861, figs. 18–21; H ♀, Estirão do Equador, AM (Amazonas), Brasil, X.79, Alvarenga col.; P 2♂♂, 1♀; MN.

Paraxenetus brailovskyi Schaffner & Carvalho, 1985

Jour. Kans. Ent. Soc. 58(2):232, figs. 5–8; H ♂, Mexico Nuevo, Leon, 15 mi W Linares, July 1–2, 1973, Mastro & Schaffner; P 5♂♂, 3♀♀; NMNH.

Paraxenetus cuneopunctatus Carvalho, 1988

Rev. Brasil. Biol. 48(4):864, figs. 26–29; H ♂, Porto Esperidião, Caceres, Mato Grosso, Brasil, IX.1984, Magno & Alvarenga; NM.

Paraxenetus rubricuneus Carvalho, 1988

Rev. Brasil. Biol. 48(4):864, figs. 30–33; H ♂, Sinop. Br 163, km 500–600, Mato Grosso, Brasil, 350 m, X.76. Alvarenga & Roppa; P 6♂♂, 1♀; MN.

Penacoris columbiensis Carvalho, 1985

Bol. Mus. Goeldi, Zool. 2(1):7, figs. 1–5; H ♂, Colombia, Purace, Cauca, Boris Malkin; P ♀; NMNH.

Penacoris laolaoensis Carvalho, 1985

Bol. Mus. Goeldi, Zool. 2(1):9, figs. 6–9; H ♂, Lao Lao, Patagonia, Argentina, Vittmer; MLP.

Perumiris machupichanus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):228, figs. 5–10; H ♂, Peru, Machupichu, II.64, Borys Malkin; P 4♂♂, 3♀♀; NMNH.

Phytocoris bellissimus Carvalho & Ferreira, 1987

Experientiae 29(10):170, figs. 58–63 (1986); H ♂, Viçosa, MG. Brasil, 12.XII.81, P. S. Fiuza Ferreira; MN.

Phytocoris iguazuensis Carvalho & Carpintero, 1986

Rev. Brasil. Biol. 46(3):620, figs. 43–46; H ♂, Parque Nacional de Iguaçu, Provincia Missiones, Argentina, XI.79, Diego L. Carpintero; P 3♂♂; CC.

Phytocoris minensis Carvalho, 1986

Jour. N.Y. Ent. Soc. 84(2):209, figs. 5–9; H ♂, Minas Gerais, Brasil, Viçosa, 13.X–15.IX.82, Fiuza & Martins; P 3♂♂, 1♀; MN.

Phytocoris translucidus Carvalho & Ferreira, 1987

Experientiae 29(10):172, figs. 64–68 (1986); H ♂, Viçosa, MG., Brasil, 2.II.83, P. S. Fiuza Ferreira; 3 ♂♂; MN.

Phytocorisca vissosensis Carvalho & Ferreira, 1987

Experientiae 29(10):174, figs. 69–72 (1986); H ♂ Viçosa, MG., Brasil, 15.VII.82, P. S. Fiuza Ferreira; P 2♂♂, 5♀♀; MN.

Platyscytus englemani Carvalho, 1985

Rev. Brasil. Biol. 45(3):288, figs. 114–117; H ♂, Panama, Barro Colorado Is., March 1972, O. Engleman; NMNH.

Platyscytus serranus Carvalho, 1985

Rev. Brasil. Biol. 45(3):289, figs. 118–121; H ♀, Serra dos Orgãos, Estado do Rio, 29.8.57, J. Becker; P 10♂♂, 14♀♀; MN.

Platytylus binotatus Carvalho & Schaffner, 1987

Jour. N.Y. Ent. Soc. 95(1):49, figs. 29–32; H ♂, México, Jalisco, 16 km N Autlan, July 31–Aug. 2, 1978; P 9♂♂, 2♀♀; NMNH.

Platytylus jataiensis Carvalho, 1988

An. Acad. Brasil. Ci. 59(4):399, fig. 17 (1987); H ♀, Fazenda do Aceiro, Jatai, Goiás, X.1962, Expedicão do Departamento de Zoologia; MN.

Platytylus paraguaiensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):399, figs. 18–20 (1987); H ♀, Horqueta, Paraguai, 44 km E Paraguay River, XII.26.1933, Alberto Schulze; P ♂ ♀; NMNH.

Platytylus rubriventris Carvalho & Schaffner, 1987
Jour. N.Y. Ent. Soc. 95(1):53, figs. 33–37; H ♂; México, Oaxaca, 2.1 mi NW Totolapan, July 11–17, 1981, Bogar, Schaffner, Friedlander; P ♀; NMNH.

Platytylus saltensis Carvalho & Carpintero, 1987
Rev. Bras. Zool. 4(1):23, fig. 10; H ♀, R. Delerma, Salta, Argentina, XI. 84, Diego L. Carpintero; CC.

Platytylus veracruzensis Carvalho & Schaffner, 1987
Jour. N.Y. Ent. Soc. 95(1):55, fig. 38; H ♀, San Rafael, Jicaltepec, Vera Cruz (México), June 96; P; (ex-JCMC) NMNH.

Polymerus atacamensis Carvalho & Carpintero, 1986
An. Acad. Brasil. Ci. 58(2):294, figs. 10–14; H ♂; Chile, Atacama, Q. San Pedro. S. Freirina, X. 80, L. Peña; P 27♂♂, 27♀♀; CC.

Polymerus peruanus Carvalho & Meléndez, 1986
Bol. Mus. Goeldi, Zool. 2(2):95, figs. 5–8; H ♂, Peru, Amazonas, Hidalgo, 17.XII.84, E. Meléndez; P 3♂♂, 11♀♀; CELM.

Poeas schuhi Carvalho, 1985
Rev. Brasil. Biol. 45(4):665, figs. 29–32; H ♂, Peru, Junin, San Ramon de Pangoa, 40 km SE Satipo, 750 m, March 4, 1972. R. T. & J. C. Schuh; P 3♂♂, 5♀♀; AMNH.

Prepops adluteiceps Carvalho, 1988
Rev. Brasil. Biol. 48(2):354, figs. 6–9; H ♂, Aguas Vermelhas, Minas Gerais, Brasil, XI.83, M. Alvarenga; MN.

Prepops alvarengai Carvalho, 1988
Rev. Brasil. Biol. 48(2):355, figs. 10–13; H ♂, Aguas Vermelhas, Minas Gerais, Brasil, XI. 83, M. Alvarenga; P 2♂♂; MN.

Prepops banosus Carvalho, 1988
Acad. Brasil. Ci. 59(4):411, figs. 1–3 (1987); H ♂, Baños, Equador, Feb. 20, 1937, W. Frost; NMNH.

Prepops barueriensis Carvalho, 1988
Rev. Brasil. Biol. 48(2):356, fig. 14; H ♀, Barueri, Sao Paulo, Brasil, 13.I.1962, K. Lemko; MN.

Prepops bechynei Carvalho, 1988
Rev. Brasil. Biol. 48(2):356, figs. 15–18; H ♀, Serra do Navio, 6.VII.1961, AP (Amapá), Brasil, J. & B. Bechyné; P ♂ 2 ♀; MN.

Prepops beniensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):412, fig. 4–7 (1987); H ♂, Huachi, Rio Beni, Bolivia, Mann, 22 Sept. Mulford Rio Expl. 1921–1922; NMNH.

Prepops bicoloroides Carvalho & Schaffner, 1987
Jour. N.Y. Ent. Soc. 95(1):36, figs. 2–5; H ♂, México, Oaxaca, 1.6 mi N Putla, August 3, 1976, Peigler, Gruetzmacher, R. & M. Murray, Schaffner; NMNH.

Prepops caatinganus Carvalho, 1988
Rev. Brasil. Biol. 48(2):357, figs. 19–22; H ♂, Senhor do Bonfim, Bahia, Brasil, V. 74, J. C. M. Carvalho; MN.

Prepops casualis Carvalho, 1988

An. Acad. Brasil. Ci. 59(4):414, figs. 8–10 (1987); H ♂, Pto. Salgar, Cundinamarca, Colômbia, 31.I.59; MEFLG.

Prepops catamarcanus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):415, fig. 11 (1987); H ♀, Catamarca, (Argentina), El Machado, 19.I.59, R. Golbach; P ♀; MLP.

Prepops chanchamaianus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):416, fig. 12 (1987); H ♀, Vale Chanchamayo, Peru, 800 m, 20.VII.41, leg. Weyrauch; NMNH.

Prepops comparapanus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):416, fig. 13 (1987); H ♀, Bolivia, Siberia, 2,500 m, Comarapa, X. 58, F. Monros; NMNH.

Prepops concinnoides Carvalho, 1988
Rev. Brasil. Biol. 48(2):358, figs. 23–26; H ♀, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI. 1972, Seabra & Roppa; P ♂ ♀; MN.

Prepops correntinoides Carvalho & Carpintero, 1987
Rev. Brasil. Zool. 4(1):24, figs. 11–14; H ♀, Parque Nacional do Iquazu, Misiones, Argentina, X. 82, Diego L. Carpintero; P 1♂, 1 ♀; CC.

Prepops cuzcoensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):417, figs. 14–17 (1987); H ♂, Peru, South America, Santa Isabel, Depart. Cuzco, Valley of River Conispata, I.4.1952, F. Woytkowski; P ♂; NMNH.

Prepops englemani Carvalho & Schaffner, 1987
Jour. N.Y. Ent. Soc. 95(1):37, figs. 6–9; H ♂, Panama, B de T, Rio Changuinola, 24–27 Jan. 1980, D. Engleman; P ♀; NMNH.

Prepops entrerianus Carvalho & Carpintero, 1987
Rev. Brasil. Zool. 4(1):27, figs. 15–18; H ♂, Concordia, Entre Rios, Argentina, 1.80. Diego L. Carpintero; P 1♀; CC.

Prepops fernandopolis Carvalho, 1988
Rev. Brasil. Biol. 48(2):359, fig. 27; H ♀, Fernandopolis, Chapada dos Bugres, Mato Grosso, Brasil, X. 1984, Roppa; MN.

Prepops fragosoi Carvalho, 1988
Rev. Brasil. Biol. 48(2):359, figs. 28–31; H ♂, Aguas Vermelhas, Minas Gerais, Brasil, XII. 1983, Moacyr Alvarenga; MN.

Prepops hambletoni Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):420, figs. 22–25 (1987); H ♂, Peru, 15 mi NE Tingo Maria, IX.23.1954, E. I. Schlinger & E. S. Ross; P ♀; CAS.

Prepops huascaraiensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):420, fig. 26 (1987); H ♀, Huascaray, Peru, 21 September 11, C. H. T. Towsend; NMNH.

Prepops iguazuensis Carvalho & Carpintero, 1987
Rev. Brasil. Zool. 4(1):27, figs. 19–22; H ♂, Parque Nacional de Iguazu, Misiones, Argentina, XII. 79, Diego L. Carpintero; P 1♂; CC.

Prepops liliae Carvalho, 1988
Rev. Brasil. Biol. 48(2):360, figs. 32–35; H ♀, Estrada Rio-Bahia, Encruzilhada, Motel da Divisa, 960 m, Bahia, Brasil, XI. 72, Seabra & Roppa; P ♂; MN.

Prepops malkinsi Carvalho, 1988

An. Acad. Brasil. Ci. 59(4):422, figs. 27–30 (1987); H ♂, Colombia, Putumayo, X. 70, Borys Malkins; P 3♀♀, 6♂♂; NMNH.

Prepops mielkei Carvalho, 1988
Rev. Brasil. Biol. 48(2):362, fig. 36; H ♀, Curitiba, PR (Paraná), Brasil, 15–24.I.84, Costa; P 3♀♀; MN.

Prepops missionesus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):423, fig. 31 (1987); H ♀, República Argentina, Gub. Missiones, 1.III.1897, S. Venturi; MLP.

Prepops nicaraguensis Carvalho & Schaffner, 1987
Jour. N.Y. Ent. Soc. 95(1):41, figs. 10–15; H ♂, Nicaragua, Esteli, 13.4 mi NW Sebaco, 17 June 1972, CA-3, R. R. & M. E. Murray; P 17♂♂, 37♀♀; NMNH.

Prepops nigritus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):424, figs. 32–34 (1987); H ♂, Peru, Monson Valley, Tingo Maria, XII.2.1954, Schlinger & Ross; P ♂ ♀; CAS.

Prepops nuevoleonensis Carvalho & Schaffner, 1987
Jour. N.Y. Ent. Soc. 95(1):43, figs. 16–19; H ♂, México, Nuevo Leon, Zaragoza, July 3, 1973, Mastro & Schaffner; NMNH.

Prepops olmosensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):424, figs. 35–38 (1987); H ♂, Olmos, Peru, 23.IV.1967, R. Vigil; NMNH.

Prepops oranensis Carvalho & Carpintero, 1987
Rev. Bras. Zool. 4(1):28, figs. 23–26; H ♂, Oran, Salta, Argentina, X.53, Hepper; P 1♂, 1♀; CC.

Prepops palatanganus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):427, fig. 39 (1987); H ♀, "Pallatanga," Equador, 3.26.22, G. & H. Tate; P 3♀♀; NMNH.

Prepops pauloi Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):427, figs. 40–43 (1987); H ♀, Colombia, Putomayo, X.70, Borys Malkins; P 3♂♂, 4♀♀; NMNH.

Prepops piraporanus Carvalho, 1988
Rev. Brasil. Biol. 48(2):363, fig. 37; H ♀, Brasil, Minas Gerais, Pirapora, IX.1976, Seabra, Roppa & Monné; MN.

Prepops riodocensis Carvalho, 1988
Rev. Brasil. Biol. 48(2):364, figs. 38–41; H ♂, Parque Estadual do Rio Doce, Minas Gerais, Brasil, M. A. Volcano & F. Pereira; P 2♂♂; MN.

Prepops rondoniensis Carvalho, 1988
Rev. Brasil. Biol. 48(2):365, figs. 42–45; H ♂, Porto Velho, Estado de Rondônia, Brasil, 9.XI.1984, Roppa; MN.

Prepops sanjavierus Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):428, figs. 44–47 (1987); H ♂, San Javier, Tucumán, 3.3.51, Wygodzinsky; MLP.

Prepops tingoensis Carvalho, 1988
An. Acad. Brasil. Ci. 59(4):430, figs. 48–51 (1987); H ♀, Peru, Monzon Valley, Tingo Maria, X.25.1954, E. I. Schlinger & E. S. Ross; P ♂ ♀; CAS.

Prepops tiquiensis Carvalho, 1988
Rev. Brasil. Biol. 48(2):365, fig. 46; H ♀, Estirao do Equador, AM (Amazonas), Brasil, 4.79, Alvarenga; MN.

Prepops vissosensis Carvalho, 1988

Rev. Brasil. Biol. 48(2):367, figs. 47–50; H ♂, Viçosa, MG (Minas Gerais), Brasil, "8.XIIX.84," Fiuza & Martins; MN.

Prepops vittatus Carvalho & Schaffner, 1987

Jour. N.Y. Ent. Soc. 95(1):45, figs. 20–23; H ♂, México, Campeche, 31.5 mi N Hopelchen, Aug. 1, 1980, Schaffner, Weaver, Friedlander; NMNH.

Prepops wanderbilti Carvalho, 1988

Rev. Brasil. Biol. 48(2):367, fig. 51; H ♀, Brasilia, Itatiaia, Lahtivirta, 980 m; MN.

Prepopsisca ecuatoriana Carvalho, 1988

An. Acad. Brasil. Ci. 59(3):254, figs. 6–10 (1987) H ♂, Equador, N. P. Santa Cecilia, III.25–31, 1969, P. & P. Spangler; P ♀; NMNH.

Prepopsisca parauara Carvalho, 1988

An. Acad. Brasil. Ci. 59(3):256, fig. 16 (1987); H ♀, Serra dos Carajás, Estado do Pará, Brasil, V. 86, O. Roppa; MN.

Prepopsisca putumaia Carvalho, 1988

An. Acad. Brasil. Ci. 59(3):255, figs. 11–15 (1987); H ♂, Colombia, X, 70, Putumayo, Borys Malkin col.; P 1♂, 7♀♀; (ex-JCMC) NMNH.

Prepopsoides jaliscoensis Carvalho & Schaffner, 1987

Jour. N.Y. Ent. Soc. 95(1):34, fig. 1; H ♀, México, Jalisco, 14 mi S Autlan, August 3, 1978, Plitt, Schaffner; P 4♀♀; NMNH.

Proba froeschneri Carvalho, 1986

Jour. N.Y. Ent. Soc. 94(2):211, figs. 10–13; H ♂, N.E. Citlaltepetl, Ver (Veracruz), Mexico, 6.27.64, elev. 11,000 ft, L. W. Swan; P 31♂♂, 47♀♀; CAS.

Proba missionensis Carvalho & Carpintero, 1986

Rev. Brasil. Biol. 46(3):621, figs. 47–50; H ♀, Parque Nacional de Iguacu, Provincia Missiones, Argentina, X.80, Diego L. Carpintero; P ♂ ♀; CC.

Note: The species name was spelled three ways in the original paper: *missioneera* (p. 607); *missionera* (p. 621 and 624); *missionensis* (p. 622). The latter was the intended name and is adopted here.

Prolygus albocuneatus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):139, figs. 1–4; H ♀ New Guinea, NE, Above Keglsug, Mt. Wilhelm, 3,000 m, July 4, 1955, J. L. Gressitt; P 2♂♂, 2♀♀; BPBM.

Prolygus alboscutellatus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):140, figs. 5–8; H ♂, New Guinea, NE, 6.4 km W Wabag, 2.020 m, 13.VI.'63, J. Sedlacek; P 31♂♂, 23♀♀; BPBM.

Prolygus biscutellatus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):141, figs. 9–12; H ♂, New Guinea, NE, Finisterre Range n. Freyberg Pass (N), 2,550 m, X.1–21.1958, W. W. Brandt; P ♂ 3 ♀; BPBM.

Prolygus finisterrensis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):143, figs. 18–21; H ♂, New Guinea, NE. Main Finisterre Range nr. Freyberg Pass (N), 2,250 m, X.1–21.1958, W. W. Brandt; P 3♂♂, 4♀♀; BPBM.

Prolygus kandanus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):144, figs. 22–25; H ♂, New Ireland, Kandan, 1.I.1960, W. W. Brandt; P 8♂♂, 37♀♀; BPBM.

Prolygus kebarensis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):145, figs. 26–30; H ♀, West New Guinea, Vogelkop, Kebar Val., W Manokwari, 550 m, 4–31.I.1962, S. Wuate & L. Quate; P ♂ ♀; BPBM.

Prolygus maai Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):146; figs. 35–38; H ♂, New Guinea, NE, Kainantu, 1,650 m, Sept. 25–30, '59, T. C. Maa; P 2♂♂, 5♀♀; BPBM.

Prolygus nakanaiensis Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):147, figs. 39–42; H ♀, New Britain, Talalo, Nakani Mts., 900 m, VII.28.1956, E. J. Ford, Jr.; P ♂; BPBM.

Prolygus punctialbus Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):148, figs. 47–50; H ♂, New Guinea, NE, U. Watut SW, 1,300–1,600 m, I.V.1966, J. L. Gressitt; P 10♂♂, 12♀♀; BPBM.

Prolygus quatei Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):149, figs. 51–54; H ♂, New Guinea, NE, Wau, Morobe District, Mt. Missim, 1,800 m, 22.IV.1966, Gressitt & Wilkes; P 5♂♂, 15♀♀; BPBM.

Prolygus watutensis Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):150, figs. 59–62; H ♂, New Guinea, NE, U. Watut, SW 1,800–2,200 m, 2.V.1968, J. L. Gressitt; P 23♂♂, 27♀♀; BPBM.

Pycnoderes antioquiensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):69, fig. 1; H ♀, La Ceja, Antioquia, Colômbia, 2.IX.54, C. Carmona; MEFLG.

Pycnoderes ararensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):70, fig. 2; H ♀, Araras, Estado de São Paulo, Brasil, 27.IX.83, L. B. L. Marcheti; MN.

Pycnoderes cataguasensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):70, figs. 3–4; H ♂, Cataguazes, Estado de Minas Gerais, Brasil, IV.85, G. S. Andrade; MN.

Pycnoderes chimborazensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):582, figs. 37–40; H ♂, Ecuador, Linje, Chimborazo, July 1955, Levi Castillo; P ♂ ♀; NMNH.

Pycnoderes chinchinaensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):71; figs. 5–8; H ♂, Chinchiná, Colombia, 4.XI.59, I. Sanabria; MEFLG.

Pycnoderes cuneomaculatus Carvalho, 1985
Rev. Brasil. Biol. 45(4):583, fig. 41; H ♂, Ecuador, Chimborazo, Naranjapata, Chilicay, 16 June 1955, R. Levi Castillo; NMNH.

Pycnoderes gabrieli Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):73, figs. 9–10; H ♂, Humaitá, Amazonas, Brasil, VIII. 1960, G. S. Andrade; P 2♂♂, 1♀; MN.

Pycnoderes iguazuensis Carvalho & Carpintero, 1986
An. Acad. Brasil. Ci. 58(1):147, fig. 1; H ♀, Parque Nacional do Iguaçu, Missiones, Argentina, X. 80, Diego L. Carpintero; P 5♀♀; CC.

Pycnoderes jamaicensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):584, figs. 42–45; H ♂, Jamaica, St. And. Par., Clydesdale, 4–9 December 1975, Gary F. Hevel; NMNH.

Pycnoderes lojaensis Carvalho, 1988

An. Acad. Brasil. Ci. 60(1):74, fig. 11, H ♀, Loja, Zamora, Equador, 2,000–2,500 m, L. S. Peña; P ♀; NMNH.

Pycnoderes manabiensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):584, figs. 46–48; H ♀, Ecuador, La Palma, Manabi, August 1955, R. Levi Castillo; P ♀; NMNH.

Pycnoderes martiniquensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):74, figs. 12–15; H ♂, Matinica, St. Joseph, Junho, 1962, J. Maldonado C.; NMNH.

Pycnoderes nicaraguensis Carvalho, 1987
Rev. Nica. Ent. 1:7, figs. 6–9; H ♀, Nicaragua, Zelaya, El Recreo, Oct. 1984; MEEB.

Pycnoderes pucalensis Carvalho, 1988
An. Acad. Brasil. Ci. 60(1):76, figs. 16–19; H ♂, Pucalá, Peru, 21.I.67, Korytkowski; P 2♂♂, 4♀♀; NMNH.

Pycnoderes tobagoensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):585, figs. 49–51; H ♂, Tobago, St. John Prov. Hermitage River Bridge, Charlottville, 12–21 March 1979, D. Hardy & W. Rowe; NMNH.

Pycnoderes venezuelanus Carvalho, 1985
Rev. Brasil. Zool. 3(4):171, fig. 3; H ♂, Venezuela, est. Portuguesa, 15.IX.1957, Borys Malkin, 7 km n Biscucuy, Bonoco-Biscucuy Road, elev. 600 m; NMNH.

Reuteroscopus cacerensis Carvalho, 1985
Rev. Brasil. Biol. 45(4):665, figs. 33–36; H ♂, Porto Esperidiao, Caceres, Mato Grosso, Brasil, XI. 1984, Magno & Alvarenga; P 19♂♂, 12♀♀; MN.

Reuteroscopus peruanus Carvalho & Meléndez, 1986
Bol. Mus. Goeldi, Zool. 2(2):98, figs. 9–11; H ♂, Peru, Amazonas, Quebrada, 13.XII.85, E. Meléndez; P 4♂♂, 12♀♀; CELM.

Rhinocapsidea sinaloa Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):232, figs. 23–26; H ♂, México, Sinaloa, 26 mi N Pericos. VIII.13.60, P. H. Arnaud, Jr., E. S. Ross, D. C. Rentz; P 38♂♂, 4♀♀; CAS.

Romna albata Eyles & Carvalho, 1988
New Zealand Jour. Zool. 15:66, figs. 7–9, 54; H ♂, Makahu Spur, Kaweka Ra, Hawke's Bay, 1,220 m, from *Phyllocladus,* 26 Feb. 1971, J. I. Townsend; P 2♂♂; EDDSIR.

Romna bicolor Eyles & Carvalho, 1988
New Zealand Jour. Zool. 15:67, figs. 13–16. 62; H ♀, Wolfe Flat, 600–680 m, Turret Range, Jan. 1970, G. Kuschel, Manapouri Exp.; A ♂ P ♀; EDDSIR.

Romna cuneata Eyles & Carvalho, 1988
New Zealand Jour. Zool. 15:69, figs. 28–30, 55; H ♂, Kea Walk, Mt. Cook, 7 Jan. 1966, on *Hebe subalpina,* A. C. Eyles; A ♀ P 1♂, 6♀♀; EDDSIR.

Romna nigrovenosa Eyles & Carvalho, 1988
New Zealand Jour. Zool. 15:72, figs. 39–41, 60; H ♂, Marlborough: Blackbirch Ra, on *Nothofagus,* 17 February 1970, A. C. Eyles; A ♀ P 1♀, 11♂♂; EDDSIR.

Romna oculata Eyles & Carvalho, 1988
New Zealand Jour. Zool. 15:72, figs. 20–23, 61; H ♂, Mt. Alpha, Wanaka, 1,341–1,524 m, 15 Jan. 1971, J. S. Dugdale; A ♀ P 4♂♂; EDDSIR.

Romna ornata Eyles & Carvalho, 1988
New Zealand Jour. Zool. 15:74, figs. 42–44, 63; H ♂, Hunua Falls, Auckland,

on Rimu (*Dacrydium cupressinum*), 10 Dec. 1960, B. M. May; A ♀ P 3♂♂, 2♀♀; EDDSIR.

Romna pallida Eyles & Carvalho, 1988

New Zealand Jour. Zool. 15:74, figs. 45–48, 53, 64; H ♂, Manaia, Taurikura, Whangarei Heads, 6 Dec. 1958, Gillean Wise; A ♀ P 3♀♀; EDDSIR.

Romna uniformis Eyles & Carvalho

New Zealand Jour. Zool. 15:78, figs. 10–12, 65; H ♂ Stewart Island: Table Hill, 304 m, 16 Feb 1986; A P 4 ♀; EDDSIR.

Romna variegata Eyles & Carvalho, 1988

New Zealand Jour. Zool. 15:74, figs. 35–38, 57; H ♂, Aniseed Valley, Nelson, 29 Dec. 1953, E. S. Gourlay; A ♀ P 7♂♂; EDDSIR.

Rondonella fasciata Carvalho, 1985

Rev. Brasil. Biol. 45(3):294, figs. 126–129; H ♂, Ji Paraná, Rondonia, Brasil, XI. 1983, Roppa; P 1♂; (ex-JCMC) MN.

Roppisca diamantina Carvalho, 1988

Rev. Brasil. Biol. 48(4):867, figs. 34–40; H ♂, Diamantino, Fazenda São João, Mato Grosso, Brasil, km 20 Br 163, Roppa; P 1♀; MN.

Saileria mexicana Carvalho, 1985

Rev. Brasil. Biol. 45(3):294, figs. 130–133; H ♂, Socorro Is., Brtwte Bay, May 2, 1925, H. H. Keifer; P 3♂♂, 2♀♀; CAS.

Saileria serrana Carvalho, 1985

Rev. Brasil. Biol. 45(3):296, figs. 134–137; H ♂, Itatiaia, Brasil, 1,100 m, Dalcy & Travassos, 8.1.50; P 1♀; (ex-JCMC) MN.

Sericophanes bolivariensis Carvalho & Costa, 1988

Rev. Brasil. Biol. 48(4):903, figs. 20–23; H ♂, Colombia, 10 mi E Bague, Tolima, 490 m, III.9.1955, E. I. Schlinger & E. R. Ross; P 1♂; CAS.

Sericophanes tigrensis Carvalho & Costa, 1988

Rev. Brasil. Biol. 48(4):903, figs. 17–19; H ♂, Argentina, Tigre, 4.43, c. Carvalho (Visna leg.); P1♂, 1♀; MACN.

Sinopia matogrossensis Carvalho, 1988

Rev. Brasil. Biol. 48(4):868, figs. 41–45; H ♂; Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.74, Alvarenga & Roppa; MN.

Sixeonotus acuminatus Carvalho & Carpintero, 1986

An. Acad. Brasil. Ci. 58(1):148, figs. 2–5; H ♀, Santa Isabel do Morro, Ilha do Bananal, Goiás, Brasil, VI.1961, M. Alvarenga; P 5♂♂, 2♀♀; MN.

Sixeonotus capitatus Carvalho & Carpintero, 1986

An. Acad. Brasil. Ci. 58(1):148, fig. 6; H ♀, Parque Nacional do Iguacu, Missiones, Argentina, Diego L. Carpintero, X. 1980; P 3♀♀; CC.

Sixeonotus chapadensis Carvalho & Carpintero, 1986

An. Acad. Brasil. Ci. 58(1):150, figs. 7–10; H ♀, Chapada dos Guimarães, 20.I.1961, Brasil, Mato Grosso, J. & B. Bechyné; P 2♂♂, 8♀♀; MN.

Sixeonotus saltensis Carvalho & Carpintero, 1986

An. Acad. Brasil Ci. 58(1):150, figs. 11–15; H ♀, La Vina, Salta, Argentina, 11.84, Diego L. Carpintero; P 16♂♂, 18♀♀; CC.

Spartacus entrerianus Carvalho & Carpintero, 1986

An. Acad. Brasil. Ci. 58(1):152, figs. 16–18; H ♀, Concordiam Entre Rios, Argentina, IV.79, Diego L. Carpintero; P 3♀♀; CC.

Spartacus minensis Carvalho, 1985

Rev. Brasil. Biol. 45(4):577; H ♂, Minas Gerais, Vicosa, 6.44, Brasil, Carvalho; P 15♂♂, 15♀♀; MN.

Note: Proposed as new for the misidentified *Spartacus albatus* of Carvalho (not Distant), 1954, Bol. Mus. Nac., Zool. 36:30, figs. 42–45.

Spartacus panamensis Carvalho, 1985

Rev. Brasil. Biol. 45(4):577, figs. 19–22; H ♂, Panamá, Prov. Tocumen, 5.X.1953, F. S. Blanton; NMNH.

Sysinas amazonensis Carvalho, 1988

An. Acad. Brasil. Ci. 60(1):85, figs. 15–18; H ♂, Brasil, Amazonas, Teffé, Alvares, 50 m, 24.II.1981, G. Ekis; MN.

Sysinas carajasensis Carvalho, 1988

An. Acad. Brasil. Ci. 60(1):85, figs. 19–22; H ♂, Brasil, Pará, Serra Norte (Carajás), Pojuca, 4.VII.1986, J. Dias; MN.

Sysinas hondurensis Carvalho & Schaffner, 1985

Fol. Ent. Mex. 64:16, figs. 14–17; H ♂, Honduras, C. A. Lake Yojoa, VII-6-1978, Gary V. Manley; P 2♀♀; NMNH.

Thomascoris henryi Carvalho, 1985

Rev. Brasil. Biol. 45(4):587, figs. 52–56; H ♂, Costa Rica, Provincia Heredia, La Selva Biological Station, Aug. 23, George Schatz; P ♂; NMNH.

Tibiocoris carajasensis Carvalho, 1988

An. Acad. Brasil. Ci. 60(1):88, figs. 23–26; H ♂, Brasil, Pará, Serra Norte (Carajás), Serraria, 20.VI.1986, M. F. Torres; MN.

Tigremiris argentinus Carvalho, 1985

Rev. Brasil. Biol. 45(3):297, fig. 138; H ♀, Republica Argentina, Tigre, 4.43, Carvalho; P 5♀♀; (ex-JCMC) MLP.

Tinginotopsis moifensis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):167, figs. 5–8; H ♀, New Guinea, NE, Moife, 2,100 m, 15 km NW Okapa, Oct. 11–13, 1959, T. C. Maa; P ♂ 2 ♀; BPBM.

Tinginotopsis wauensis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):168, figs. 9–12; H ♂, New Guinea, NE, Wau, Morobe District, 1,200 m, 1–4.VIII.1962, J. Sedlacek; P 6♂♂, 10♀♀; BPBM.

Tinginotum floraensis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):170, figs. 13–15; H ♂, New Guinea, NE, Mt. Flora, 3,150 m, 12.VI.'66, J. L. Gressitt; P 3♂♂, 6♀♀; BPBM.

Tinginotum grandis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):171, figs. 16–19; H ♂, New Guinea, NE, Wau, 1,200 m, 7.IX.1964, J. Sedlacek; P 4♂♂, 3♀♀; BPBM.

Tinginotum kanadensis Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):172, figs. 20–23; H ♂, New Ireland, Kandan, 1.I.1960, W. W. Brandt; P 7♂♂, 4♀♀; BPBM.

Tinginotum rubrovenosus Carvalho, 1987

Rev. Brasil. Biol. 47(1–2):175, figs. 29–32; H ♂, New Guinea, NE, Mt. Flora, 3,100 m, 12.VI.1966, L. L. Gressitt; P 5♂♂; 3♀♀; BPBM.

Tropidosteptes corcovadensis Carvalho, 1986

Rev. Brasil. Biol. 46(2):403, figs. 1–5; H ♂, Brasil, Sumaré, Santa Tereza, Santos, Machado, Emanuel, Cruz, 6.9.944; P ♂; MN.

Tropidosteptes fortunensis Carvalho, 1986
Rev. Brasil. Biol. 46(2):406, figs. 11–14; H ♀, Panamá, Canal Zone, 1t Fortuna, 5.77, H. Wolda; P ♂ ♀; NMNH.

Tropidosteptes lineatus Carvalho, 1986
Rev. Brasil. Biol. 46(2):408, figs. 19–22; H ♀, Brasil, Nova Teutonia, F. Plaumann, 9.1944; P 18♂♂, 10♀♀; MN.

Tropidiosteptes paulistanus Carvalho, 1986
Rev. Brasil. Biol. 46(2):409, fig. 23; H ♀, Brasil, Campos do Jordão, Estado São Paulo, 1,600 m, 3.1945, Wygodzinsky; MN.

Tropidosteptes tunjanus Carvalho, 1986
Rev. Brasil. Biol. 46(2):412, figs. 27–31; H ♀, Colombia, Boyaca, 12 km N Tunja, 13 July 1982, Clark & Cave; P 1♂, 2♀♀; NMNH.

Tucuruiella robusta Carvalho & Ferreira, 1987
Experientiae 29(10):179, figs. 74–77 (1986); H ♂, Viçosa, MG. Brasil, 2.XII.1981, P. S. Fiuza Ferreira; P ♂; MN.

Tucuruisa pilosa Carvalho, 1987
Acta Amazon. 16–17:590, figs. 1–2; H ♂, Tucurui, Pará, Brasil, I.79, M. Alvarenga col.; MN.

Tytthus entrerianus Carvalho & Carpintero, 1986
Rev. Brasil. Biol. 46(3):624, figs. 51–54; H ♂, Concordia, Entre Rios, Argentina, (3) IV.79; (5) I. 80, Diego L. Carpintero; P 5♂♂, 3♀♀; CC.

Urapura antennata Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):184, fig. 26; H ♀, New Guinea, Neth. Wisselmeren, 1.530 m, Urapura, Kamo Valley, Aug. 16, 1955, J. L. Gressitt; BPBM.

Vanettia rubra Carvalho & Ferreira, 1987
Experientiae 29(10):177, fig. 73 (1986); H ♀, Vicosa, MG. Brasil, 25.II.82, P. S. Fiuza Ferreira; MN.

Waucoris rubrus Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):161, figs. 20–23; H ♂; New Guinea, NE, 11 km S Mt. Hagen (town), 2,200–2,300 m, 21.V.1963, J. Sedlacek; P 12♂♂, 18♀♀; BPBM.

Waucoris wauensis Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):164, figs. 24–27; H ♂, New Guinea, NE, Wau, Morobe District, 1,200 m, 14.VII.1961, J. Sedlacek; P 1♂, 12♀♀; BPBM.

Wauella squamata Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):186, figs. 27–31; H ♂, New Guinea, NE Sepalakambang, Salawaket Range, 1,920 m, IX.12.1956, M. Sedlacek; P ♂ ♀; BPBM.

Wumea clypealis Carvalho, 1987
Rev. Brasil. Biol. 47(1–2):187, figs. 32–36; H ♀, New Guinea, NE, Wum, Upper Jimmi Valley, 840 m, VI.16.1956, J. L. Gressitt; P 19 ♂ ♀; BPBM.

Xenetopsis brasilianus Carvalho, 1988
Rev. Brasil. Biol. 48(4):871, figs. 46–50; H ♂, Sinop, Rio Teles, Mato Grosso, Brasil, IX.74, Roppa; MN.

Xenocylapus brasiliensis Carvalho, 1988
Rev. Brasil. Biol. 48(4):886, figs. 44–47; H ♀, Bresilien, Nova Teutonia, Santa Catarina, X.1975, Fritz Plaumann, 300–500 m; P 6♂♂, 11♀♀; MN.

Zacynthus mexicanus Schaffner & Carvalho, 1985

Jour. Kans. Ent. Soc. 58(2):234, figs. 9–12; H ♂, Mexico, Oaxaca, 2.1 mi NW Totolapan, July 11–17, 1981, Bogar, Schaffner, Friedlander; P ♀; NMNH.

LIST OF JOURNALS CITED BY ABBREVIATIONS

Acta Amazon.—Acta Amazonica
An. Acad. Brasil. Ci.—Anais da Academia Brasileira de Ciências
Ann. Soc. Ent. France—Annales de la Societe Entomologique de France
Bol. Mus. Goeldi, Zool.—Boletim do Museu Paraense Emilio Goeldi, série Zoologia
Bol. Mus. Nac., Zool.—Boletin do Musee Nacional, Zoologia, Rio de Janeiro
Fol. Ent. Mex.—Folia Entomologica Mexicana
Jour. Kans. Ent. Soc.—Journal of the Kansas Entomological Society
Jour. N.Y. Ent. Soc.—Journal of the New York Entomological Society
New Zealand Jour. Zool.—New Zealand Journal of Zoology
Proc. Ent. Soc. Wash.—Proceedings of the Entomological Society of Washington
Rev. Brasil. Biol.—Revista Brasileira de Biologia
Rev. Brasil. Ent.—Revista Brasileira de Entomologia
Rev. Brasil. Zool.—Revista Brasileira de Zoologia
Rev. Nica. Ent.—Revista Nicaraguense de Entomologia

LIST OF ABBREVIATIONS FOR INSTITUTIONS CONTAINING HOLOTYPES

BMNH—British Museum of Natural History, London
BPBM—Bernice P. Bishop Museum, Honolulu
CAS—California Academy of Sciences, San Francisco
CC—Collection of D. L. Carpintero, Buenos Aires
CELM—Entomology Collection of the Universidad Nacional Agraria, La Molina
EDDSIR—Entomological Division DSIR, Lincoln
IML—Instituto Miguell Lillo, Tucuman
INPA—Instituto Nacional de Pesquisas Amazonicas, Manaus
JCMC—Collection of José Candido de Melo Carvalho, Rio de Janeiro
MACN—Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires
MEEB—Museu Entomological de la Escuela de Biologia, Leon
MEFLG—Museo Entomologica Francisco Luiz Gallego, Medellin
MLP—Museo de La Plata, La Plata
MN—Museu Nacional, Rio de Janeiro
MPEG—Museu Paraense Emilio Goeldi, Belém
MZU—Museum Zoologicum Universitatis, Helsinki
MZUC—Museu de Zoologia da Universidade de Copehague, Copenhagen
NMNH—National Museum of Natural History, Washington, D.C.
NZAC—New Zealand Arthropod Collection, Aukland
UNAM—Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Mexico City

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PSEUDOSAICA PANAMAENSIS, A NEW GENUS AND SPECIES OF ASSASSIN BUG FROM PANAMA (HETEROPTERA: REDUVIIDAE: SAICINAE)

R. L. Blinn

Department of Entomology, North Carolina State University,
Raleigh, North Carolina 27659-7613

Abstract.—The new genus *Pseudosaica* is described to accommodate *Saica florida* Barber and the new species *P. panamaensis* from Panama. Forewings, male genitalia, and other structures are illustrated. Its relationship to the genera *Saica* and *Polytoxus* (Saicinae) is discussed.

The members of the subfamily Saicinae (Heteroptera: Reduviidae) are closely related to the thread-legged bugs, Emesinae (Wygodzinsky, 1966), and are characterized by the: absence of ocelli; forecoxae more or less elongate; anterior acetabula opening downward; second segment of the rostrum more or less expanded basally; opposed surfaces of the rostrum and head armed with stiff setae, a few spine-like bristles, or spines; pronotum strongly declivent to insertion of collum; and mesoscutum and scutellum produced into an erect or horizontal spine or tubercle.

Saicinae is a relatively small subfamily with 6 genera and 24 species listed by Villiers (1943) from the Western Hemisphere. The most extensive treatment of the subfamily is that of McAtee and Malloch (1923) who presented a key to the American genera and species. Since Villiers' catalog, Monte (1943) described *Paratagalis spinosus*, a new genus and species from Brazil and Maldonado (1981) described *Buninotus niger,* a new genus and species from Panama. Both authors provided a key to the American genera.

Herein, *Pseudosaica* is described to accommodate *Saica florida* Barber and the new species, *P. panamaensis.* Illustrations of the forewings, male genitalia, and other structures are given. When label data for holotypes are cited, the letters in parentheses represent separate labels with (a) being closest to the specimen. All measurements are in millimeters.

The following abbreviations are for institutions and their curators who kindly lent material used in this study: AMNH—American Museum of Natural History, New York, R. T. Schuh; KU—University of Kansas, Lawrence, R. W. Brooks; MSS—Mississippi Entomological Museum, Mississippi State, T. L. Schiefer.

Pseudosaica, new genus

Figs. 1–9

Type species: *Pseudosaica panamaensis,* new species.

Diagnosis. This genus is characterized by the spines near the humeral angles of the pronotum, mesoscutum, and scutellum; posterior border of male hypopygium produced into a single, median, erect and barbless spine; posterior margin of abdominal sternite VII and pygidial plate of the female slope ventrocephalad; and the subconical process on the lower anterior angle of prothorax dorsocephalad of the anterior acetabulum.

Description. Body narrow and elongate; surface sericeous, interspersed with sparse to dense pilose setae. Macropterous and micropterous forms in both sexes.

Head longer than wide; bilobed, with a curved impression connecting eyes at their posterior margin. Eyes round, well separated from upper and lower margins of head. Antenna inserted level to upper margin of eyes; antennal segments slender, filiform; with fine recumbent pilosity, segments I and II also with pilose setae (length and density of pilose setae varies depending on species). Head ventrally with 1–4 pairs of long spine-like setae located ventrolaterally behind eyes opposing second rostral segment and 1–2 pairs located laterally on each jugum above rostral base. Rostral segment II bulbous, with 2 pairs of long spine-like setae opposing venter of head.

Pronotum constricted behind middle. Anterior lobe dorsally with level, subrectangular area over most of length, this area bordered laterally and anteriorly with a distinct suture, each anterolateral angle subconical; lower anterior angle in form of a subconical process (Fig. 1), and a similar subconical process at about mid-lateral level of collum. Median dorsal length of posterior lobe ⅔ or more length of anterior lobe and elevated in macropterous forms; ½ or less length of anterior lobe and not elevated in micropterous forms; with a long erect spine near humeral angles.

Mesoscutum with a long erect spine; scutellum with two processes, a small basal median erect knob, and an erect apical spine.

Hemelytra with 2 closed cells (Figs. 2, 6); micropterous forms with hemelytral pads barely attaining posterior border of metanotum; tip of hemelytra in macropterous forms extending to tip of abdomen or slightly beyond.

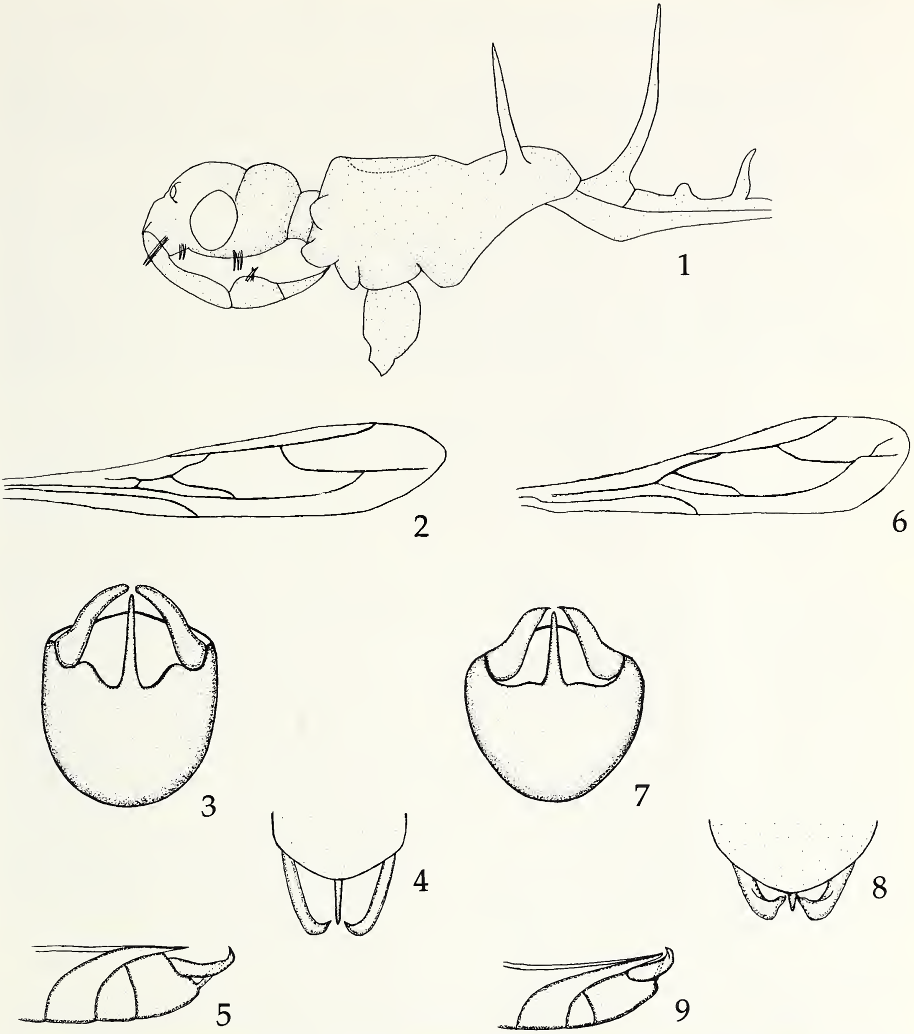
All legs lacking spines; forecoxa with apical hispid patch, foretrochanter with 2 hispid patches (1 basal and 1 apical), forefemur bowed, with 2 rows of spine-like setae (1 ventral extending along basal ⅔ and 1 on inner surface extending entire length of femur), foretibiae bowed, with 1 row of spine-like setae along basal ⅔ of inner surface; all segments of remaining legs sericeous, interspersed with long erect pilosity.

Abdomen narrow and parallel in males and macropterous females, somewhat obovate in micropterous females; posterior margin of sternite VII in females sloping ventrocephalad. Posterior border of male hypopygium produced into a single, median, erect and barbless spine; claspers curved strongly inward apically; dorsal tergite above hypopygium broadly curved. Female pygidial plate sloping ventrocephalad.

Etymology. The generic name is from the Greek *pseudos,* meaning fallacy or lie, and refers to its similarity to the genus *Saica.* The gender is feminine.

Discussion. Pseudosaica will key to *Saica* in Maldonado (1981) based on the presences of spines near the humeral angles of the pronotum and on the mesoscutum and scutellum. To facilitate generic placement of *Pseudosaica,* and to correct errors in the key, Maldonado's (1981) key to the American genera of Saicinae should be modified as follows [couplets 3–5 not repeated]:

1. Forelegs without stout spines, at most with stiff erect setae 2
– Foretibiae with one and forefemora with two, rows of stout spines 3
2. Posterior pronotal lobe with upward projecting spines or tubercles; mesoscutum and scutellum with an upward projecting apical vertical spine or tubercle; opposed surfaces of beak and head with spine-like setae 2a



Figs. 1–9. *Pseudosaica* spp. 1–5. *P. panamaensis* 1. head and pronotum, lateral view. 2. right forewing. 3. hypopygium, posterior view. 4. terminal dorsal tergite, dorsal view. 5. hypopygium, lateral view. 6–9. *P. florida* 6. right forewing. 7. hypopygium, posterior view. 8. terminal dorsal tergite, dorsal view. 9. hypopygium, lateral view.

– Pronotum unarmed; apex of mesoscutum produced into a long horizontal tapering spine; opposed surfaces of beak and head with rows of bristles ..... *Oncerotrachelus* Stål

2a. Process on lower anterior angle of prothorax acute to subacute; antennal segment II subequal to ½ the length of antennal segment I; process of male hypopygium bifurcate; posterior margin of abdominal sternum VII in females vertical to subvertical .... *Saica* Amyot and Serville

– Process on lower anterior angle of prothorax subconical; antennal segment II subequal to ⅓ the length of segment I; process of male hypopygium a single, erect barbless spine; posterior margin of abdominal sternum VII in females sloping ventrocephalad .... *Pseudosaica,* new genus

A preliminary review of the saicine genera suggests a close relationship among *Pseudosaica,* the New World genus *Saica,* and Old World genus *Polytoxus.* These genera share the following characters: 1) absence of spines on the forelegs; 2) spines near the humeral angles of the pronotum, mesoscutum, and scutellum; and 3) absence of setigerous spines.

Males of *Saica* differ from those of *Polytoxus* and *Pseudosaica* in having a bifurcate median process on the posterior border of the hypopygium (males of *Polytoxus* and *Pseudosaica* have a single median process on the posterior hypopygial border). In the genus *Polytoxus,* however, the median process of the hypopygium is more elaborate than in *Pseudosaica* and is more or less compressed laterally forming a keel along its ventral margin and hooked apically. In the genus *Pseudosaica* the median process of the hypopygium is a simple, erect spine. Further phylogenetic analysis of the saicine genera is needed to establish the relationships among these genera.

Pseudosaica panamaensis, new species
Figs. 1–5

Diagnosis. Recognized by the uniformly yellowish brown color, uniformly colored legs, unbanded femora and tibiae, and by the structure of the male hypopygium.

Description. Male, structure as described and illustrated for genus. General color yellowish brown, pale median fuscous stripe on pronotum. Uniformly clothed with pale recumbent setae intermixed with sparse pale pilosity on legs, antennal segments I and II, venter of thorax and abdomen.

Length 8.89, width of abdomen 1.13. Head: width 0.73, vertex 0.46, length 0.87. Rostrum: I, length 0.63; II, 0.29; III, 0.33. Antenna: I, length 4.00; II, 1.30; III, [broken]; IV, [broken]. Pronotum: length 1.45, basal width 1.20, humeral spines 1.00. Mesoscutum: spine 1.02. Scutellum: posterior spine 0.31. Venation as in Figure 2, veins forming pterostigma red.

Male hypopygium as in Figures 3–5, clothed with pale pilosity; process of hypopygium erect, extending between claspers, apex truncate in lateral view; claspers long, curved inward and slightly dorsad apically, covering median spine in normal repose.

Female unknown.

Holotype. Male, labeled: (a) "Canal Zone: Barro, Colorado. 19-VII-1924. N. Banks."; deposited in the AMNH. No paratypes.

Etymology. The specific name is taken from the type locality and the Latin "*-ensis,*" meaning "of."

Distribution. Known only from the type locality in Panama.

Pseudosaica florida (Barber), new combination
Figs. 6–9

Saica fusco-vittata [*sic*] Barber, 1914: 504. Preoccupied by *Saica fuscovittata* Stål, 1859: 262 [now *Polytoxus fuscovittata* (Stål)].
Saica fuscovittata McAtee and Malloch, 1923: 250; Villiers, 1943: 322.
Saica florida Barber, 1953: 142. New name for *Saica fuscovittata* Barber.

Diagnosis. Length 6.50–8.00. Characterized by a dorsal median fuscous stripe extending from the head to the apex of the abdomen, a similar stripe beginning behind the eyes and continuing along the sides of the sternum, the femora with a preapical and the tibiae with a prebasal fuscous band, and the antennae, legs, and dorsum densely clothed with long pilosity. Venation as in Figure 6, macropterous and micropterous forms in both sexes. Male hypopygium as in Figures 7–9.

Holotype. Male, labeled: (a) "Everglade Fla., Apr. 9–[19]12" (b) "TYPE" (c) "Am. Mus. Nat. Hist. Dept. Invert. Zool. No. 24261" (d) "*Saica fusco-vittata* Type ♂ Barber" (e) "HOLOTYPE SAICA FUSCOVITTATA H. G. BARBER"; deposited in the AMNH.

Specimens examined. MISSISSIPPI: 1♂, Hancock Co., Pearlington, 17-VIII-1965, H. R. Hepburn (KU); 1♀, Hancock Co., W St. Louis Bay, 22-IX-1981, M. LaSalle (MSS); 1♂, Hancock Co., W St. Louis Bay, 23-I-1982, M. LaSalle, *Spartina cynosuroides* litter-Berlese (MSS); 1♀, Hancock Co., W St. Louis Bay, 20-II-1982, M. LaSalle, *Spartina cynosuroides* litter-Berlese (MSS); 1♀, Hancock Co., W St. Louis Bay, 13-III-1982, M. LaSalle, *Juncus roemerianus* litter-Berlese (MSS).

Distribution. Known in the literature only from Florida and Virginia (Froeschner, 1988). The Mississippi records, cited above, represent a new state record. Hoffmann's (1953) record of *P. florida* (as *Saica fuscovittata*) from Virginia was based on a misidentification and represents a widely distributed undescribed species of *Saica.*

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BRACHYSTELES PARVICORNIS (COSTA), A SPECIES OF ANTHOCORIDAE NEW TO NORTH AMERICA (HEMIPTERA: HETEROPTERA)

Adam Asquith and John D. Lattin

Systematic Entomology Laboratory, Department of Entomology,
Oregon State University, Corvallis, Oregon 97331

Abstract.—The Palearctic species of Anthocoridae, *Brachysteles parvicornis* (Costa), is newly recorded from two localities in North America. It is considered an accidental introduction from Europe.

Brachysteles parvicornis (Costa) is a Palearctic species of Anthocoridae, whose natural range includes much of western Europe from Denmark to North Africa, and southeastern England to Yugoslavia with a disjunct population in the Crimean Region (Péricart, 1972). The species is found in mosses and lichens on trees, including species of *Pinus, Buxus, Juniperus* and ericaceous plants, a habitat somewhat different from most Anthocoridae, but not unlike that of many Microphysidae (Carayon, 1972; Péricart, 1972). It has also been collected in moist prairies or marshes on *Carex* spp. and other herbs. Although the species may feed on small insects and arthropods, its chief prey seems to be members of the mite suborder Oribatida (Carayon, cited in Péricart, 1972). Only a single, rather protracted generation occurs in Europe, at least throughout most of its range. Hibernation takes place in the adult stage, usually under the bark of trees in the genera *Ulmus, Larix* and *Platanus* (Péricart, 1972). Sometimes, large numbers of individuals are encountered. Mature nymphs were collected toward the end of July near Paris.

Specimens of *Brachysteles parvicornis* were discovered in the collection of the American Museum of Natural History, New York. One series of three males and one female bore the following data: [New York] Huntington L. I., Dec[ember] 13, 1925, under pine B[ar]k, F. M. Schott. The second record is a single male from: N[ew] J[ersey], Noodline, V. 11. 1925, F. M. Schott.

The genus *Brachysteles* Fieber is a member of the tribe Dufouriellini (Lyctocorinae), as recognized by Štys (1975). Six species are now recognized in the genus (Péricart, 1972:259), two of these occur in the western Palearctic, *B. parvicornis* (Costa) and *B. wollastoni* White and the others occur in the Middle East and Far East.

Brachysteles pallidus was described from the Caribbean by Reuter (1884), reported from the "Southern States" by Uhler in 1886, and included in Blatchley (1926). Barber (1939) transferred *Brachysteles pallidus* Reuter to *Paratriphleps* Champion where it now remains, and thus the genus *Brachysteles* is not considered to occur in North America (Henry, 1988).

Brachysteles parvicornis closely resembles North American species of *Cardiastethus* Fieber. It is a small (2.1–2.5 mm total length) species, with the head and pronotum dark chestnut brown and the hemelytra yellowish brown (Fig. 1). The dorsum is thickly clothed with long, semierect golden pubescence. In Herring's (1976) key to

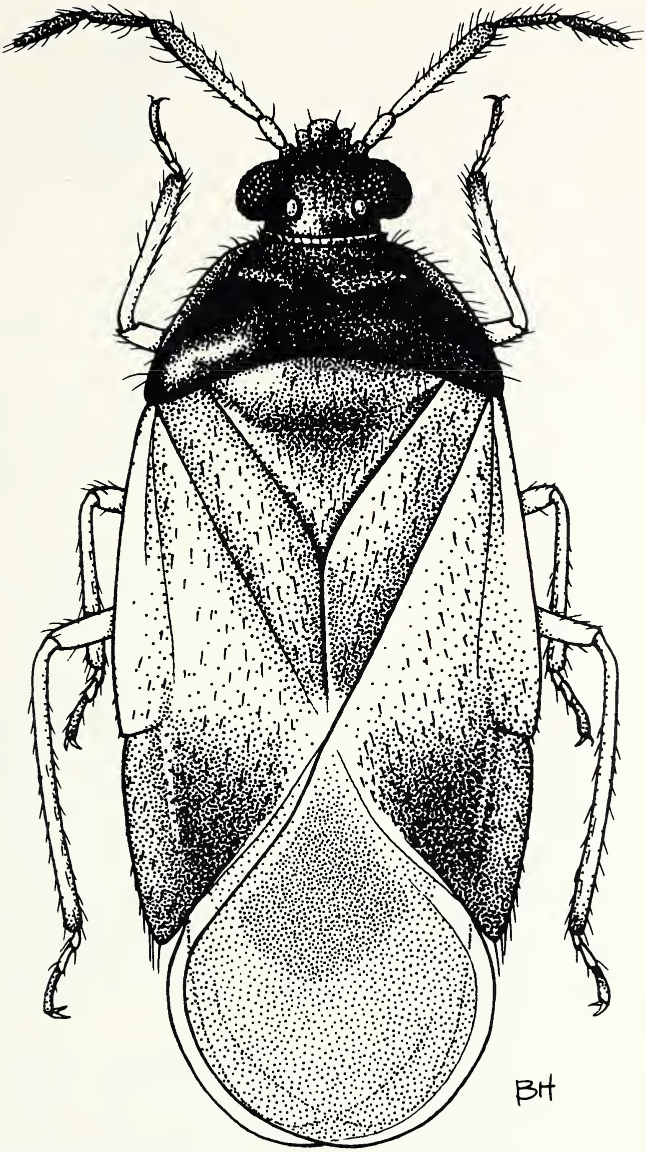
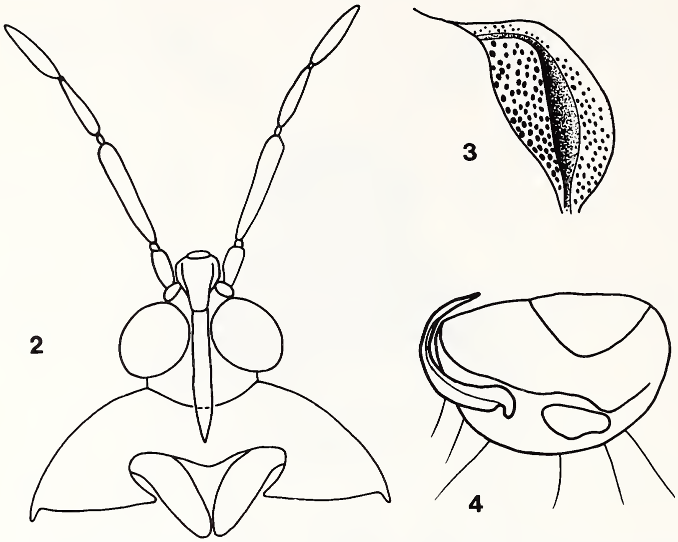


Fig. 1. *Brachysteles parvicornis.* Dorsal habitus of adult male.

the genera of North American Anthocoridae, *B. parvicornis* will run to *Cardiastethus.* It may be distinguished from *Cardiastethus* principally by the short rostrum, which does not reach the procoxal cavity (Fig. 2). In all North American *Cardiastethus,* the rostrum reaches at least to the procoxae. *Brachysteles parvicornis* also has an extremely short head, with the first antennal segment extending beyond the apex of the tylus. In species of *Cardiastethus,* the first antennal segment at most only reaches the



Figs. 2–4. *Brachysteles parvicornis.* 2. Ventral view, showing relative length of rostrum and antennal segments. 3. Peritreme of left metathoracic scent gland. 4. Dorsal view of male genital capsule and clasper.

tip of the tylus. The scent gland of *B. parvicornis* has the general shape of that found in *Cardiastethus,* but differs in that the anterior extension of the channel is well below the dorsal edge of the peritreme (Fig. 3). In *Cardiastethus,* this extension lies along the dorsal edge of the peritreme, often as a raised ridge. The male clasper of *B. parvicornis* is very similar to those of North American *Cardiastethus* (Fig. 4), but differs in being shorter and thicker than *C. cavicollis* Blatchley, *C. borealis* Kelton and *C. assimilis* (Reuter).

Péricart (1972) provided a detailed discussion of this species. Males are macropterous with the tip of the wing extending beyond the apex of the abdomen. Females may be macropterous, submacropterous (wing tip just reaching apex of abdomen), or brachypterous. All specimens examined from North America (males and females) were macropterous.

Because this species is known only from two collections near metropolitan sea ports, we view this as a European introduction. The occurrence of specimens from two different localities suggests the possibility of established populations, although we have not yet seen additional material. This is a small, inconspicuous bug, and easily overlooked in the field. Several other species of Anthocoridae are presently considered accidental introductions into North America, including *Orius minutus* (L.) in the Pacific Northwest (Tonks, 1953), *Anthocoris confusus* Reuter in the Northeast (Anderson and Kelton, 1963), *Anthocoris nemoralis* (F.) in the Pacific Northwest and Ontario (Anderson and Kelton, 1963), *Temnostethus gracilis* Horváth and *Acompocoris pygmaeus* (Fallén) into the Northeast (Kelton, 1977).

Because both the historical and present day distributions of many species are poorly known, their status as natural residents of North America or as introductions remains unresolved. For example, *Xylocoris galactinus* (Fieber), *X. cursitans* (Fallén), *Dufouriellus ater* (Dufour) and *Lyctocoris campestris* (F.) occur in North America and also occur in the Palearctic region (Péricart, 1972; Kelton, 1978).

Brachysteles parvicornis could be a native North American species, occurring naturally in both Europe and the eastern United States, although this is unlikely. Alternatively, the specimens could represent an undescribed species of North American *Brachysteles* closely related to *parvicornis*. There are several examples of amphi-Atlantic species pairs of Heteroptera (Schaefer and Calabrese, 1980). In Europe, *Brachysteles parvicornis* is polymorphic with macropterous, submacropterous and brachypterous forms, while only macropterous specimens have been collected in North America. The taxonomy of these morphs and different populations is still equivocal (J. Péricart, pers. comm.). The confirmation of the North American record was based upon a female specimen. The distribution and relationships of the Dufouriellini in North America are imperfectly known. For example, several of the eastern species of *Cardiastethus* are known only from the type localities. Careful collecting, with attention to phenology, habitat and habits will be required to clarify these problems.

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PSALLUS LEPIDUS FIEBER, *DERAEOCORIS PICEICOLA* KNIGHT, AND *DICHROOSCYTUS LATIFRONS* KNIGHT: NEW RECORDS OF PLANT BUGS IN EASTERN NORTH AMERICA (HETEROPTERA: MIRIDAE)

A. G. Wheeler, Jr. and E. Richard Hoebeke

Bureau of Plant Industry, Pennsylvania Department of Agriculture,
Harrisburg, Pennsylvania 17110, and
Department of Entomology, Cornell University,
Ithaca, New York 14853

Abstract.—The first U.S. record of the Palearctic *Psallus lepidus* Fieber is given. Previously known in the Nearctic region only from the Canadian Maritime Provinces, this phyline is reported from Massachusetts on Old World species of ash, *Fraxinus*. The deraeocorine *Deraeocoris piceicola* Knight and mirine *Dichrooscytus latifrons* Knight are recorded from spruce, *Picea* spp.: the former in Connecticut, Maine, New York, and Vermont and the latter from Maine, New Hampshire, New York, and Vermont. These are the first records of the western *Deraeocoris piceicola* in eastern North America and the first northeastern U.S. records for *Dichrooscytus latifrons,* not previously known east of Michigan in the United States. *Psallus lepidus* is adventive in eastern North America, whereas *Dichrooscytus latifrons* and *Deraeocoris piceicola* are considered indigenous in the East.

Recent collecting in the northeastern states has produced the first U.S. record of *Psallus lepidus* Fieber, a Palearctic ash plant bug known in the New World only from Nova Scotia and Prince Edward Island (Kelton, 1983). This phyline is here reported from Massachusetts. We also report the native *Deraeocoris piceicola* Knight from Connecticut, Maine, New York, and Vermont and *Dichrooscytus latifrons* Knight from Maine, New Hampshire, New York, and Vermont. The former is a spruce-inhabiting mirid recorded previously in western North America; the latter bug, although widespread on spruce and other conifers in eastern Canada, is known in the eastern U.S. only from Michigan's Upper Peninsula. Voucher specimens of all species have been deposited in the collections of Cornell University (CUIC), Pennsylvania Department of Agriculture (PDA), and National Museum of Natural History (USNM).

Psallus lepidus Fieber

This dark red to reddish-brown phyline occurs throughout most of the British Isles, continental Europe, and North Africa (Carvalho, 1958). European ash, *Fraxinus excelsior* L., is the primary host (e.g., Butler, 1923; Southwood and Leston, 1959). *Psallus lepidus* may be an ash specialist that uses other plants only for adult feeding; Stichel (1956) noted that it is sometimes found on other deciduous trees. Eggs overwinter on host trees, and adults appear in mid-June in England and may be present until early September (Butler, 1923; Wagner, 1952; Southwood and Leston, 1959).

The last-named authors suggested the possibility of two annual generations in Britain; however, our data indicate that, at least in Massachusetts, this mirid is univoltine.

Kelton (1983) first reported *P. lepidus* from the New World. Records from European ash, dating from 1966, were cited for three localities in Nova Scotia and from Charlottetown, Prince Edward Island. Kelton provided an adult diagnosis, illustrations of the male genitalia, and characters that allow *P. lepidus* to be distinguished from the similar *P. flavellus* Stichel, an adventive plant bug found coexisting with *P. lepidus* on European ash in Nova Scotia. Wagner (1975) also described *P. lepidus* and figured the male genitalia; a color illustration of an adult female is available in Reuter (1878).

We collected late instars (4♀♀ were reared) of *P. lepidus* on European ash at the Arnold Arboretum (Harvard University), Jamaica Plain, Suffolk Co., Massachusetts, 27 May 1988. Nymphs also were present on other Old World ash species, including *F. angustifolia* Vahl (and subspecies *oxycarpa* Willd.) and *F. pallisae* Willm. When placed in rearing containers, the nymphs fed mainly on fruits (samaras), which they discolored and coated with dark spots of excrement. Fourth and fifth instars were found on the same ash trees the following season; 11 males and 4 females were reared from material collected 26 May 1989.

The second year, we noticed that seeds of host trees were discolored and spotted with excrement. This apparent preference for fruits contrasts with native ash plant bugs, *Tropidosteptes* spp. (Mirinae), which feed on foliage, causing chlorosis, leaf curl, and sometimes defoliation (Dickerson and Weiss, 1916; Leonard, 1916; Usinger, 1945).

Deraeocoris piceicola Knight

Knight (1927) described this deraeocorine from Colorado, where it was collected on native spruce, *Picea* sp., infested with gall-forming Adelgidae, and from British Columbia. It was not mentioned again until Kelton (1980) recorded it from white spruce, *P. glauca* (Moench.) Voss, in Alberta, noting that it probably preys on adelgids. In Oregon, Razafimahatratra (1980) recorded it from Engelmann spruce, *P. engelmanni* Parry ex Engelm.; Pacific silver fir, *Abies amabilis* Forbes; noble fir, *A. procera* Rehd.; and lodgepole pine, *Pinus contorta* Dougl. ex Loud. He noted that predation had been observed on aphids and adelgids in the field and laboratory. Although Kelton (1980) implied that *D. piceicola* had been recorded from the Yukon Territory, no reference or localities were cited. Through the courtesy of Michael D. Schwartz, we are able to provide the following records: YUKON TERRITORY: Burwash Landing, 27 July 1948, Mason & Hughes; Carcross, 1 August 1982, L. A. Kelton; Dawson, 21 July 1982, ex spruce, LAK; Destruction Bay, 26 July 1982, ex spruce, LAK; Haines Jct., 2 August 1948, swept ex willow, Mason & Hughes; Morley R., 9 August 1982, ex alder and lodgepole, LAK; North Fork of Klondike R., no date; Rancheria, 11 August 1982, ex lodgepole and spruce, LAK; Tagish, 17 July and 11 August 1983, ex spruce, LAK; Watson Lk., 13 August 1982, ex larch, LAK; and Whitehorse, 16 July 1982, ex spruce, LAK.

On 18 June 1988, we collected pinkish nymphs of an unfamiliar *Deraeocoris* species at Watertown, Jefferson Co., New York. Fourth and fifth instars were common on white spruce infested with aphids and adelgids. Nymphs were reared on aphid-infested spruce terminals, and the 12 adults (7♂♂, 5♀♀) that matured were confirmed by T. J. Henry as the western *D. piceicola*. We also reared adults (4♂♂, 2♀♀) of this species from late instars collected 18 June on white spruce on the St. Lawrence University campus at Canton, St. Lawrence Co., New York. Two females were collected 31 July 1988 on white spruce at Alfred, Allegany Co., New York.

In 1989, one of us (AGW) and Thomas J. Henry collected *D. piceicola* (adults and/or nymphs) from the following additional localities: CONNECTICUT: *Hartford Co.:* Marlborough, 15 July, *P. glauca.* MAINE: *Androscoggin Co.:* Bates College, Lewiston, 30 June, *P. glauca*; Rte. 202, Greene, 1 July, *P. glauca. Aroostook Co.:* Rte. 1 N. of Monticello, 5 July, *P. glauca*; Univ. of Maine, Presque Isle, 5 July, *P. glauca. Cumberland Co.:* Bowdoin College, Brunswick, 29 June, *P. glauca. Kennebec Co.:* Colby College, Waterville, 2 July, *P. glauca, P. pungens,* and *P. abies. Penobscot Co.:* Univ. of Maine, Orono, 3 July, *P. abies.* NEW YORK: *Jefferson Co.:* Watertown, 10 June, *P. glauca. Oswego Co.:* Pulaski, 10 June, *P. glauca. Schoharie Co.:* SUNY–Cobleskill, 23 July, *P. glauca.* VERMONT: *Bennington Co.:* Rte. 67, NW of Bennington, 25 June, *P. glauca.*

Dichrooscytus latifrons Knight

Knight apparently collected this mirine with *Deraeocoris piceicola* in 1925, but did not describe it as a new species for more than 40 years; holotypes of both species were taken 20 August 1925 at Pingree Park, Colorado (Knight, 1927, 1968). A host was not mentioned, but it almost certainly was the same native spruce on which *D. piceicola* was taken. Knight (1968) also based his original description of *D. latifrons* on specimens from Arizona. Kelton (1972) added records from Alberta, British Columbia, Manitoba, Saskatchewan, and Yukon Territory, in addition to New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, and Quebec in eastern Canada. He stated that white spruce was the most common host and that smaller numbers had been taken on subalpine fir, *Abies lasiocarpa* (Hook.) Nutt.; lodgepole pine, *Pinus contorta*; and western white pine, *P. monticola* Dougl. ex D. Don.

Kelton's (1972) record from Sault Saint Marie, Michigan, has remained the easternmost for the United States. On the Clarkson University campus, Potsdam, St. Lawrence Co., New York, we collected 2♂♂ and 2♀♀, 18 June 1988, on white spruce. The following day on the St. Lawrence campus, Canton, New York, we collected fifth instars (5♂♂, 3♀♀ were reared) and two teneral females. They were present on white spruce with nymphs of *Deraeocoris piceicola.*

As with the previous species, AGW and T. J. Henry collected *D. latifrons* from additional localities in 1989: MAINE: *Androscoggin Co.:* Rte. 202, Greene, 1 July, *P. glauca. Aroostook Co.:* Rte. 1, N of Monticello, 5 July, *P. glauca*; Univ. of Maine, Presque Isle, 5 July, *P. glauca. Cumberland Co.:* Bowdoin College, Brunswick, 29 June, *P. glauca. Kennebec Co.:* Belgrade, 1 July, *P. pungens*; Colby College, Waterville, 2 July, *P. glauca, P. pungens* and *P. glauca. Penobscot Co.:* Hampden, 3 July, *P. glauca*; Univ. of Maine, Orono, 3 July, *P. glauca. York. Co.:* Kennebunk, 29 June, *P. glauca.* NEW HAMPSHIRE: *Grafton Co.:* Hanover, 26 June, *P. glauca.* VERMONT: *Bennington Co.:* Rte. 67, NW of Bennington, 25 June, *P. glauca.* An additional unpublished Vermont record, provided by M. D. Schwartz, is: *Essex Co.:* North Concord, 8 July 1978, ex spruce, L. A. Kelton.

DISCUSSION

New World populations of *P. lepidus* almost certainly are adventive. Kelton (1983) considered it likely that this Old World mirid had been accidentally introduced with nursery stock. Before the imposition of strict quarantine legislation, millions of seedlings and other plants entered the United States each year (e.g., Howard, 1895; Marlatt, 1911). Arboretum records show that the European ash harboring *P. lepidus* was brought in, apparently as a seedling, from Surrey, England, in 1886. Other hosts of the bug at the Arnold Arboretum were imported as seed (E. Johnson, pers. comm.).

The occurrence of *Deraeocoris piceicola* and *Dichrooscytus latifrons* in northern New York and New England may represent indigenous populations of boreal forest Miridae. If so, it is somewhat surprising that neither species was recorded in Parshley's (1917) list of New England Heteroptera or in Knight's (1923) Miridae of Connecticut and other northeastern states. White spruce, a host of both species in the Northeast, is native from Labrador to Alaska and south to New York, Minnesota, and Montana (Everett, 1981); it is a characteristic tree throughout the Canadian boreal forest (Scudder, 1979). Kelton (1972) collected *Dichrooscytus latifrons* at several localities in eastern Canada and reported a nearly transcontinental distribution across Canada. *Deraeocoris piceicola* has not been recorded east of Colorado. Although Kelton did not mention the occurrence of this species in eastern North America in his (1980) review of mirids in the Prairie Provinces, he may have been aware of unpublished records. No material from eastern North America, however, is available in the Canadian National Collection, Ottawa (M. D. Schwartz, pers. comm.). It is possible, of course, that *D. piceicola* has been introduced to the East on Colorado or white spruce and that the eastern distribution of both species has been extended through shipments of spruce nursery stock.

ACKNOWLEDGMENTS

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DESCRIPTION OF TWO NEW SPECIES OF *POLYCENTROPUS* FROM ALABAMA WITH A CHECKLIST OF THE *POLYCENTROPUS CONFUSUS* SPECIES-GROUP (TRICHOPTERA: POLYCENTROPODIDAE)

Steven W. Hamilton, Steven C. Harris, and Paul K. Lago
Center for Field Biology and Department of Biology,
Austin Peay State University, Clarksville, Tennessee 37044;
Aquatic Biology Program, Department of Biology, University of Alabama,
Tuscaloosa, Alabama 35487; and
Department of Biology, University of Mississippi,
University, Mississippi 38677

Abstract.—Two new species of the *Polycentropus confusus* species-group are described. *Polycentropus alabamensis,* n. sp. is found in small streams primarily in northeastern Alabama and *P. vernus,* n. sp. was collected from small headwater and intermittent streams of the Cumberland Plateau. Also included is a checklist of the *P. confusus* species-group. This group comprises 14 species in addition to the new species described herein. All species of this group occur in eastern North America.

Until recently very little was known about the trichopteran fauna of Alabama and the Southeastern United States, in general. Surveys of Alabama caddisflies conducted by one of us (SCH) since 1981 have revealed a large number of species in this state including many undescribed species. Herein we describe two new species of the *Polycentropus confusus* species-group.

The species of this group are easily recognized by features of the male terminalia (cf. Figs. 1, 2). These features include the long, thin, curved dorsal processes (d.p.) of the preanal appendages (pre. app.), the shorter, slightly curved intermediate appendages (int. app.), the membranous combined segments IX and X (IX+X), the erect dorsobasal process on the inferior appendages (inf. app.), and the curved, relatively simple phallus containing a large, tubular phallic sclerite. (ph. sc.).

Including the two new species, this group comprises 16 described species variously distributed throughout eastern North America. An additional new species has been discovered in Arkansas (D. E. Bowles, pers. comm.) and may be endemic to the highlands of that region. Following the descriptions, we provide an alphabetized checklist of the species of the *confusus* species-group and the Provinces and States from which they are known (Hamilton, 1986).

The holotypes and several of the paratypes of both new species are deposited in the National Museum of Natural History, Washington, D.C. The other paratypes are deposited in the insect collections of the University of Alabama, Clemson University, Illinois Natural History Survey, and those of the authors. Most specimens were collected at ultraviolet lights, others, including a male metamorphotype were hand-collected, usually with a sweep net. All material is preserved in 80% ethanol.

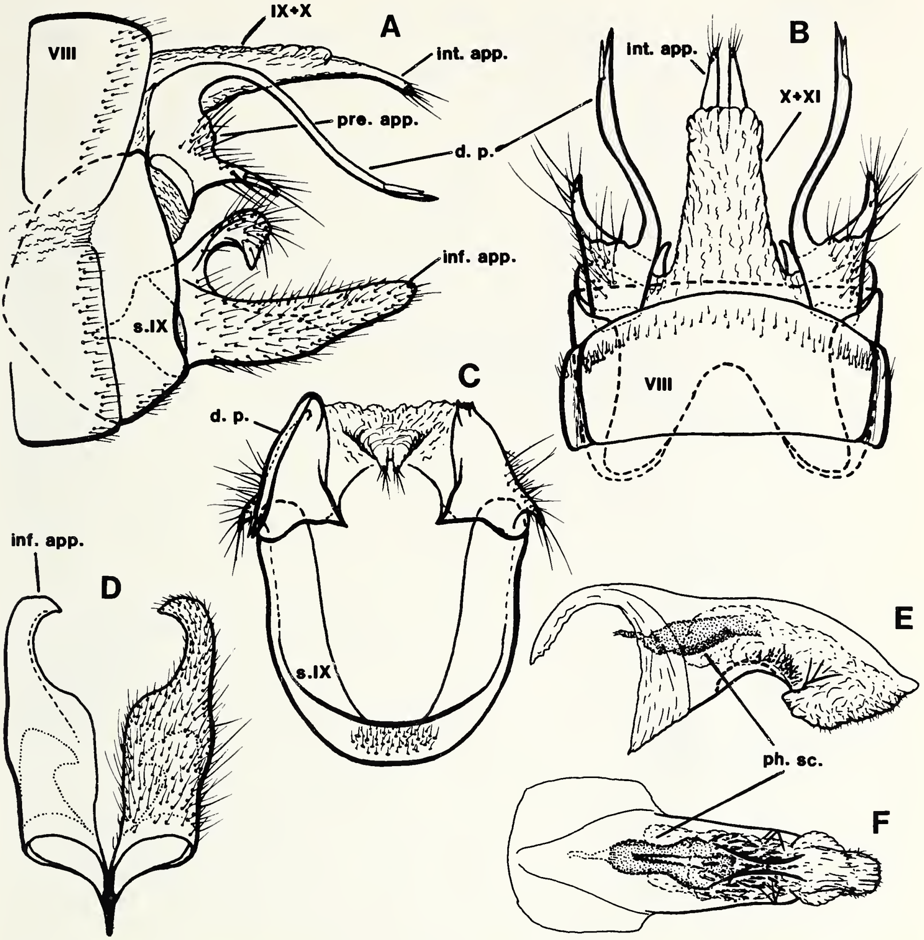

Fig. 1. *Polycentropus alabamensis,* male terminalia. A. Left lateral. B. Dorsal. C. Caudal. D. Inferior appendage, ventral. E. Phallus, left lateral. F. Phallus, dorsal. Abreviations: d.p., dorsal process of preanal appendage; inf. app., inferior appendage; int. app., intermediate appendage; IX+X, combined ninth and tenth segments; ph. sc., phallic sclerite; pre. app., preanal appendage; s.IX, ninth sternite; VIII, eighth tergite.

Polycentropus alabamensis Hamilton, Harris and Lago, new species
(Fig. 1, A–F)

Polycentropus new species 12, Hamilton, 1986:70–71, fig. 4.2.
Polycentropus n. sp. (nr. *elarus*), Lago and Harris, 1987:258.

Male. Fore wing length 5.2–7.6 mm. Body pale brown to yellow below, dorsum of head and thorax darker, with long, erect setae; fore wings clothed with fine, brown setae, with numerous scattered intervenal areas of pale setae (in alcohol). Male terminalia as in Figure 1. Abdominal sternite IX (s.IX), large, semicircular in lateral

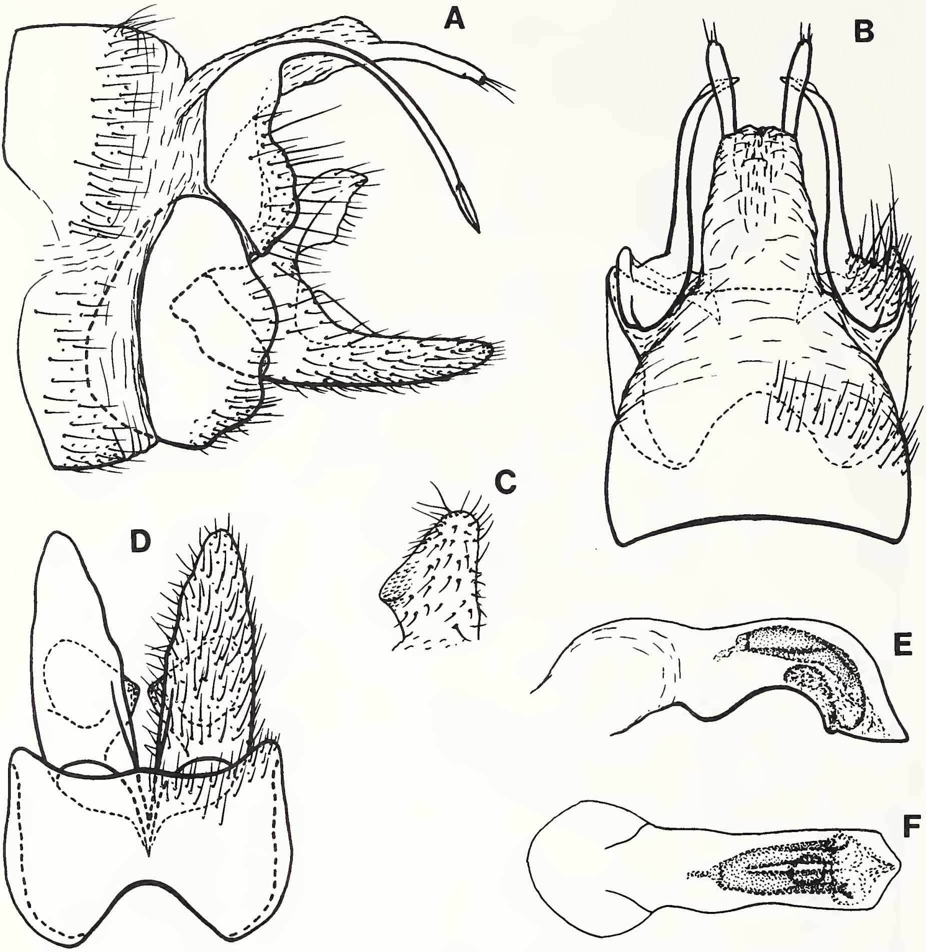

Fig. 2. *Polycentropus vernus,* male terminalia. A. Left lateral. B. Dorsal. C. Dorsobasal arm of inferior appendage, posterior. D. Ventral. E. Phallus, left lateral. F. Phallus, dorsal.

aspect, anterior margin rounded, posterior margin nearly straight; in ventral aspect anterior margin deeply emarginate. Intermediate appendages (int. app.) apically free, slightly decurved; proximally fused to venter of membranous segment IX and X (IX+X). Body of each preanal appendage (pre. app.) short, with prominent, acute caudoventral point, dorsal process (d.p.) slightly sinuate, decurved basad, recurved distad. Each inferior appendage (inf. app.) with elongate ventral portion, in lateral aspect distal half slightly narrower than basal half, in ventral aspect greatly narrowed beyond middle with apex acute, curved mesad; dorsobasal arm prominent, in lateral aspect "neck" long and thin, enlarged apex "goose-head" shaped with acute ventrally directed point. Phallobase tubular, moderately decurved, narrowed apicad, larger basad, with mesoventral concavity, apicodorsal area constricted; distal membrane with microspines; phallic sclerite moderately long, in dorsal aspect narrowed at middle, enlarged slightly distad, with narrowed distal portion.

Discussion. This species is most closely related to *P. elarus* as evidenced by the similar apical narrowing of the inferior appendages, the shape and size of the dorsobasal arm of the inferior appendage, the similar shape of the preanal appendages, and the sinuate curvature of the dorsal process of the preanal appendage. *Polycentropus alabamensis* can be distinguished from *P. elarus* and the other *confusus* group species by the prominent, acute, caudoventral point on each preanal appendage and the narrowed, incurved apex of each inferior appendage.

This species is most commonly collected in small streams of the Cumberland Plateau physiographic region, except for several specimens taken in Choctaw County which is in the Coastal Plain physiographic region. This area of Choctaw County, the Red Hills, is hilly and atypical of the region both in physiography and fauna.

Types: *Holotype.* Male, United States: Alabama: Lawrence County: tributary to Bee Branch below falls, Bankhead National Forest, T8S-R9W-Sec. 26, 28.v.1985, S. C. Harris. *Paratypes.* Same data as holotype, 8 males; same data as holotype except Bee Branch, 2 males; Marshall County: Thompson Falls on Mink Creek, 3 mi E. of Arab, 28.v.1985, 4 males, P. E. O'Neil and R. L. Smith; Tuscaloosa County: Little Tyro Creek, 6 mi SE Berry, T17S-R10W-Sec. 11, 18.v.1982, 1 male and 26.v.1982, 1 male, S. C. Harris and P. E. O'Neil; Hurricane Creek on unmarked Co. Rd., 3 mi SE Brookwood, 7.v.1985, 2 males, S. C. Harris; same data except, 7.vi.1985, 2 males, P. E. O'Neil and R. L. Smith; Keeple Creek near jct. with Hurricane Cr., 3.5 mi SW Brookwood, 7.v.1984, 1 male, P. E. O'Neil and R. L. Smith; Fayette County: Tyro Creek on unmarked Co. Rd., 3.5 mi S Berry, 25.vii.1983, 1 male, S. C. Harris; Blue Water Creek at Bluewater Trace Road, 25.v.1983, 2 males, S. C. Harris; Franklin County: Dismal Branch at Dismal Wonders Garden, 25.vi.1983, 2 males, S. C. Harris; tributary to Dismal Branch at Dismal Wonders Garden, 25.vi.1983, 2 males, S. C. Harris; same data except 29.vi.1983, 1 male, S. C. Harris; Dismal Branch at falls, in Dismal Wonders Garden, 29.vi.1983, 1 male, S. C. Harris; Dismal Branch below canyon at Dismal Wonders Garden, 29.vi.1983, 1 male, S. C. Harris; Choctaw County, spring along Hwy. 17, 4 mi SW Butler, 6.vi.1983, 3 males, S. C. Harris and P. E. O'Neil; same data except 16.v.1982, 6 males, S. C. Harris; Jefferson County: Dry Creek at Co. Hwy. 132 near Trussville, 28.v.1983, 2 males, S. C. Harris; Cahaba River at Interstate-59, 26.vi.1985, 1 male, P. E. O'Neil.

Etymology. Latin, "from Alabama." All specimens currently known are from Alabama.

Polycentropus vernus Hamilton, Harris and Lago, new species
(Fig. 2, A–F)

Polycentropus n. sp. (nr. *chelatus*), Lago and Harris, 1987:258.

Description: *Male.* Fore wing length 2.8–3.6 mm. Body pale brown to yellow below, dorsum of head, meso- and methathoraces darker with long, erect setae, prothorax lighter; fore wings clothed with fine brown setae, with scattered area of pale setae in distal, intervenal areas (in alcohol). Male terminalia as in Figure 2. Abdominal sternite IX large, semicircular in lateral aspect, anterior margin more curved ventrad, posterior margin moderately sinuate; in ventral apsect anterior margin deeply emarginate. Intermediate appendages apically free, slightly decurved, proximally fused to venter of membranous segments IX and X. Body of preanal appendage short with broad, very shallow emargination of posterior margin; dorsal process long and evenly decurved. Each inferior appendage with elongate ventral protion, in lateral aspect only slightly narrowed distad, in ventral aspect narrowing gradually distad; dorsobasal arm of the inferior appendage prominent, in lateral aspect "neck" short and membranous on posterior surface, enlarged apex with in-turned blade-like portion longer than "neck," apex curved slightly posteriad, in posterior aspect this part triangular; mesal point with numerous small spines. Phallobase tubular, moderately decurved, with ventral swelling basad, apex slightly pointed in dorsal aspect, internally with spicule-covered membrane; phallic sclerite moderately elongate, in dorsal apsect slightly narrowed posteriad.

Discussion. This new species is most similar to the *confusus* group species with the more elongate "head" or enlargement on the dorsobasal arm of the inferior appendage. These species are *P. chelatus, P. confusus, P. floridensis, P. neiswanderi, P. pentus,* and *P. thaxtoni.* Owing to the suggestion of one of us (SWH), this species has been listed as "*P.* n. sp. (nr. *chelatus*)" by Lago and Harris (1987), but it appears to be more similar to *P. pentus* and *P. floridensis.* The new species can be separated from the above mentioned species through a combination of several characters including the shape of the body of the preanal appendage, the size and shape of the dorsal arm of the inferior appendage, the length and shape of the ventral arm of the inferior appendage, and the shape of the phallus. On *Polycentropus vernus* the emargination of the body of the preanal appendage is very shallow compared to *P. floridensis* and *P. thaxtoni* and is also different from that of other members of the *confusus* group. The phallus of the new species with its basoventral swelling is only similar to *P. floridensis* and *P. pentus.* The shape of the inferior appendage can be used to separate these two species from *P. vernus.* In *P. pentus* the dorsobasal arm of the inferior appendage is strongly curved, almost sickle-shaped, while in the new species it is triangular. Also, in *P. pentus* the mesobasal tooth on the basal arm of the inferior appendage is little developed, while it is well developed in both *P. vernus* and *P. floridensis.* While the dorsobasal arm of *P. floridensis* is similar to that of the new species, the lateral margin of the basal arm is more excavated, exposing the relatively prominent mesobasal tooth.

Polycentropus vernus has been collected most frequently in small intermittent or headwater streams of the Cumberland Plateau physiographic region during Spring.

Types: *Holotype.* Male, United States: Alabama: Fayette County: small intermittent stream entering Wallace Branch at headwaters, 5.5 mi SE Berry, T16S-R10W-Sec. 36, sweep net, 16.v.1982, S. C. Harris. *Paratypes.* Fayette Co., same data as holotype, 10 males; same data except 26.iv.1983, 1 male; same data except 26.iv.1983, 1 male metamorphotype; same data except 15.iii.1984, 1 male; same data except 11.iv.1984, 9 males; same data except Wallace Branch at headwaters, 5 mi SE Berry, 16.v.1984, 2 males; Tuscaloosa Co., Wallace Branch, 5 mi S Berry, T17S-R10W-Sec. 10, 28.iv.1982, 1 male, S. C. Harris; same data except 25.iv.1982, 1 male; Little Tyro Creek, 6 mi SE Berry, T17S-R10W-Sec. 11, 16.v.1984, 2 males, P. E. O'Neil and R. L. Smith; same data except 19.iii.1982, 1 male; small intermittent stream entering Little Tyro Creek, 6 mi SE Berry,T17S-R10W-Sec. 11, 26.iv.1983, 1 male, S. C.

Harris; Tyro Creek on unmarked Co. Rd., 3.5 mi E New Lexington, T17S-R10W-Sec. 15, 28.iv.1982, 1 male; Walker County: Wolf Creek off Hwy 102, 7 mi S Carbon Hill, 26.iv.1983, 1 male, S. C. Harris and P. E. O'Neil.

Etymology: Latin, "of springtime," referring to this species being most frequently collected in early Spring.

Polycentropus confusus Species-Group Checklist

P. alabamensis Hamilton, Harris and Lago, n. sp.—U.S.: Alabama

P. blicklei Ross and Yamamoto, 1965—Canada: Ontario, Quebec; U.S.: Alabama, Delaware, Georgia, Kentucky, Maryland, Mississippi, New Hampshire, New Jersey, New York, Pennsylvania, South Carolina, Tennessee, Virginia

P. carlsoni Morse, 1971—U.S.: Alabama, South Carolina

P. carolinensis Banks, 1905—Canada: Quebec; U.S.: Mississippi, New Hampshire, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia

P. chelatus Ross and Yamamoto, 1965—U.S.: Indiana, Tennessee

P. chenoides Ross and Yamamoto, 1965—U.S.: Delaware, New York

P. centralis Banks, 1914—Canada: Newfoundland; U.S.: Alabama, Arkansas, Illinois, Indiana, Kansas, Missouri, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Wisconsin

P. confusus Hagen, 1861—Canada: Ontario, Quebec; U.S.: Alabama, Arkansas, Delaware, Georgia, Indiana, Kentucky, Maine, Massachusetts, Michigan, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Tennessee, Virginia, West Virginia, Wisconsin

P. elarus Ross, 1944—Canada: Ontario, Quebec; U.S.: Alabama, Indiana, Kentucky, Massachusetts, New Hampshire, New York, Ohio, Pennsylvania, Tennessee, Virginia

P. floridensis Lago and Harris, 1983—U.S.: Alabama, Florida

P. maculatus Banks, 1908—Canada: Newfoundland, Ontario, Quebec; U.S.: Kentucky, Maine, Massachusetts, New Hampshire, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia

P. neiswanderi Ross, 1947—U.S.: Ohio

P. pentus Ross, 1941—Canada: Ontario, Quebec; U.S.: Illinois, Maine, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Tennessee, West Virginia, Wisconsin, Wyoming

P. pixi Ross, 1944—U.S.: Massachusetts, New Hampshire, New Jersey, New York, Virginia

P. thaxtoni Hamilton and Holzenthal, 1986—U.S.: Georgia

P. vernus Hamilton, Harris and Lago, n. sp.—U.S.: Alabama

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MACROCHLIDIA, NEW GENUS: THE DESCRIPTION OF A REMARKABLY LARGE TORTRICID MOTH (LEPIDOPTERA: TORTRICIDAE: CHLIDANOTINAE)

John W. Brown[1]

Entomology Department, National Museum of Natural History,
Smithsonian Institution, Washington, D.C. 20560

Abstract.—*Macrochlidia,* new genus, is described from Colombia and Venezuela; it includes two species: *M. major,* new species, and *M. minor,* new species. Females of *M. major* are the largest moths in the Chlidanotinae (Tortricidae). The male genitalia of *Macrochlidia* are characterized by fusion of the hami and socii; the characteristic chlidanotine "asteroid" signum of the female is greatly reduced. The Neotropical fauna of Chlidanotini currently includes 25 described species placed in six genera; over half of the Neotropical Chlidanotini species represented in major collections worldwide are undescribed.

Tortricids are comparatively small moths included in the broad category "Microlepidoptera." The largest individuals in the family include females of *Anacrusis* Zeller (Atteriini) and *Cerace* Meyrick (Ceracini), with forewing lengths reaching approximately 21 and 26 mm respectively. I recently discovered a series of an undescribed Chlidanotini in the collection of the British Museum (Natural History). The largest female has a forewing length of approximately 21 mm; it is the largest species in the subfamily Chlidanotinae. A new genus, *Macrochlidia,* is described below to accommodate this extraordinary species, *M. major,* new species, and a second new species, *M. minor.*

Depositories are abbreviated in the text as follows: BMNH, British Museum (Natural History), London, England; USNM, United States National Museum, Smithsonian Institution, Washington, D.C. A survey of collections at the following institutions revealed an abundance of undescribed Chlidanotini but failed to produce additional specimens of the new genus: American Museum of Natural History, New York, New York (AMNH); Academy of Natural Sciences, Philadelphia, Pennsylvania (ANSP); California Academy of Sciences, San Francisco, California (CAS); Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (CMNH); Natural History Museum of Los Angeles County, Los Angeles, California (LACM); San Diego Natural History Museum, San Diego, California (SDNHM); Essig Museum of Entomology, University of California, Berkeley (UCB).

Dissection procedures followed those presented by Powell (1964). Nomenclature for genitalic structures and wing venation follows Horak (1984); abbreviations are as follows: DC = discal cell; FW = forewing; HW = hindwing.

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[1] Present address: Entomology Section, Natural History Museum of Los Angeles County, 900 Exposition Blvd., Los Angeles, California 90007.

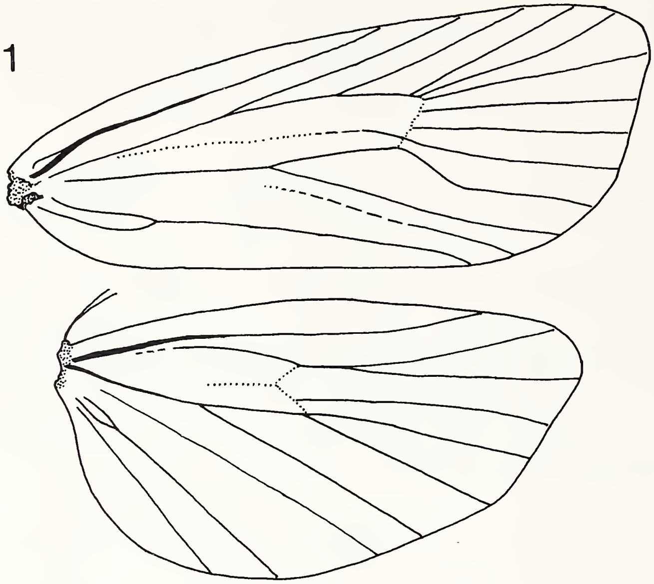
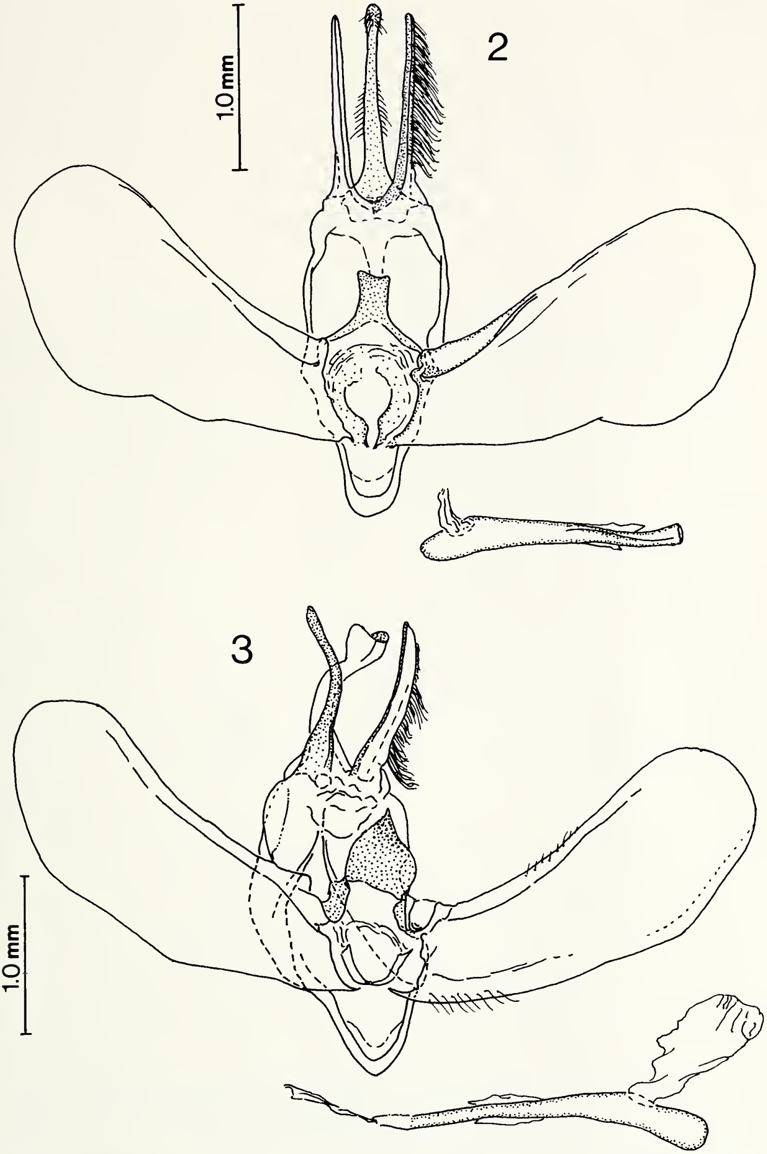


Fig. 1. Wing venation of *Macrochlidia major* female.

Macrochlidia, new genus

Head: Antenna simple, slightly flattened in distal 0.4; conspicuously thicker in male; cilia extremely short. Labial palpi long; segment II upturned, with long, bushy scales ventrally; segment III ca. 0.45 as long as II, slender, exposed, with appressed scales. Maxillary palpi inconspicuous. Scaling on frons smooth below mid-eye, roughened above. Ocelli small. Chaetosema poorly developed, with few setae. Thorax: Smooth scaled with upraised tegulae (probably an artifact of spreading). No specialized structures on legs. Forewing: Venation as in Figure 1. Length 2.2–2.3× greatest width; length of DC ca. 0.65× FW length; width of DC ca. 0.15 its length; CuA_2 originating ca. 0.6 along length of DC; all veins separate; R_4 to costa, R_5 to termen; CuP present; chorda absent; M-stem faint throughout most of DC, prominent in distal portion. Hindwing: Venation as in Figure 1. Sc + R and Rs separate; crossvein and base of Rs weak; Rs and M_1 short-stalked; M_3 and CuA_1 connate; M_2 and M_3 fairly distant in origin; CuP weak; M-stem absent; dense patch of elongate setae at base of 1A + 2A. Abdomen: Dorsal pits absent. Male genitalia: As in Figures 2–3 (3 dissections). Uncus simple, well developed, enlarged or narrow apically; uncus with sparse, fine setae ventrally near apex, laterally along subbasal region. Socii long, narrow, fused to hami, with dense, fine setae. Gnathos reduced to membranous band. Subscaphium absent. Transtilla with large, free, medial flap, projecting from diaphragma. Valva large, slightly broadened distally, with rounded apex; distal 0.5 covered with fine setae and faint parallel creases; costa with weakly invaginated region in basal 0.4; clasper and pulvinus absent. Saccus-vinculum complex moderately large, subrectangular; weakly attenuate distally. Aedeagus simple, narrow, with slightly expanded, rounded phallobase; vesica with or without cornuti. Female genitalia



Figs. 2–3. 2. Male genitalia of *Macrochlidia major*. 3. Male genitalia of *Macrochlidia minor*.

(based on *M. major* only): As in Figure 4 (2 dissections). Papillae anales broadened medially, curving laterad, with setae from elongate, nipple-like bases. Apophyses long, slender, nearly equal in length. Sterigma weakly sclerotized with sparse patches of strong setae; deep rectangular invagination of sterigma at ostium, subtended ventrally by a pair of submedial lobes of sternum VII. Ductus bursae long, slender.

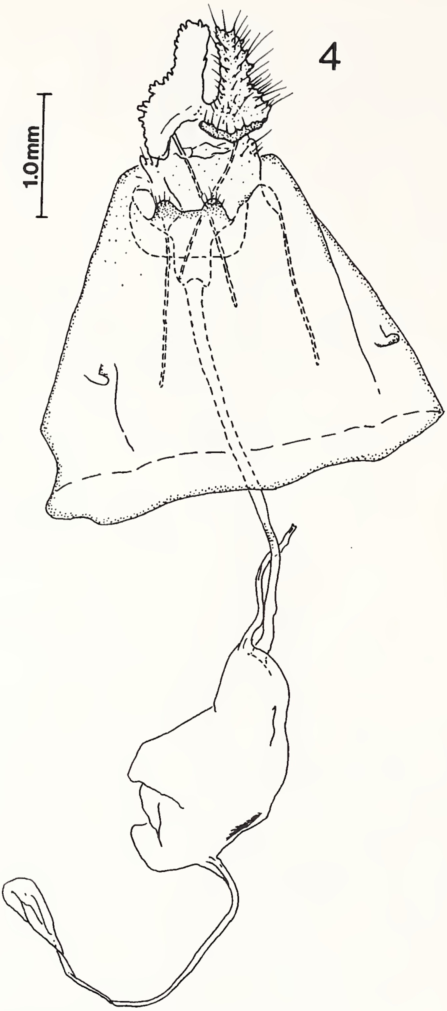


Fig. 4. Female genitalia of *Macrochlidia major.*

Corpus bursae moderately small, pear-shaped (in mated females); signum a small longitudinal patch of tiny spines. Ductus seminalis arising from near junction of corpus and ductus burase. Frail accessory bursa with narrow ductus arising at anterior end of corpus bursae.

Diagnosis. Adults of *Macrochlidia* are the largest in the Chlidanotini; only *Pseudocomotis* Brown approaches *Macrochlidia* in forewing length (Brown, 1990). Based on the two new species, *Macrochlidia* can be distinguished superficially from all other chlidanotine genera by its simple forewing pattern—uniform light beige-brown with few, small, scattered, dark brown dots. The male genitalia of *Macrochlidia* are similar to *Monortha* Razowski and Becker in the fusion of the socii and hami, but *Macrochlidia* lack the strong spine-like setae on the socii and uncus that are present in *Monortha.*

The broad, sclerotized, medial flap of the transtilla appears to be an autapomorphy for the genus. The female genitalia of *Macrochlidia* are similar to those of other Chlidanotini and Hilarographini in the shape and configuration of the corpus, ductus, and accessory bursae. However, in *Macrochlidia* the signum is greatly reduced.

The genus includes two previously undescribed species from Colombia (1,800–2,800 m) and Venezuela (1,400 m). Nothing is known of the biology.

Macrochlidia major, new species

Figs. 2, 4, 5

Male. FW length 14.5–18.5 mm ($\bar{x}$ = 16.5; N = 2). Head: Frons and vertex light tan-ocherous. Labial palpus white, light tan laterally. Antenna light tan. Thorax: Concolorous with head. Forewing: Unicolorous light beige-brown with minute light brown dots; a pair of dark brown dots along termen ca. 0.75 from tornus to apex; a few scattered brown scales near apex of DC. Fringe concolorous with wing with small black smudge along termen near apex. Hindwing: White with light gray-brown overscaling. Fringe conolorous with wing. Abdomen: Segment VIII with broad, square, u-shaped notch on sternum; posterior edge of tergum with elongate specialized scales. Genitalia: As in Figure 2 (drawn from BM slides no. 26114, 26111; N = 2). Uncus slender, elongate, weakly enlarged apically, with sparse, fine setae ventrally near apex and laterally along subbasal portion of uncus. Socii and hami fused, but components distinct; hami slender, sclerotized, slightly curved; socii weakly sclerotized, digitate, only slightly shorter than hami, with dense, long, fine setae. Gnathos not developed. Transtilla with broad, medial subrectangular plate. Valva large, expanded distally with broad, round apex; costa with shallow longitudinal invagination in basal 0.5; sacculus weakly developed. Saccus broad, semi-rectangular, rounded distally. Anellus semi-sclerotized. Aedeagus a simple, narrow tube with medial line of sclerotization in distal 0.5.

Female. FW length 16.0–21.0 mm ($\bar{x}$ = 19.5; N = 3). Similar to male but FW markings slightly larger, more well defined, and pregenital abdomen unmodified. Genitalia: As in Figure 4 (drawn from BM slides no. 26112, 26113; N = 2). Papillae anales broadest in middle. Posterior portion of sterigma with stout bristle-like setae around perimeter; posterior margin of sternum VII with a pair of short submedial lobes bearing 5–7 strong, bristle-like setae; ostium recessed in a deep narrow cup. Caudal portion of ductus bursae with fine spicules. Signum a narrow patch of fine, needle-like spines.

Type material. Holotype male: Colombia, Magdalena, Sierra de Santa Marta, 2,800 m, 10°54′N, 73°58′W, Oxford Expedition to Colombia, VII.3/IX.2.73 [3 July to 2 September 1973], BM 1973-500 (BMNH). 1M, 3F paratypes as follows: COLOMBIA: Sierra del Libano, 6000′, V.1898 [May 1898], H. H. Smith (BMNH).

Macrochlidia minor, new species

Figs. 3, 6

Male. FW length 14.0 mm (N = 1). Head: Frons and vertex white. Labial palpus white medially, tan-brown laterally. Antenna tan-brown. Thorax: Yellow-ocherous. Forewing: Light beige-brown, darker along costa, with sparse, scattered, small, dark brown dots; small, diffuse, dark brown spot in basal 0.25; costa with faint, white,

Figs. 5–6. 5. Adult female of *Macrochlidia major.* 6. Adult male of *Macrochlidia minor.*

transverse strigulae; tornus with 3–4 dark brown dots. Fringe checked white and beige. Hindwing: White with faint light beige overscaling. Fringe concolorous with wing. Genitalia: As in Figure 3 (drawn from USNM slide no. 68725; N = 1). Uncus irregularly enlarged apically; setae sparse or absent. Hami and socii long, slender, weakly curved distally, with long, fine setae. Transtilla with broad, semi-rectangular flap, attenuate distally, weakly dentate in distal 0.33. Valva large, broad. Saccus v-shaped. Aedeagus simple, narrow; vesica with patch of 6 small, slender cornuti.

Female. Unknown.

Type material. Holotype male: Venezuela, Aragua, Choroni Pass, 1400 m, I-10-66 [10 January 1966], S. S. & W. D. Duckworth (USNM).

DISCUSSION

The Chlidanotini are a well defined, monophyletic group, and are almost certainly the sister group to the Hilarographini (Brown 1990). Tuck (1981) presented a tribal checklist of the 16 genera and 37 species of the world fauna. However, because he was unaware of the occurrence of chlidanotines in the Neotropical region, he considered the tribe to be restricted to the Indo-Australian and African tropics. This interpretation was followed by Horak and Brown (in press). Razowski (1987) recognized 16 Neotropical species of Chlidanotini, and proposed 4 new genera to accommodate 10 of these. Recognition of the tribe in South America demonstrates a probable Gondwanan origin of the group, consistent with previous hypotheses that the Chlidanotinae represents the most primitive tortricoid subfamily. The two other tribes in the subfamily (i.e., Hilarographini and Polyorthini) also exhibit southern continental distributions (Diakonoff, 1974: Heppner, 1982).

Over half of the known species (ANSP, BMNH, UCB, USNM) of Neotropical Chlidanotini are undescribed. The tribe currently includes 21 Neotropical species placed in six genera; four additional species are assigned to polyphyletic genera included in subfamilies other than the Chlidanotinae.

ACKNOWLEDGMENTS

I thank the following for allowing me to examine specimens in their care: J. F. G. Clarke (USNM); C. L. Hogue (LACM); D. K. Faulkner (SDNHM); D. H. Janzen, University of Pennsylvania, whose material is deposited at ANSP; F. H. Rindge (AMNH); J. A. Powell (UCB); K. R. Tuck (BMNH). This work was completed under the support of a Smithsonian Postdoctoral Fellowship.

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NOTES ON THE BIOLOGY OF *BRACHYSERPHUS BARBERI* TOWNES (HYMENOPTERA: SERPHIDAE), A PARASITOID OF THE FUNGUS BEETLE *MYCETOPHAGUS MELSHEIMERI* LECONTE (COLEOPTERA: MYCETOPHAGIDAE)

E. Richard Hoebeke and Quentin D. Wheeler
Department of Entomology, Cornell University,
Ithaca, New York 14853

Abstract.—In northern Florida, *Brachyserphus barberi* was observed as a solitary internal parasitoid of larvae of the fungus beetle *Mycetophagus melsheimeri.* Mature larvae of the parasitoid emerge through the intersegmental membrane of the abdomen of the host larva and pupate within about 3 days; adult emergence occurs approximately 6–7 days after pupation. A review of the distribution and biology of the parasitoid and host is provided, and beetle host records of world species of *Brachyserphus* are summarized.

This short communication provides further documentation of the parasitism of coleopterous larvae by a species of the serphid genus *Brachyserphus* (Hymenoptera: Serphidae). Herein, we give our observations on the biology of *B. barberi* Townes parasitizing larvae of the fungus beetle, *Mycetophagus melsheimeri* LeConte (Coleoptera: Mycetophagidae), a previously unreported host.

While collecting insects on the floodplain of the Apalachicola River near Bristol, Florida (in Torreya State Park) on 25 March 1986, we found numerous adults, larvae and pupae of *M. melsheimeri* in a dry, unidentified fungus under the bark and in the well-decayed wood of a felled gum tree (*Nyssa* sp.). Some of the beetle larvae were parasitized by solitary internal parasitoids of the hymenopterous family Serphidae, which were subsequently identified by ERH as *Brachyserphus barberi.* One beetle larva, still alive when collected, had a mature parasitoid larva protruding through the intersegmental membrane near the apex of the abdomen. Another beetle larva, already dead by the time of its collection, had a parasitoid pupa embedded by its caudal end in the abdomen of the host (Fig. 1). These and other live beetle larvae were kept in small rearing dishes (8 cm dia., 2 cm deep) at ambient temperature for further study and observation. On 26 March, another beetle larva appeared quiescent and distended. By that evening, a parasitoid larva had appeared through the ventral abdominal body wall of the host. These three beetle larvae and their associated parasitoids were closely monitored daily to determine parasitoid development.

Although all three of the parasitoids succumbed before adult emergence, developmental data for the last larval and pupal stages can be roughly estimated. One of the parasitoid pupae was nearly fully developed, with full adult cuticular coloration, when an elevated temperature in the rearing container induced death; the parasitoid was probably within hours of emergence. This specimen was originally collected as a mature larva, already protruding from its host. Three days later (on 28 March) pupation occurred, and on 3 April (6 days later) death ensued. In another example, a quiescent and distended beetle larva was collected on 25 March; on the following

Fig. 1. Pupa of *Brachyserphus barberi* embedded in dead host larva, *Mycetophagus melsheimeri.*

day (26 March) a parasitoid larva emerged through the abdominal wall and on 29 March (3 days later) pupation occurred.

The parasitoid genus *Brachyserphus* Hellen is a member of the Serphinae, largest of the Serphidae subfamilies, whose known hosts are mostly coleopterous larvae (Townes and Townes, 1981). The biology and host relationships of most of the eleven described species of *Brachyserphus* remain unknown. Ashmead (1893) reported the rearing of *B. abruptus* (misdet. *Exallonyx obsoletus* (Say)) from the nitidulid *Stelidota strigosa* by J. H. Comstock in 1879. Parasitism of larvae of the nitidulids *Meligethes aeneus* (F.) and *M. viridescens* (F.) by *Brachyserpus parvulus* Nees was documented by Osborne (1955), who later (1960) described and illustrated the egg, and first and last larval instars of this parasitoid. *Brachyserphus parvulus* was also reported by Morley (1922), bred from larvae of *Diphyllus lunatus* F. (Erotylidae) found in the pyrenomycete fungus *Daldinia concentrica* (Bolt. ex Fr.) Ces. & de Not. (cited as *Sphaeria concentrica*) and from larvae of *Orchesia micans* Panzer (Melandryidae) in Germany. In England, Nixon (1938) bred both sexes of *B. parvulus* from bracket fungi on ash, containing *O. micans.* Pschorn-Walcher (1958, 1964) documented the same species as a parasitoid of larvae of *Triplax* sp. (Erotylidae) and *Phalacrus corruscus* (Phalacridae).

Brachyserphus barberi Townes is one of seven described species of the genus found in North America and occurs in the southeastern United States. The species description (Townes, 1981:120) was based on material from Texas, Maryland and Missouri. The holotype female was "reared from *Rhipidandrus* or *Mycetophagus* in [the polypore] *Irpex lacteus,* Anahuac, Texas, Nov. 1918, H. S. Barber." No other host records are known for this species. Our rearing it from *Mycetophagus melsheimeri* and its collection in Florida represent a new host and a new state distribution record, respectively.

Adults and larvae of *Mycetophagus melsheimeri,* like most Mycetophagidae, probably feed exclusively on fungi, and are generally found under bark, in shelf-fungi, and on moldy vegetable refuse. This species is widely distributed in eastern North America with specimen records from Maryland, Pennsylvania, Virginia, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, and Iowa (Parsons, 1975).

Voucher specimens of the reared beetles and the parasitoids are in the collections of Cornell University (Ithaca, NY) and Henry K. Townes (Gainesville, FL).

ACKNOWLEDGMENTS

We thank H. K. Townes (American Entomological Institute, Gainesville, FL) for providing confirmation of our identification of the parasitoid, and an anonymous reviewer for comments on a draft of this paper.

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Note added in proof: On 2 May 1990, Dr. Henry Keith Townes passed away following an extended illness. His death marks the end of a career devoted to the taxonomic study of the parasitic Hymenoptera. We wish to dedicate this paper to the memory of Dr. Townes and his numerous contributions to our knowledge of the Parasitica and particularly the family Serphidae.

J. New York Entomol. Soc. 98(3):379–382, 1990

PUPA OF THE BEE *PARARHOPHITES OROBINUS* (HYMENOPTERA: APOIDEA: MEGACHILIDAE)

JEROME G. ROZEN, JR.

Department of Entomology, American Museum of Natural History,
Central Park West at 79th, New York, New York 10024

Abstract.—The pupa of *Pararhophites orobinus* (Morawitz) (Pararhophitinae) is described, illustrated, and compared with the known pupae of other Megachilidae. The pupa is distinct from those of the megachilid subfamilies Fideliinae, Lithurginae, and Megachilinae. The similarities and differences of the pupae of the four subfamilies of the Megachilidae are discussed.

Because of the systematic significance of the palaearctic bee *Pararhophites* to the rest of the Megachilidae and because of its uncertain taxonomic placement in the past, a description of the pupa of *Pararhophites orobinus* (Morawitz) is recorded here, and its features are compared with those of other megachilids.

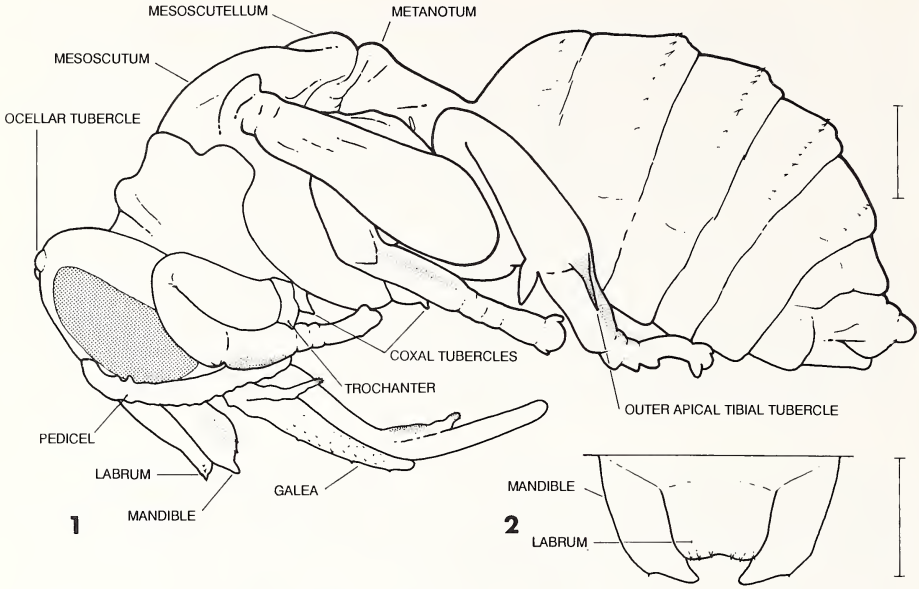
Until recently *Pararhophites* had been thought to be related to either the Anthophoridae or Melittidae (see McGinley and Rozen, 1987, for references). However, a study of the nesting biology and larvae of *Pararhophites orobinus* (Morawitz) suggested a very different relationship of the genus to the long-tongued bees. As a consequence McGinley and Rozen (1987) analyzed these relationships using adult and larval anatomy and biological features. We concluded that the genus was the sister group of the megachilid subfamilies Lithurginae, Megachilinae and also Fideliinae (considered by some authors as a separate family). The genus was placed in the monotypic subfamily Pararhophitinae as the basal clade in the Megachilidae.

I brought back live diapausing larvae from Pakistan in 1984 in the hope of being able to include pupae in our analysis, but no pupa developed by the time that study was published. Finally in September 1989, more than five years after being collected, one of the dozen remaining larvae pupated, perhaps making this specimen a record holder for the length of time a bee has survived as a diapausing larva that then pupated.

Pupa of *Pararhophites orobinus*
Figs. 1, 2

Diagnosis: The small tubercles on the galeae and labral apex are unique characters, not found in other bee pupae. These features, as well as the general lack of tubercles on the rest of the head and thorax, immediately set this pupa apart from pupae of many other bees. See Discussion for other pupal characters that distinguish the Pararhophitinae from the Megachilinae, Lithurginae and Fideliinae.

Head: Integument nonspiculate, smooth except microscopically granulate in patches on such places as lateral surface of mandibles, apex of palpi, and ventral surface of second segment of labial palpi; setae absent. Antenna without tubercles except pedicel



Figs. 1, 2. Pupa of *Pararhophites orobinus.* 1. Lateral view of body. 2. Frontal view of mandibles and labrum. Scale bars = 0.5 mm.

with small dorsal projection next to eye; vertex without tubercles, smooth; ocellar tubercles slightly developed; genal tubercle absent; frons and clypeus without tubercles; labrum long, flat, apically bilobed, and bearing series of small sharp-pointed tubercles along apical margin; mandible strongly swollen subapically as seen from side; this swelling bearing a few small sharp-pointed tubercles ventrally; mandibular apex faintly pigmented; galea bearing scattered small to very small tubercles, larger ones of which are sharp-pointed.

Mesosoma: Integument nonspiculate, mostly smooth but microscopically granulate in some places (as illustrated by stippling in Fig. 1), especially noticeable on lower surface of fore basitarsus, outer surface of mid basitarsus, outer apical tubercle of hind tibia, and dorsal surface of much of hind tarsus; setae absent. Lateral angles of pronotum not produced; posterior lobes of pronotum not produced but with integument along posterior edge pigmented; mesepisternum without tubercle; mesoscutum without tubercles or swelling and without midline groove; axillae and mesoscutellum not produced or tuberculate. Tegula without tubercles; wing without tubercles or swellings. Fore leg with coxa bearing pointed, moderate-sized tubercle arising from inner apex; trochanter with smaller apical tubercle; tibia with very small tubercle on outer apex; rest of fore leg without tubercles. Mid leg with coxa bearing moderately small, sharp-pointed apical tubercle; rest of mid leg without tubercles except for very small outer apical tubercle on tibia. Hind leg without tubercles except tibia with elongate, tapering tubercle arising from outer apex; this tubercle more elongate and slender than tibial spurs and allowing for development of long adult setae.

Metasoma: Integument nonspiculate; setae absent. Tergum I with indefinite transverse band of a few irregularities and small sharp-pointed tubercles near apical margin; terga II–IV with more distinct transverse apical rows of small sharp-pointed tubercles, some of which are apically pigmented; tergum V with a few subapical tubercles; tergum VI without tubercles; sterna without tubercles and with transverse posterior margins; apex of abdomen rounded, not produced into elongated apical spine.

Material Studied: 1 female pupa, Killi Sarda, 12 km south of Quetta, Baluchistan, Pakistan, collected as larva May 14, 1984, pupated approximately September 14, 1989, drawn and described when discovered on September 21, 1989, as pale live pupa with pigmented eyes (J. G. Rozen, R. J. McGinley).

Discussion: Information about bee pupae is beginning to accumulate. Only two species of the Megachilidae (both in *Megachile*) were described by Michener (1954) in his seminal study of bee pupae. Since then, pupae of some taxa have been described, and specimens of others have been collected and are available for examination. The pupa of *Pararhophites orobinus* may shed light on the relationships of the genus to the rest of the Megachilidae. Its description supplements our comprehension of the subfamilies within the family and of the anatomical variation within the family.

Pupae of the Megachilinae (*Anthidiellum, Anthidianum [?], Stelis, Heterostelis, Hoplostelis, Dioxys, Chalicodoma, Heriades, Hoplitis, Osmia, Coelioxys, Megachile*) known to me or described in the literature (see McGinley, 1989, for references) lack tubercles on the vertex except for somewhat enlarged ocellar tubercles in some species. Distinct tubercles on the lateral lobes and angles of the pronotum are also missing, and there are no tubercles on the mesoscutum, mesoscutellum, or propodeum, except *Coelioxys* has a somewhat protuberant scutellum and enlarged axillae, corresponding to developing adult features. All known megachiline pupae bear conspicuous dorsal setae on the head, mesosoma, and metasoma.

Pupae of the Lithurginae are unknown except for those of *Lithurge chrysurus* Fronscolombe (Roberts, 1973) and *Trichothurgus dubius* (Sichel) (Rozen, 1973b). So far as is known they agree with the megachiline characteristics listed above, although they also have setae on their legs, a character which is not recorded for most Megachilinae. Conspicuous setae on vertex, mesonotum, and metasoma may be a synapomorphy of the Megachilinae and Lithurginae. However, this feature is not totally satisfactory because pupal setae, though microscopic and inconspicuous, occur in the Fideliinae.The pupa of *Neofidelia profuga* Moure and Michener (Rozen, 1973a) is setose, but the pupa of *Fidelia villosa* Brauns (Rozen, 1970) is not. The pupae of both *Neofidelia* and *Fidelia* share tegular tubercles, apparently a unique feature within the Megachilidae though found in other families. *Fidelia villosa,* alone among the megachilids, also has a median scutellar tubercle.

The pupa of *Pararhophites* stands apart from the other megachilids in that it does not bear either conspicuous or inconspicuous setae, it lacks tegular tubercles as well as scutellar tubercles, and, unlike any other known bee pupa, it has small tubercles on its galea and at the apex of its flat, bilobed clypeus. It shares the slender elongate tubercle arising from the outer apical edge of the hind tibia with the female pupa of *Neofidelia profuga* (Rozen, 1973a). This seems to be a convergence allowing for development of long adult bristles at the apex of the tibia in females of both *Neofidelia* and *Pararhophites.* A similar tubercle, also encasing adult setae, is found in the obviously unrelated *Hesperapis trochanterata* Snelling (Rozen, 1987) (Melittidae).

ACKNOWLEDGMENTS

This paper is an addendum to the 1987 study and the persons acknowledged there, as well as Dr. Ronald J. McGinley, are thanked here for their assistance. The Smithsonian Institution's Foreign Currency Program under the direction of Gretchen Ellsworth provided a grant for the field trip leading to this paper.

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NOTES AND COMMENTS

J. New York Entomol. Soc. 98(3):383–384, 1990

SURFACE WAVE COMMUNICATION IN WATER STRIDERS; FIELD OBSERVATIONS OF UNREPORTED TAXA (HETEROPTERA: GERRIDAE, VELIIDAE)

Surface wave communication has been reported in water striders (Gerridae), backswimmers (Notonectidae), giant water bugs (Belostomatidae), spiders and frogs (see recent summary by Kraus, 1989). Among the water striders this form of communication has been noticed only in the family Gerridae, in *Gerris* (2 spp.), *Limnoporus* (3 spp.) and *Rhagodotarsus* (1 sp). During a recent expedition to South America, funded by the National Geographic Society, I observed two additional water striders creating surface waves, apparently in exactly the same manner as *Rhagadotarsus kraepelini* Breddin which Dan. A. Polhemus and I observed and photographed on Luzon in 1985. The surface waves are created by a stationary insect vibrating in a vertical plane to produce concentric circular surface waves (see Wilcox, 1972). The taxa observed were a tiny trepobatine species (Gerridae; Trepobatinae), 2.5–3.2 mm in length, and *Microvelia longipes* Uhler (Veliidae; Microveliinae), the first records of such behavior for either a veliid or a member of the gerrid subfamily Trepobatinae. It is tempting to speculate that many other insects associated with the water surface also communicate in this way but have not been noticed.

The gerrid (a new genus and new species close to *Telmatometra,* to be described in another publication) was in the middle of a small quiet forest pool inhabited by a number of other conspecific water striders (INPA Forest Management Station, Coll. Loc. 2477, 29-VIII-1989, 98 km NW of Manaus, Brazil). This species was found only on quiet pools associated with small headwater streams in a seasonally dry rain forest, either connected with the stream or nearby in the forest. These tiny insects resemble early instar nymphs of the gerrid genus *Brachymetra* that inhabit the same pools, which may be why they have previously been overlooked. The observation was fortuitous because the forest beneath the canopy is quite dark, and only by chance the proper oblique light was available to clearly see the surface waves and the insect creating them for a period of about 30 seconds.

Many male specimens of *Microvelia longipes* were observed on several occasions creating surface waves in the concrete lined pools of the Caiman holding pens on the main INPA facility in Manaus during late August, 1989. The males were separated from each other by approximately 6 inches or more, and each would vibrate for 15 to 30 seconds, then cease for a time. At any given time a number of males could be seen vibrating at once. In one instance two males were seen grappling after one had been vibrating, suggesting that the surface waves are repelling signals to ward off intruding males. Whether signalling is also intended to attract females for mating would be an interesting area for investigation (see Wilcox, loc. cit.). Because *Mi-*

crovelia longipes is perhaps the commonest water strider in South America and readily colonizes temporary pools as well as almost every pond, it should be very easy to raise and study in either the laboratory or outdoor tanks. The great variability of leg lengths in males of this species has long been a puzzle; leg length will mechanically affect the frequency of vibration, thus possibly conferring a "signature" on each male. A test of this working hypothesis should be a fruitful area for study.—*John T. Polhemus, University of Colorado Museum, 3115 S. York, Englewood, Colorado 80110.*

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ERRATA

Corrections to: Kerzhner, I. M. 1990. Neotropical Nabidae (Heteroptera), 3: species of the genus *Arachnocoris* from Costa Rica. J. New York Entomol. Soc. 98(2):133–138.

p. 134, line 12, should read: *Diagnosis.* Related to *A. berytoides* (Uhler) (Grenada) which differs in its. . . .
p. 134, line 23, should read: . . . Distance between ocelli 2. . . .

Correction to: Futuyma, D. J. 1990. Observations on the taxonomy and natural history of *Ophraella* Wilcox (Coleoptera: Chrysomelidae), with a description of a new species. J. New York Entomol. Soc. 98(2):163–186.

p. 170, line 24, should read *Ophraella artemisiae*, new species. The original spelling is incorrect, as it is based on an inadvertent error.

BOOK REVIEWS

J. New York Entomol. Soc. 98(3):385–386, 1990

Zoogeography of Caribbean Insects.—James K. Liebherr, ed. 1988. Cornell University Press, Ithaca, New York. ix + 285 pp. $39.95.

This book is the result of a symposium, "Historical Biogeography of the Caribbean Insect Fauna," held in late 1985. The editor asserts that "The diversity of insects far outclasses that of any other taxon in the Caribbean." If so, then reference to insects is essential to any general understanding of faunal origins and history in the Antilles. This volume is the first to concentrate on biogeography of insects from the region and provides not just a "progress report on our understanding of the Caribbean insect fauna" as promised in the preface, but also a comment on the general practice of biogeography in the Antilles.

In an introductory chapter, "The Caribbean: fertile ground for biogeography," J. K. Liebherr establishes the critical position of Middle America for New World biogeography and of insects as the data source to study it. The possibility of complex faunal origins arises not just from the fact that Caribbean land is highly subdivided into separate islands, but also from the fact that several of the islands themselves are composed of slivers of land that have been previously aggregated in different patterns. Insects seem to provide the high levels of endemism that will be necessary to resolve the consequent complex history.

T. W. Donnelly's chapter, "Geological Constraints on Caribbean Biogeography," is a guide to the previous great controversy in Antillean geography, the relative applicability of stabilist versus mobilist models of geological history. Geologists now seem to be of one mind that mobilism provides the best explanation of geological observations in the Caribbean Basin, but the original controversy lives on in slightly reworded form: which are more useful, the "less mobilist" models or the "more mobilist" models? Donnelly favors the former, but the authors of several of the chapters on systematics favor the latter. The next great controversy should be whether land surfaces and the organisms that occupy them are *both* old enough that mobilist models might explain aspects of biotic history as well. The argument will be long fought because many animal distributions suggest great age (or inordinate dispersal), but few rocks or geophysical features of very early age have been found.

The preface claims that ". . . the wealth of insect species and, in many cases, the restricted distributions of insect taxa suggest that biogeographic data from insects will dwarf the data obtainable from other taxa." Eight contributors make a good case for the boast in chapters on West Indian members of the Lygaeidae, auchenorrhynchous Hemiptera, Scaritinae, the carabid genus *Platynus,* the polycentropodid genus *Polycentropus,* Drosophilidae, Formicidae, and Halictidae. This is but a small portion of the great wealth of Caribbean insects, but, given the current state of revisionary systematics, one shouldn't expect a more comprehensive treatment in the first book on the topic. For readers primarily interested in the animals per se, the chapters provide a good summation of each group. However, for those interested in general patterns of relationship that might illuminate the history of the islands and, therefore, the history of other organisms, there will be hard going. The authors use diverse techniques of analysis, presumably appropriate to the level of knowledge in the different groups. The differences in style, methods, and even in questions addressed make it difficult to extract any general information about insect biogeography. A critique of biogeographic methods, used by the contributors and others, is given in a closing chapter by E. F. Connor.

The volume includes a mix of papers addressing aspects of historical or ecological biogeography. Among the latter, E. O. Wilson, writing on "The Biogeography of West Indian Ants," finds a species-area curve that he judges typical for oceanic islands. But he also makes the following very notable observation: "In contrast to the contemporary ants, the late Tertiary fauna of the Greater Antilles, as revealed by recent studies of Dominican amber, is more nearly characteristic of a continental fauna." Several genera were formerly present on Hispaniola, including army ants which Wilson deems to be poor colonizers, but which have become extinct since the late Tertiary. The observation is contrary to what one would expect if dispersal were the origin of the ant fauna. In that case, the number of clades in Hispaniola should be increasing as dispersal takes place over geologically significant periods of time. Wilson's observation that the Tertiary fauna in amber is rich and continental in aspect, while the modern fauna is less rich and oceanic, suggests that a fragment of a continental fauna is becoming impoverished subsequent to isolation.

What general knowledge was gained by using insects as the base for studying Caribbean biogeography? The answer comes primarily from three chapters that attempted to find statements of relationship among at least three areas of endemism. S. W. Hamilton, in a chapter entitled "Historical biogeography of two groups of Caribbean *Polycentropus*," shows that one clade of caddisflies has a distribution congruent with Rosen's (1985) North American–Caribbean track, while the other apparently involves dispersal from northern South America into the lesser Antilles. The two groups imply that the Greater and Lesser Antilles have had separate histories, a point corroborated by Liebherr with examples from *Platynus* beetles. D. A. Grimaldi, in a chapter entitled "Relicts in the Drosophilidae," finds that fruitflies show that the Greater Antilles share a history with Africa that is not shared with Central America. He reviews data on fossils of diverse groups, in addition to several recent discoveries of fruitflies in amber, and finds considerable evidence that the Antillean fauna is older than generally realized. It is this point that will be critical in the post-stabilist analysis of Caribbean distribution patterns. If the distributions of Antillean organisms are ancient, the question of dispersal will become moot on any general scale.—*Michael L. Smith, Department of Herpetology and Ichthyology, American Museum of Natural History, New York, New York 10024.*

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Interindividual Behavioral Variability in Social Insects.—Robert L. Jeanne, ed. Westview Press, Boulder. 456 pp.

Westview Press is a leader in publishing timely and informative studies in insect biology. This volume provides novel insights into the topic of interindividual behavioral variability in social insects. Until recently, both the lay public and researchers alike thought of the social insect as an automaton. The "superorganism" concept of the social insect colony implied fixed roles for individuals, the colony's survival being paramount. Recent studies in kin and nestmate recognition have shown that social insects can discriminate among individuals and can also form dominance hierarchies.

Individual differences in behavior are currently best understood in primitively eusocial insects. However, all chapters but one in this volume deal with behavioral variability in highly eusocial insects such as ants and honey bees. In his introduction to this book, Jeanne states that it is not far-fetched to believe that no two social insect colony members behave alike during their lifetimes.

The first chapter, by Jaisson, Fresneau, and Lachaud, deals with individual traits of social behavior in ants. The methodological difficulties of studying individual social insects are discussed. One frequently used method is to isolate subjects for study. However, isolation itself may change behavior. The more widely used technique is marking and following individuals inside the colony.

The authors say that studies of social insects are either descriptive or experimental in nature. Descriptive studies use two possible recording methods. The first is the "sporadic sampling method," where behaviors are recorded at random. The second is the "systematic scanning method," where each behavior performed by each individual is recorded. The first method is good for estimating the number of behavior elements in the species. The second method is useful where there are fewer individuals and one wants to know how an individual behaves in the context of its society.

The authors give examples of the behavioral repertoires of *Pheidole, Leptothorax,* and *Zacryptocerus.* They point out that to a certain degree these repertoires are arbitrary since they depend on the criteria of the observer. It is therefore difficult to compare species using this kind of information.

Next there is a discussion of behavioral variability due to polymorphism (size castes) and age. An ethogram of *Pheidole hortensis* illustrates the different behaviors of minor and major workers. The authors then give an example of how social organization in *Ectatomma ruidum* was depicted using hierarchical cluster analysis and a dendrogram. They give examples from the literature of how social regulation can be studied by changing subcaste ratios, reducing the numbers of individuals in a colony, or removing a subcaste entirely.

The physiological correlates of individual behavior (such as ovarian development) are discussed next, followed by summaries of several studies on the ethogenesis of individual behavior. These studies deal with the role of individual experience during the young adult and larval stages. For example, if *Ectatomma* workers are isolated at emergence for 10 days and are then reintroduced to their colonies, they seemingly "regress' in behavior to day 1 individuals. They then normally develop into nurse ants.

The authors conclude that a "socially average" individual does not exist and that social insect colonies cannot be understood as just the average or sum of their members.

Harvester ants (*Pogonomyrmex barbatus*) like to keep their nests free of debris. Gordon used this trait to learn about the importance of the group context in role switching. By placing toothpicks on their mounds, she forced an increase in colony maintenance activity. She also interfered with foraging by putting barriers on their foraging trails. She wanted to know whether environmental changes that affect the numbers of workers doing one task also affect the numbers engaged in other tasks. She found that there is in fact interdependence of different tasks. Hence, understanding what an individual will do depends not only on its internal state and how workers doing some task respond to environmental changes, but also how workers doing some task respond to changes in the numbers doing other tasks. Understanding the individual's behavior cannot be understood without also understanding the dynamics of group behavior.

Calabi and Rosengaus, in a chapter on behavioral transitions in the ant *Camponotus,* used marked ants to show that, although the average responses of ants appear deterministic within age groups, individual workers show significant differences in the frequencies of behaviors. For example, although it is generally accepted that young workers care for brood, the authors found that 58% of their marked ants of known age never showed brood care. Indeed, given ants varied monthly in their proportionate frequencies of different behaviors despite constant colony conditions. This example of the use of transition probabilities will benefit readers unfamiliar with the technique.

Traniello's description of foraging behavior in *Formica schaufussi* also highlights individual variability. Workers can be classified as "persistent" or "non-persistent" foragers. The former do more area-restricted searches and generally leave and enter search sites at different angles. The latter do only limited area-restricted food searches and enter and leave the search area at the same angles. Using individually marked workers, the author shows that there is strong variation in how far workers travel and how long they are out of the nest, regardless of the success of their previous excursion. Thus, according to Traniello, workers vary in foraging "initiative" and thereby spatially partition their efforts.

His research shows that individual worker experience is also important and changes the persistence of foraging behavior in both types of workers. Sucrose rewards increase foraging persistence more than protein rewards (termites) in both types of workers, although the differences between the groups are still significant. If we assume that liquid carbohydrates are more likely to be persistent food sources than insects, then the workers are able to correlate their search duration with the type of food.

In the introduction to his study with *Leptothorax allardycei,* Cole points out that the superorganism concept of the social insect colony discouraged the search for individual differences. Kin selection theory, on the other hand, requires learning about individual behavior since we are interested in whether individuals receive differential treatment according to their relatedness. Reproductive competition among ant workers has received little attention. In *Leptothorax* the workers can reproduce and even have a dominance hierarchy among themselves that is correlated with their degree of ovarian development and the direction of food flow. Liquid food tends to go from lower- to higher-ranking individuals. The alpha worker is also nearer the eggs more often. Cole says that the superorganism concept is valid in cases where workers do not reproduce. Otherwise, there may be a conflict between a worker maximizing its own fitness and what is best for the colony as a whole. In the movement patterns of the workers, it is not possible to extrapolate from some "average" worker to explain nest behavior. Rather, colony order in this ant is involved with brood attraction and the agonistic interactions that form the dominance hierarchy. Colony efficiency may actually decline under these circumstances.

Carlin's report on dominance behavior among polygynous queens in the ant *Iridomyrmex purpureus* shows that dominance competition is evidenced by frequent bouts of mutual antennation in early stages of colony development. Mature colonies of this species can have more than one ovipositing queen, although they are in separate nest chambers and will fight if put together (this form of polygyny is called "oligogyny"). Carlin found that the dominance hierarchy begins upon emergence of the first workers 2.5 months after founding. The queens characteristically engage in bouts of mutual antennation lasting about 2 seconds, at an average rate of 30 times per hour for nearly a year. The bouts always end unambiguously with one of the queens backing or turning away. These bouts rarely involve biting. The queens do not eat each other's eggs. They begin to move apart after about a year, and are permanently separated after 23 months.

Before permanent separation, the queens occasionally reunite. Carlin found that the dominance ranking before the separation did not persist. Bouts of antennation were now longer. A queen that had won a recent bout was more likely to win the next bout. Oviposition during the bout increases the likelihood of winning for the subordinate queen and she lays more eggs than expected during these bouts. The queen's proximity to the egg pile is also important. Before separation, the dominant queen spent 81% of her time on the egg pile. During the reunions, both queens had a higher probability of winning if they were on the egg pile. The workers do not participate in queen dominance interactions. Carlin concludes that "hymenopteran colony politics is at least as intriguing as that of chimpanzees."

Rissing and Pollock also studied polygyny in an ant, *Veromessor pergandei.* Queens of this species co-found colonies. Pleometrosis can have several benefits, including rapid production of workers and a territorial advantage. The authors recently proved the latter using a test arena into which founding single- and multiple-queen colonies opened. Brood raiding was common among these colonies. In most cases (16/19) the multiple-queen colonies survived. Relatedness does not seem important in the queen associations, since queens collected at distant locations did just as well as those nearby in forming polygynous associations. After emergence of workers, most colonies reduce to monogyny, with many queens fighting to the death.

To survey the fate of polygynous queens in ants, the authors have tabulated what is known about monogyny and polygyny in ants. (I take exception to their suggestion that functional monogyny is best known in *Solenopsis invicta*—most fire ant researchers do not accept this interpretation.) In some species, once the advantages of queen mutualism are over, the queens eliminate one another. In other cases where oligogyny occurs, queen conflict is minimized. Furthermore, the authors state that, if workers show fidelity to their own queen or if there is restricted movement of workers among the various queens, the degree of relatedness between the queen and her workers rises. Such intra-colonial colony structures may make kin selection possible under these conditions.

Vander Meer, in his chapter on behavioral and biochemical variation in the fire ant, *Solenopsis invicta,* gives many examples of how ant biochemistry relates to their behavior and systematics. For example, major fire ant workers actually have less venom alkaloids than minor workers and are therefore not a soldier caste specialized for nest defense.

He has also looked at changes in responsiveness to pheromones. Brood-tending workers give the most consistent bioassay to a queen attractant, followed by reserves and foragers. Vander Meer concludes that the brood-tenders are the most "sensitive" (I prefer the term "responsive") to the attractant. They are also the most responsive to the trail pheromone. Since brood-tenders are young workers, Vander Meer suggests that senescence could account for the reduced responsiveness by the other workers.

In discussing nestmate recognition, Vander Meer distinguishes between endogenous (having a genetic component) and exogenous (environmentally derived) odors. It is still not known whether cuticular hydrocarbons are the recognition cues in ants. Individual colonies can be identified by their hydrocarbon pattern. However, the hydrocarbon make-up is dynamic, changing over time. Vander Meer says that the learning of nestmate odors must be an iterative learning process to allow for these changes.

Fewell's article on foraging behavior in the harvester ant *Pogonomyrmex occidentalis* indicates that workers either forage individually without trails or en masse on large trunk trails. He hypothesizes that habitat variation could explain the variability. He observed 15 colonies and determined the mean vegetational coverage around the nests. The foraging activity of the workers was then determined. Colonies surrounded by variable density vegetation (clear areas mixed with vegetation) usually had major trunk trails, while those surrounded by more even vegetation had more individual foraging. Ants in areas of low vegetation forage twice as far as those with high vegetation. Ants also form trunk trails in response to clumped resources (seeds). Thus, flexibility in colony foraging is dependent upon local resources. The author believes that foraging efficiency is improved with this strategy.

Post, Jeanne and Erickson present a comprehensive description of behavioral variability in *Polistes fuscatus variatus* based on data from 54 workers in 7 colonies. The first part of their article has a complete descriptive catalog of behavioral repertoires among workers (37 in all). They analyzed lifetime differences in these repertoires and age-related changes in behavior as well as individual variation in age polyethism and the frequency of giving food or pulp to nestmates.

The authors found that the behaviors are not performed at equal frequencies by all workers. Within each colony, workers can be categorized into one of three specialities: prey foragers, pulp and prey handlers, and non-foragers. These differences are quantitative rather than qualitative. Task partitioning by workers returning with prey is evident, workers turning over their booty to nestmates and then returning to the field. There is also evidence of age polyethism, although the only individual variation is the age at which the workers first leave the nest.

In the next chapter, Jeanne, Downing and Post discuss age polyethism and individual variation in *Polybia occidentalis,* an advanced eusocial wasp. The authors studied no less than 67 behavioral categories! Typical of many social insects, the young workers initially do building activities and change to foraging as they get older. The switchover is abrupt in some individuals, gradual in others. Individuals also differ in the age of their behavioral change.

There is also evidence of age polyethism with respect to foraging specialty, some workers foraging first for pulp and later for nectar. Not all workers show this trend. Furthermore, the typical eusocial pattern of worker specializations from in-nest, to on-nest, and finally off-nest phases, is not necessarily followed by all workers. Some rarely leave the colony during their entire lives. In those workers that progress from in-nest to on-nest tasks, the age of switching varies among individuals. If the colony were studied at the group level with "average" workers, we would see a gradual temporal change of behavior. However, when individuals are analyzed, the changes are more sudden. The authors say that in this species the order of roles is fixed, but not the absolute transition ages. They suggest age-dependent thresholds of responses to colony needs, with thresholds varying among workers.

"Undertaker" honey bees are the subject of Visscher's chapter. One inevitable consequence of social life is the need to dispose of the dead. The author found that an average of 54 dead bees/day were removed from each of 5 colonies, or about a liter a month of corpses. To study the responses of workers, Visscher placed freshly killed bees into hives. He built a trap that facilitated labeling bees that were removing corpses, and then found that some individuals remove corpses more often than expected by chance alone. He concluded that a specialized group of workers, comprising no more than 2% of the bees at any given time, is responsible for most of the undertaking. These bees have made their first orientation flights, but have not yet begun foraging. The author estimates that only 10% of all bees ever participate in this chore. He also did some tests to show that there is probably a chemical releaser for this necrophoric (undertaking) behavior.

Waddington's contribution to this book discusses the relationships between body size, individual behavior, and social behavior in honey bees. Larger bees begin new tasks earlier in life and also forage more frequently. The author measured 309 newly emerged bees and then counted the number of circuits in their waggle dance when they were signaling a food resource. The dance duration is known to be correlated with flight distance. For nectar collectors, there was no significant correlation between bee size and distance flown. On the other hand, there was a positive correlation with pollen collectors. In a second experiment, the author trained bees to food sources and also found a positive correlation between the bee's size and the distance to flowers.

Waddington states that proboscis length is related to body size in bees, so that different size bees can exploit different resources. He suggests that bee species that forage independently benefit from size variability since they can exploit a variety of resources. Species with recruitment to food, on the other hand, forage more efficiently if they have little size variation. The author tested these predictions using 11 species of stingless bees that vary widely in the complexity of their recruitment systems. In agreement with the predictions, he found a negative correlation between the size variance of the different species and the complexity of their recruitment system.

The final chapter in this book, by Plowright and Plowright, deals with "elitism" in social insects. By this the authors mean that some workers (the "elites") do much more work than others (the "loafers"). Why is this so? Do "reserves" constitute a back-up work force for emergencies? What are the causal mechanisms that account for these differences of behavior? Are the individuals genetically distinct or are the differences just probabilistic? The authors develop a positive feedback model of elitism, in which the successful completion of a task makes an individual more likely to repeat it ("internal" factors). The "external" factors in this model include the number of hungry larvae or state of food reserves in the colony. Using this model of worker behavior, the authors ran Monte Carlo simulations of social insect colonies. One of three general outcomes gave a bimodal distribution of time spent working, i.e., both elites and loafers were generated. This outcome does not prove that stochastic processes account for elitism, but that it is at least possible. The authors caution that many more ethological studies are needed to determine the relevant parameters for the development of elitism in real colonies. The simulations differ from real colonies in one important respect: if the model is run too long, the effects of the initial conditions are lost. In real colonies, on the other hand, elitism persists over time.

When I finished this book I was convinced that the study of individual differences in social insects has barely begun. Noticeably absent were any references to termites (hymenopterists seem to have a bias against working with them). Most social insect biologists will want a copy of this book in their libraries.—*Les Greenberg, Department of Entomology, Texas A&M University, College Station, Texas 77843.*

INSTRUCTIONS TO AUTHORS

The *Journal of the New York Entomological Society* publishes original research resulting from the study of insects and related taxa. Research that contributes information on taxonomy, classification, phylogeny, biogeography, behavior, natural history, or related fields will be considered for publication. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie.

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NEW APTEROUS CARVENTINAE FROM NEW ZEALAND (HETEROPTERA: ARADIDAE)

Ernst Heiss
J. Schrafflstr. 2A, A-6020 Innsbruck, Austria

Asbtract.—From New Zealand there are known, to date, six apterous genera of Carventinae, each with only one described species. Two new species, *Acaraptera waipouensis,* n. sp. and *Leuraptera yakasi,* n. sp., both from North Island, are described, and their general habitus and male genitalic structures are figured. Additional data are provided for *Acaraptera myersi* Usinger and Matsuda.

The subfamily Carventinae is represented in New Zealand so far by six apterous genera (*Acaraptera, Carventaptera, Leuraptera, Lissaptera* and *Neocarventus,* all described by Usinger and Matsuda, 1959 and Clavaptera Kirman, 1985) each with only one species. They seem to be inhabitants of the moss and leaf litter layer of indigenous forests.

Through the kindness of Dr. R. T. Schuh, American Museum of Natural History, New York, I had the opportunity to examine a lot of Carventinae from New Zealand, with two new species which are described below. The same new species were represented in a small lot of Aradidae from the North Island of New Zealand I acquired years ago for my collection.

Measurements were taken with a micrometer eyepiece, 40 units = 1 mm.

I particularly thank Randall T. Schuh (AMNH) for the loan of the interesting material and linguistical advise, and S. Tatzreiter, University of Innsbruck for the scanning electron micrographs.

Acaraptera waipouensis, new species

Figs. 1a, b; 2a, b; 3a–e; 4c, d

Diagnosis. Distinguished from the only known species of this genus occurring in New Zealand, *A. myersi* Usinger and Matsuda 1959, by a set of characters, e.g., anterolateral angles of pronotum less angularly produced, the lower portion of its anterior margin wider and only slightly convex, metanotum not fused with mediotergite I and clearly separated by a transversal suture; mediotergites I and II separated at middle but fused laterally.

Description. Male. Apterous; body ovate, smooth and shiny beneath incrustation, appendages, head, lateral borders of body and pygophore sparsely granulate.

Head. Shorter than width across eyes (22:32); anterior process of gena slightly produced over clypeus, its apex rounded. Antenniferous tubercles with subparallel lateral margins, apices blunt. Eyes globose, granular. Postocular tubercles forming rounded lobes not reaching lateral margin of eyes, strongly converging posteriorly. Vertex with 2(1 + 1) longitudinal, anteriorly diverging carinae and 2(1 + 1) ovate smooth

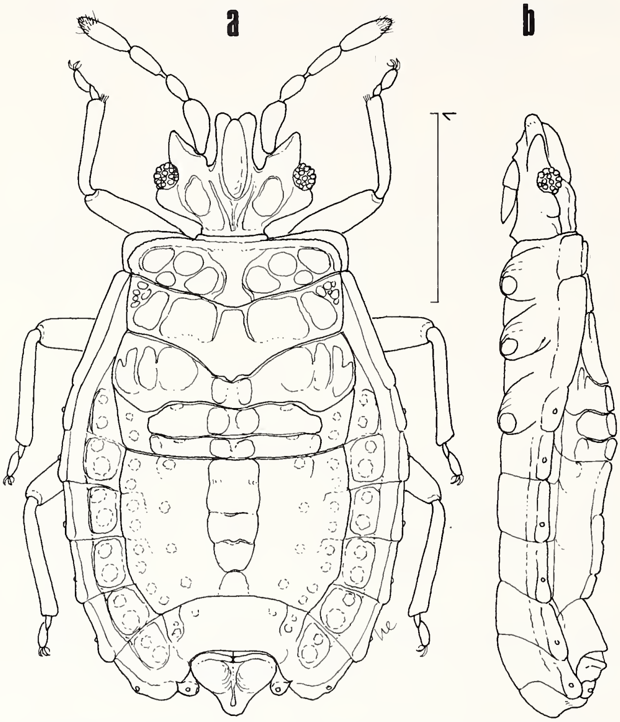

Fig. 1. a–b. *Acaraptera waipouensis,* n. sp. a. Male paratype, dorsal habitus. b. Lateral view.

depressions laterad. Antennae longer than width of head across eyes (36:32), relative length of antennal segments I to IV = 11:5.5:8.5:11. Rostrum short, not reaching posterior margin of head, rostral atrium open. Rostral groove wide and closed posteriorly, its lateral borders granulate. Posterior to the rostral groove is a paired cuticular structure as shown in Figure 4c which is yet unreported in Aradidae; its function was not investigated.

Thorax. Pronotum more than 3× wider than long (43:13.5), anterolateral lobes angulately rounded, placed on a lower level than disk; anterior margin at most slightly produced over thin collar. Disk with a median flat elevation and 8(4+4) flat rounded elevations laterad, delimited laterally and anteriorly by a granulate carina; posterior margin produced backward.

Mesonotum longer than pronotum (15.5:13.5) with subparallel lateral margins delimited by the reflexed portion of pleura, which extends from anterior margin of dorsal laterotergite (DLTg) II to posterior margin of pronotum; surface with ill defined flat elevations, raising toward projecting posterior margin which is bisinuate at middle.

Metanotum shortest at middle with 2(1+1) widening lateral lobes, separated from mediotergite I by a deep suture; elevated along median line, there bearing 2(1+1) distinct oblique elevations depressed between them; lateral portion with flat irregular elevations.

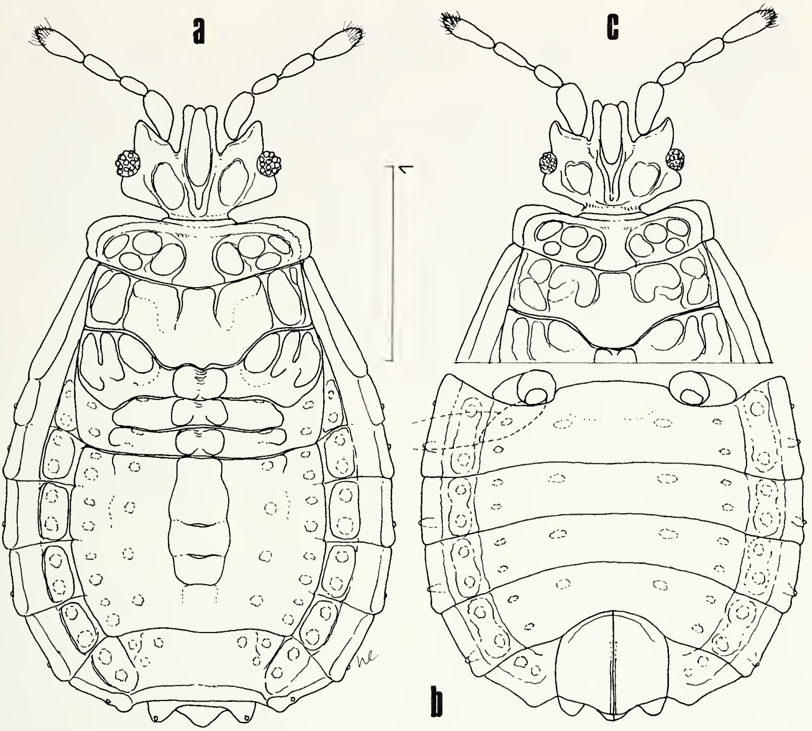

Fig. 2. a–b. *Acaraptera waipouensis,* n. sp. a. Female paratype, dorsal habitus. b. Venter. c. *Acaraptera myersi,* female holotype, dorsal habitus (after Usinger and Matsuda).

Mediotergites (MTg) I and II elevated at middle, with the same medially depressed oblique elevations as metanotum; fused at depressed lateral portions, but clearly separated by a deep suture at middle. DLTg I+II fused, triangular.

Abdomen. Tergal plate formed by completely fused MTg III to VI with slightly convex lateral margins elevated along median line, with a median, flattened elongate elevation bearing marked scent gland openings; DLTg III to VI deeply depressed on inner half, bearing 2 glabrous impressions each, lateral margin carinate, increasingly thickened and slightly protruding posteriorly. DLTg II and III fused. MTg VII elevated posteriorly, anterolateral angles rugose. DLTg VII rounded posteriorly. Paratergites VIII short, rounded with a laterally pointed tip.

Male Genitalic Structures. Pygophore pyriform with a longitudinal median impression flanked by 2(1+1) bulbous elevations laterally; surface granular, anterior margin carinate. Parameres as Figure 3a–e.

Ventral Side. Pro-, meso- and metasternum medially fused, but weak transverse sutures are present. Sternites I to III completely fused. Spiracles II to VII lateral and visible from above, VIII subterminal.

Legs slender, trochanters distinct, claws with thin pulvilli.

Females. Similar to male but larger and body more rounded laterally. The median ovate elevation on MTg VI is mostly missing or scarcely indicated. DLTg VII with

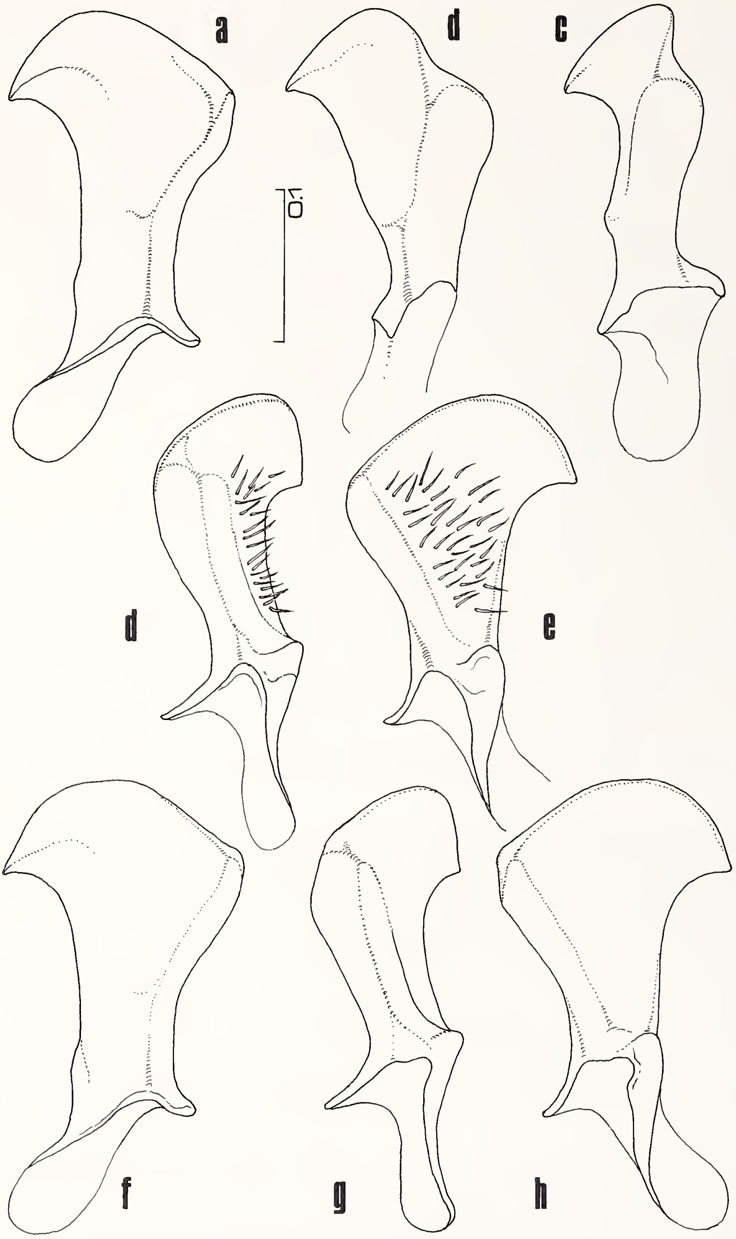

Fig. 3. a–e. *Acaraptera waipouensis,* n. sp., left paramere in different positions. f–h. *Acaraptera myersi,* left paramere.

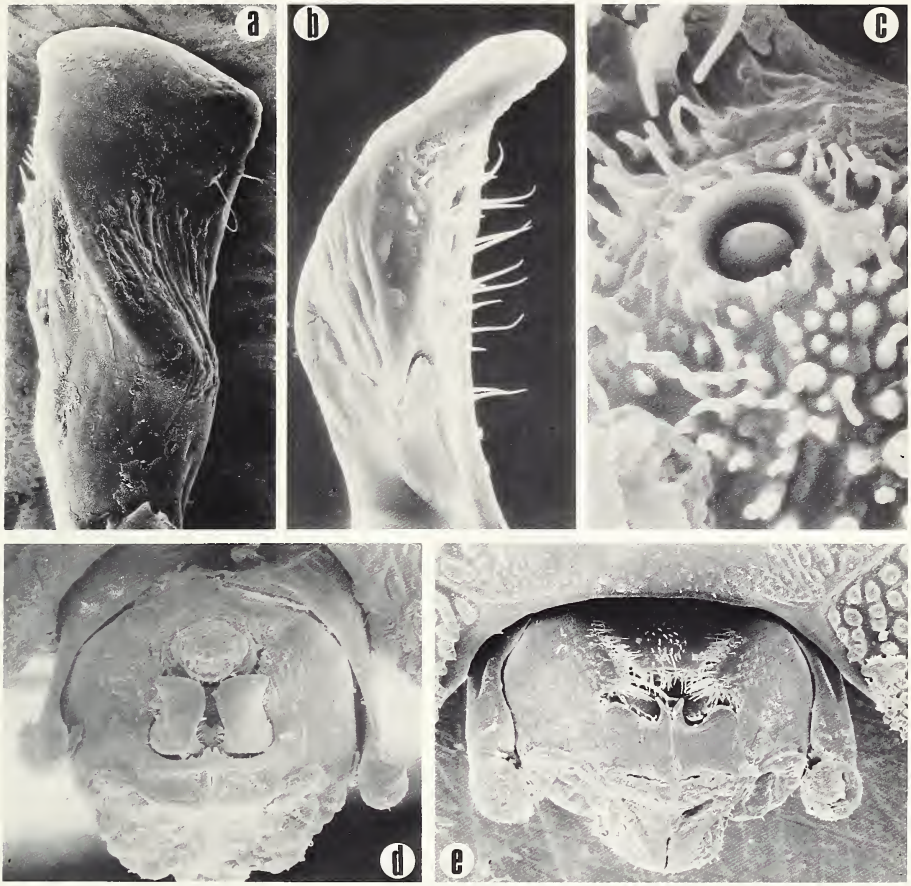

Fig. 4. a–b. *Acaraptera myersi.* a. Left paramere dorsal. b. Right paramere lateral. c–d. *Acaraptera waipouensis,* n. sp. c. Cuticular structure on ventral posterior margin of head, on top right the rostral groove is visible. d. Pygophore dorsal. e. *Leuraptera yakasi,* n. sp., pygophore dorsal.

nearly straight lateral margins converging posteriorly. Paratergites VIII triangularly rounded, not reaching apex of triangular tergite IX.

Coloration. Amber with variable extension of darker parts as medial part of pro- and mesonotum, metanotum and MTg I+II except the median oblique elevations, DLTg I+II, median elevation of tergal disk except a light spot over MTg IV and V, lateral parts of MTG VII and pygophore. Females are mostly darker with piceous abdomen but with amber markings of glabrous impressions and posterior-exterior angles of DLTg III to VI.

Holotype. ♂, New Zealand ND: Waipoua State Forest, ca. 150 m, Toronui Track, 13 April 1980 A. Newton & M. Thayer leg. in kauri, podocarp, broad-leaf, nikau-palm forest leaf and log litter (AMNH).

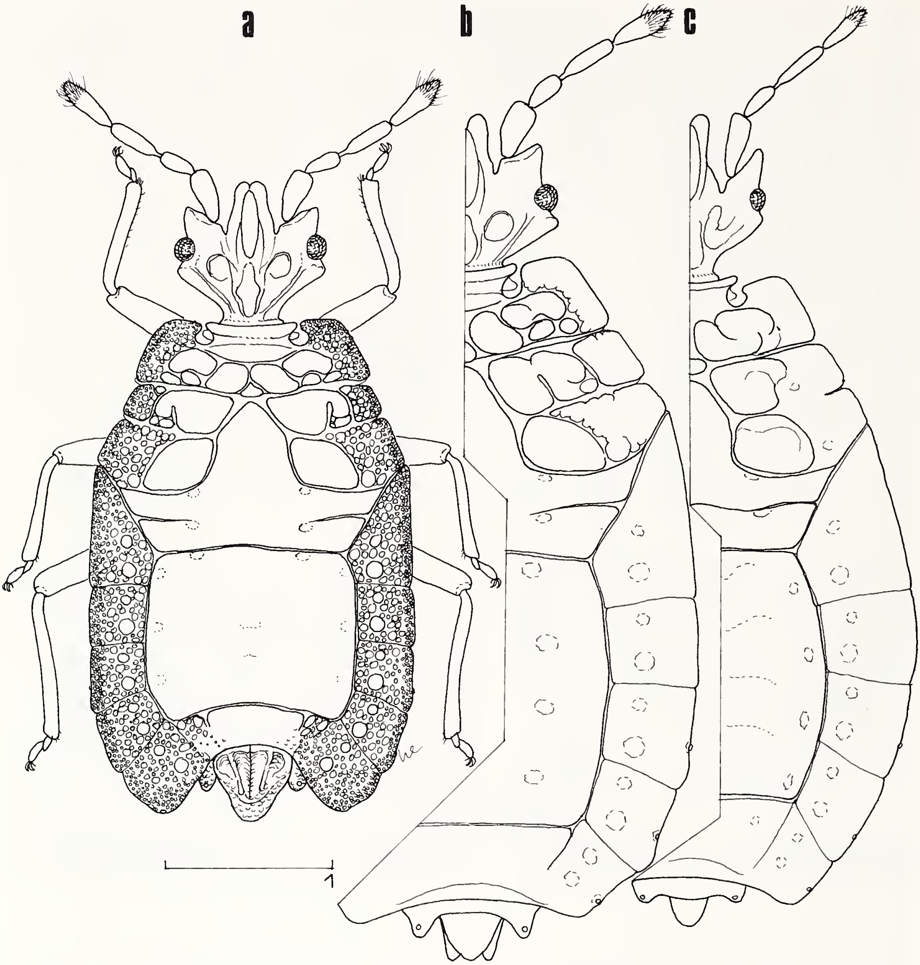

Fig. 5. a–b. *Leuraptera yakasi,* n. sp. a. Male paratype, dorsal habitus. b. Female paratype, dorsal habitus. c. *Leuraptera zealandica* Us. & Mats., female allotype, dorsal habitus (after Usinger and Matsuda).

Paratypes. 2♂♂ 3♀♀ collected with holotype; 2♀♀ collected in same forest and circumstances and by same collectors but Kauri Ricker Track, 13 April 1980; 4♂♂ 1♀ same but Wairau summit 387 m 14 April 1980; 1♀ 11–14 April 1980; 1♀ same but Waikohatu Bridge 290 m 12 April 1980; 1♀ same but Yakas Tree Track 350 m 13 April 1980 (all in AMNH); 4♂♂ 6♀♀ Neuseeland, Nordinsel, Intamoe Rg. N. Dargaville Okt. 86 Haller (coll. EH).

Measurements. Holotype male: Length 3.15 mm, width of abdomen across tergite III, 1.72 mm; female: length 3.35–3.50 mm, width of abdomen across tergite IV, 2.05–2.10 mm; relative length of antennal segments I to IV = 12:6:9.5:11.5. Paratype males vary in size from 3.1 to 3.2 mm.

Etymology. Named after its type locality, Waipoua State Forest.

Acaraptera myersi Usinger and Matsuda, 1959

Figs. 2c; 3f–h; 4a, b

Acaraptera myersi Usinger and Matsuda 1959:149 (descr., fig. ♀). Lee and Pendergrast 1976:492 (stylets). Kormilev and Froeschner 1987:65 (cat.).

Material Examined. There are several specimens which have been collected with holotype and paratypes of *A. waipouensis,* n. sp. at Waipou State Forest in April 1980, lg. A. Newton & M. Thayer (AMNH) and few from Intamoe Range N. Dargaville lg. Haller (coll. EH). Further records are from New Zealand BP: Tarukenga Scenic Reserve 9 km W. Ngongotaha, ca. 490 m, 2 April 1980 (1♂, 3♀♀); NZ TO: Opepe Reserve Lake Roroiti 610–650 m, St. Arnaud Track 25 March 1980 (1♀), all lg. A. Newton and M. Thayer (AMNH).

As the genitalic structures are not yet known, the parameres being similar to those of *A. waipouensis,* n. sp. are figured (Figs. 3f–h; 4a, b).

Acaraptera, new species

There is a single female from North Island, Intamoe, Rg. N. Dargaville in my collection, which differs considerably in some characters from both other species of New Zealand Acaraptera: Smaller, body less rounded (like ♂ of *A. waipouensis*), fusion of thorax as in *waipouensis,* but oblique elevations at middle of metanotum, MTg I and II evanescent. Tergal plate with distinct sutures delimiting mediotergites III to VI. Length 2.95 mm, width of abdomen across tergite III 1.65 mm.

Due to the single specimen at hand I refrain from describing the taxon until more material is available.

Leuraptera yakasi, new species

Figs. 4e; 5a–c

Diagnosis. Distinguished from the only known species of this genus *L. zealandicus* Usinger and Matsuda 1959, by the following characters: head wider, antennal segment III longer than I, antenniferous tubercles and clypeus shorter; collar not produced over anterolateral margin of pronotum; lateral portion of mesonotum completely separated from metanotum by a deep sulcus; suture between MTgI and II only laterally visible, lacking at middle where tergites are completely fused. Body of female less rounded, subparallel (see Fig. 5b, c).

Description. Male. Apterous; body parallel (♂) or subparallel (♀) with thorax constricted anteriorly; surface smooth and matte beneath incrustation, except head, lateral parts of thorax and DLTg's which are covered with shiny granules of different size. Appendages finely granulate.

Head. Distinctly wider across eyes than long (37:31), anterior process of genae longer than clypeus, its apices rounded and contiguous. Antenniferous tubercles short, its apices blunt. Eyes semiglobose. Postocular tubercles angular, reaching lateral margin of eyes, strongly converging to constricted neck region. Vertex with a strong median longitudinal carina flanked by 2(1+1) smooth elevations and posteriorly converging carinae on either side. Antennae about 1.3× as long as width across eyes (49:37), segment III pedunculate at base; relative length of segments I to IV = 12:9:

14:14. Rostrum short, not reaching posterior margin of head, arising from a slit-like atrium; rostral groove large, its lateral margins formed by granulate carinae.

Thorax. Pronotum 3× as wide as long (54:17) with nearly straight but upturned lateral margins, converging anteriorly; anterolateral angles rounded, deeply incised before collar, the latter ring-like bearing 2(1+1) rounded tubercles dorsolaterally and 2(1+1) laterally projecting tubercles on a lower level. Collar depressed posterior to ring-like rounded ridge, followed by a transverse elongate ridge posteriorly. Disk with irregular flat elevations separated by deep sulci, irregularly granulate laterad.

Mesonotum separated into 2(1+1) lateral lobes by a prominent median elevation which is highest on mesonotum and comprises the fused median portions of meso- and metanotum and fused MTg I + II. Lateral lobes with a smooth hook-like sclerite on either side, lateral portion densely granulate, separated by a deep suture from metanotum.

Metanotum also split by fused median elevation into 2(1+1) lobes which show a smooth ovate sclerite on inner side; roughly granulate laterad.

MTg I and II fused at middle, separated laterally by a distinct suture. Lateral margin straight, strongly converging posteriorly.

Abdomen. Tergal disk flat, MTg III to VI completely fused, lateral margins slightly convex. DLTg II and III fused; lateral margin of DLTg II to V parallel, VI converging posteriorly, VII rounded, surface roughly granulate. MTg VII smooth, elevated posteriorly, basolateral angles granulate. Paratergites VIII small with rounded apices reaching only ½ of pygophore.

Male Genitalic Structures. Pygophore pyriform with a shorter dorsal lobe and a projecting lower lobe, the first with a median cleft and 2(1+1) longitudinal carinae converging posteriorly, depressed laterad. Anterior margin with a transverse carina. Posterior rim of dorsal opening with 2(1+1) large projecting sclerites (like parandria of Aradinae) which are contiguous along median line, with rounded anterolateral lobes and pointed, bent downward apices at middle which are fused posteriorly to the rim, but are flexible and can be upfolded along the median cleft, a flexible line following the posteriorly converging carinae (Fig. 4e). Opening of pygophore laterally with nose-like projections which are densely beset with long setae. Parameres could not be studied.

Ventral Side. Smooth and shiny medially, pleura and ventral LTg's granulate, pygophore transversely rugose. Spiracles II to IV ventral, gradually approaching lateral margin but not visible from above; V to VII lateral and visible from above; VIII terminal.

Legs slender, trochanters distinct, claws with thin long pulvilli.

Female. Larger than male and body more rounded laterally. Posterior margin of MTg VII sinuate; paratergites VIII produced posteriorly and angularly rounded, reaching ½ of tricuspidate tergite IX.

Coloration. Uniformly ferrugineous, partly darkening along deep sutures of thorax and abdomen.

Holotype. ♂, New Zealand ND: Waipuoa State Forest, Yakas Tree Track 350 m 11 April 1980 in mixed broadleaf podocarp forest, leaf and log litter, lg. A. Newton and M. Thayer (AMNH).

Paratypes. 1♂ 1♀ collected with holotype (AMNH); 1♂ 2♀♀ Neuseeland, Nordinsel, Intamoe Rg. N. Dargaville, Okt. 86 lg. Haller (coll. EH).

Measurements. Holotype male: Length 3.80 mm, width of abdomen across tergite IV, 1.95 mm; Female: length 4.90–4.95 mm, width of abdomen, 2.75 mm; relative length of antennal segments I to IV = 14:9:16:15. Paratypes male vary in size from 3.50 to 3.80 mm.

Etymology. Named after the type locality, Yakas Tree Track.

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A REMARKABLY LARGE NEW SPECIES OF *DISCOCORIS* FROM COLOMBIA (HETEROPTERA: THAUMASTOCORIDAE)

James A. Slater[1] and Randall T. Schuh[2]

[1]Department of Ecology and Evolutionary Biology, University of Connecticut,
Storrs, Connecticut 06268, and
[2]Department of Entomology, American Museum of Natural History,
New York, New York 10024

Abstract.—*Discocoris imperialis,* recorded as occurring on the infructescences of the palm *Socratea montana* R. Bernal & A. Henderson, and of nearly twice the length of previously known species of the genus, is newly described from Colombia. Scanning electron micrographs are presented of the pretarsus, head, and nymphal abdominal scent glands.

The family Thaumastocoridae has for many years been a subject of special interest to hemipterists because of its unusual distribution (Australia-India-Western Hemisphere) and the difficulty of understanding its systematic relationships to other families of Cimicomorpha.

Drake and Slater (1957) reviewed the classification and systematic position of the Thaumastocoridae. Slater and Brailovsky (1983), in reviewing the South American taxa, refuted Viana and Carpintero's (1981) proposal to elevate the new world Xylasstodoridinae, containing the genera *Xylastodoris* Barber and *Discocoris* Kormilev, to family level and returned it to subfamily status. [See Slater and Brailovsky (1983) for use of this subfamily spelling.]

The single species of *Xylastodoris* is known only from Cuba and southern Florida. *Discocoris* was heretofore known from four South American species.

Western Hemisphere thaumastocorids are rarely collected, presumably because of their relative inaccessibility on their palm hosts. Thus any additions to our knowledge of the group are important. *Xylastodoris luteolus* Barber is known to feed on the newly developing fronds of the royal palm, *Roystonea regia* (HBK) O. F. Cook (Baranowski, 1958). Species of *Discocoris* for which host information is available feed on the infructescenses of palms (Schuh, 1975).

The species described below is of special interest because of its relatively great size, and because its discovery affords an opportunity to study the immatures with accompanying host data.

Discocoris imperialis, new species

Diagnosis. This is a relatively gigantic thaumastocorid, nearly twice the length and several times the bulk of any previously known species. In the key to *Discocoris* species of Slater and Brailovsky (1983), it will run to couplet 1 with *D. kormilevi* Viana and Carpintero because of the great forward expansion of the anterolateral portions of the pronotum. It also agrees with *D. kormilevi* in having the ocelli placed considerably behind the posterior margins of the compound eyes. Slater and Brailovsky (1983) suggested that the other species of *Discocoris* have the ocelli located on a line with the posterior margin of the eyes. This is not true of *D. drakei* Slater & Ashlock, which also has an anteriorly tapering tylus.

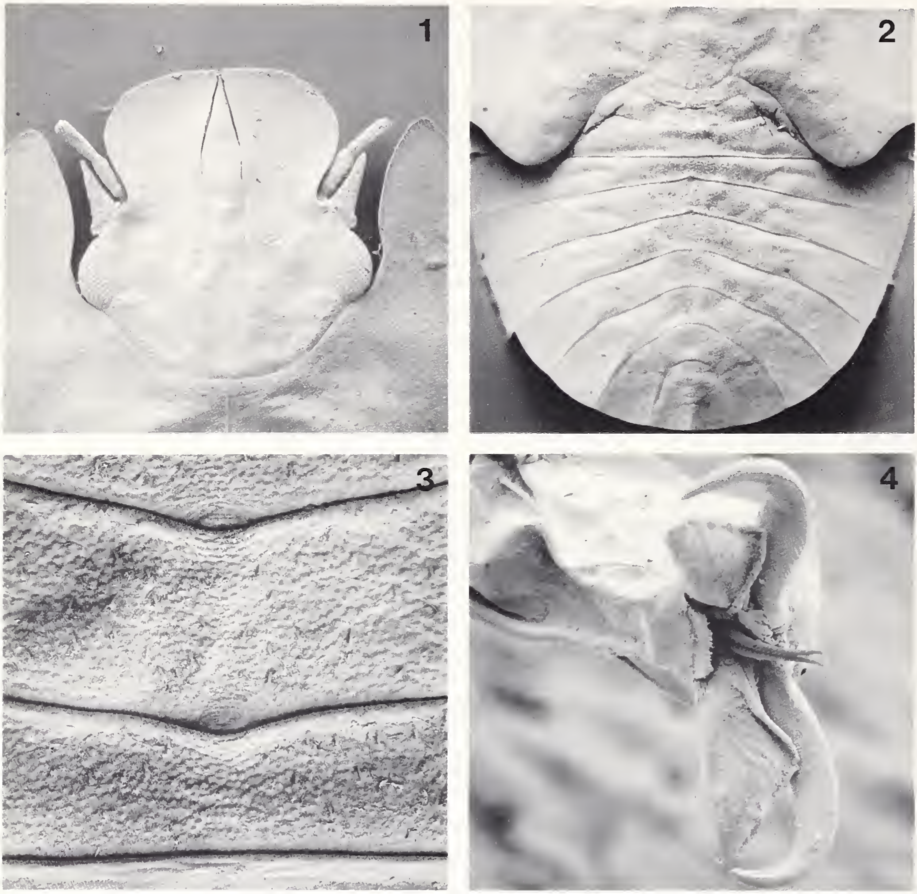
Description. Female. COLORATION, VESTITURE, AND SURFACE TEXTURE. Very broadly ovate. General coloration light testaceous, shading to reddish brown over almost entire head (except anterior portions of juga), mesal area of pronotum, and central area of scutellum and hemelytra. Eyes red. Marked with chocolate brown on posterior margin of pronotum before base of clavus, on distal ends of clavus, and anteocular head spines. Corial cells spotted with large irregular brown blotches. Pronotum with an incomplete pale median stripe.

Entire dorsum with large coarse nonanastomosing brown punctures, these becoming increasingly small laterally on pronotal and corial flanging expansions. Clavus with 3 rows of punctures. Entire body surface nearly glabrous, minute hairs present laterally.

STRUCTURE AND MEASUREMENTS. Head broad, non-declivent. Juga arcuate, expanded laterally from base to level of middle of tylus, almost meeting mesally, extending forward same distance as tylus. Tylus strongly tapering anteriorly to terminate in a blunt "point." Eyes strongly protruding but not stalked. An elongate, acute, slightly curved spine (antenniferous tubercle) arising at anterior margin of eye and extending anterolaterad to level of distal end of first antennal segment. Ocelli positioned near base of head, far behind posterior margins of compound eyes.

Total body length 4.64 mm. Length of head 0.92 mm, width 1.10 mm, interocular space 0.70 mm, maximum distance across juga 0.80 mm. Pronotum with anterior margin very deeply concave, expanded laterally and produced forward beyond eyes, lateral margins angulate with greatest width at middle of pronotum, a few small teeth present along lateral edge: median length 0.82 mm, maximum width 2.84 mm, maximum length 1.40 mm, width across base 2.40 mm. Scutellum shallowly convex lacking a median elevation, length 0.82 mm, width 1.26 mm. Length of claval commissure 0.30 mm. Corium broadly, ovately rounded, asymmetrical, maximum width near anterior end; veins elevated, forming closed cells, lateral margins lacking small teeth, maximum width near anterior end; length 3.04 mm, median distance (apex of clavus to apex of corium) 1.80 mm, maximum width across hemelytra 3.60 mm. Bucculae low anteriorly becoming increasingly less elevated posteriorly, buccal cavity open throughout length, extending nearly to base of head, exceeding second labial segment posteriorly. Meso- and metasternum with a deep median furrow. Forefemora moderately incrassate, mutic. Labium very long extending to fourth (3rd visible) abdominal sternum, second segment remote from base of head, third segment reaching middle of mesosternum; length of labial segments (in mm) I 0.20, II 0.30, III 1.08, IV 1.20. Length of antennal segments (in mm) I 0.20, II 0.20, III and IV missing. Ovipositor completely wanting.

Fifth-instar nymph. Body extremely flattened, concave below, almost "scalelike," broadly ovate, nearly hemispherical. Light testaceous. Head shape much as in adult, but juga exceeding tylus and almost in contact anterior to apex of tapered tylus (Fig. 1). Elongate spine anterior to eye straight, with outer edge of base expanded as a blunt projection (Fig. 1). Length of head 0.86 mm, width 1.00 mm, interocular space 0.68 mm. Pronotum produced forward beyond eyes to area of maximum width of juga, most of head being immersed beneath enormously expanded arcuate anterior pronotal projections (Fig. 1): median length 0.52 mm, maximum length 1.24 mm,



Figs. 1–4. *Discocoris imperialis.* 1. Dorsal view of head of fifth-instar nymph (62×). 2. Abdominal tergum of fifth-instar nymph (35×). 3. Detail of abdominal scent gland opening of fifth-instar nymph (200×). 4. Pretarsus (722×).

maximum width 2.50 mm; posterior margin straight. Mesothoracic wing pads broadly arcuate, but curved mesad at almost a right angle at distal third of outer margin, tapering to rounded apex in an almost sigmoid curve. Wing pads barely extending over anterior portion of abdominal tergum three, length 1.08 mm, maximum width across pads 2.80 mm. Abdomen with a minute scent gland opening between abdominal terga 3–4 and 4–5 (Figs. 2, 3). All abdominal terga from anterior margin of segment 4 through segment 9 sloping anteriorly from lateral margins to meson, with increasing curvature successively on each segment posteriorly to apex of abdomen (Fig. 3). Labium extending caudad onto abdominal sternum 4; length of segments (in mm) I 0.18, II 0.20, III 0.94, IV 1.0. Antennae as in adult. Pretarsus as in Figure 4.

Fourth-instar nymph. Similar in shape and color to fifth instar, but with wing pads scarcely covering tergum 1 and labium extending caudad onto abdominal sternum 6.

Holotype. Female, COLOMBIA: *Medellin:* near El Nueve, Quibdo Road, at 1,150 m. Henderson & Bernal, on infructescence of *Socratea montana* R. Bernal & A. Henderson (Palmae); deposited in the American Museum of Natural History, New York.

Additional specimens. Same data as holotype, 14 fifth-instar nymphs, 1 fourth-instar nymph, 3 third-instar nymphs; deposited in the American Museum of Natural History.

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A FURTHER CONTRIBUTION TO THE SYSTEMATICS OF THE GENUS *TOONGLASA* (HEMIPTERA: LYGAEIDAE: BLISSINAE)

James A. Slater[1] and Harry Brailovsky[2]

[1]Department of Ecology and Evolutionary Biology, University of Connecticut,
Storrs, Connecticut 06268, and
[2]Instituto de Biologia, Universidad Nacional Autonoma de Mexico,
Mexico, D.F.

Abstract.—Six new species of *Toonglasa* are described from Mexico and one from Venezuela. A revised key to all known species is included, together with habitat and host plant data. Most species live upon various species of bamboo with several instances of more than one species occurring on the same host plant. Additional distributional data are given for *Toonglasa barrerai, forficuloides, tumorosis, tylosis, munda, thackstonae* and *umbrata.* A dorsal view is included of *T. elegans* and figures of the genitalia of *T. bifida.*

One of the most striking developments in blissine systematics in recent years has been the discovery of an extensive fauna living on various species of bamboos in Mexico.

In the present paper we describe seven new species, present a revised key to species that expands that of Slater and Brailovsky (1983), discuss host plant relationships and give additional distributional data for several previously described species.

This additional information is made possible largely by the extensive collections of the junior author and his colleagues in recent years.

Toonglasa was established by Distant (1893) for the large flattened species *forficuloides.* Distant had before him a single male collected at Omilteme, Guerrero, Mexico at 5,000 feet elevation. This remained the only known specimen for nearly 100 years until the junior author and colleagues discovered sizeable populations of *forficuloides* and established its host plant as a species of bamboo.

This new material allowed dissection of the genitalia and the study of nymphs and led Slater and Brailovsky (1983) to conclude that *forficuloides* was congeneric with *Extarademus* Slater and Wilcox (1966).

Although genitalia sometimes will separate species in this genus, they have not proven to be useful for separation of most of the closely related species described below; the external differences in all cases have proved to be more useful and important.

REVISED KEY TO SPECIES OF *TOONGLASA*

1. Pronotum in large part dull pruinose in texture, never shining over entire dorsal surface 2
– Pronotum either shining over entire dorsal surface or at most with a very narrow pruinose strip along extreme posterior margin 14
2. Tylus much broadened at anterior end to form a splayed-out, truncate apex; males

with pair of sharp spines projecting from ends of connexiva seven .... *tylosis* (Slater & Wilcox)

– Tylus narrow and of uniform width throughout, never broadly splayed out and truncate at apex; males either with or without acute spines projecting from ends of abdominal connexiva seven 3

3\. Second antennal segment relatively elongate, always more than 1.25 times interocular space 4

– Second antennal segment relatively short, never more than 1.20 times interocular space 9

4\. Antennae uniformly black 5

– Antennal segments one, two and three light yellow 6

5\. Head pruinose except for tylus and a small area anterior to each ocellus; scutellum completely pruinose; antenniferous tubercles not hooked; legs bright yellow .... *yushaniacola* Slater & Brailovsky

– Head broadly shining on surface of vertex; scutellum with a shining elevated median ridge; antenniferous tubercles strongly hooked; femora black .... *nigra,* n. sp.

6\. Pronotal shining bar very broad, encompassing entire posterior area of pronotum and reaching posterior pronotal margin .... *tumorosoides,* n. sp.

– Pronotum with a distinct but narrow pruinose area along posterior margin behind transverse shining bar 7

7\. Pronotum chiefly pruinose, shining calli patches extensively interspersed with pruinose dots; males with short acute posteriorly projecting spines from posterior margin of 7th abdominal connexiva; sterna 5–7 with spines present on elevated tumid areas .... *tumorosis* (Slater & Wilcox)

– Pronotum with extensive shining areas; calli areas smooth and polished, at most with a few scattered silvery hairs present; males lacking spines projecting from 7th abdominal connexiva; if spines present on abdominal sterna these not placed on swollen tumid areas 8

8\. Antennae chocolate brown to black; transverse impression across pronotum broadly pruinose throughout; scutellum dark gray, strongly contrasting with adjacent pale corium; males with conspicuous hooked spines on sterna three through seven (brachypters only known) .... *wilcoxae,* n. sp.

– First three antennal segments pale yellow; transverse pronotal impression with pruinosity tapering from lateral margin and not present mesally; scutellum pale tan, concolorous with adjacent areas of corium; males lacking hooked abdominal sternal spines .... *prunimunda,* n. sp.

9\. Males with numerous sharp spines present on abdominal sterna five through seven ... 10

– Males lacking distinct sharp spines on abdominal sterna 11

10\. Membrane of front wing with veins anastomosing; body short and stout .... *reticulata,* n. sp.

– Membrane of front wing with veins longitudinal, not anastomosing; body elongate and slender .... *umbrata* (Distant)

11\. Labium subequal in length to pronotal length; eyes placed on short broad "shelf" .. 12

– Pronotal length greater than labial length; eyes sessile 13

12\. Fore femur with a stout bifid spine; membrane of fore wing with a large dark discal central macula, but basal and marginal areas of membrane pale; males lacking a series of ridges and grooves along posterior margin of sternum eight .... *bifida,* n. sp.

– Fore femur with a single slender spine; membrane of fore wing dark gray-black throughout; males with a series of ridges and grooves along posterior margin of sternum eight .... *barrerai* Slater & Brailovsky

13\. Pronotum with silvery hairs covering large shining calli area; clavus, corium and membrane uniformly pale tan .... *thackstonae* Slater & Brailovsky

– Pronotal calli glabrous and shining; clavus dark gray contrasting strongly with pale yellowish-white adjacent corial area; membrane with a large black median macula . . . . *pulchella,* n. sp.

14. Membrane with a large, distinct median dark discal spot (Cuba) . . . . *discalis* (Barber)

– Membrane often suffused, but lacking a distinct discal spot 15

15. Labium extremely short, extending only short distance onto prosternum, remote from fore coxae, with third labial segment not attaining base of head . . . . *humerus* (Slater & Wilcox)

– Labium more elongate, extending posteriorly almost to fore coxae, third labial segment considerably exceeding base of head 16

16. Extreme posterior portion of pronotum with a very narrow marginal pruinose band, contrasting with shining area of rest of pronotum; males with hind femora strongly incrassate and bearing a series of short spines near middle of ventral surface; metathoracic scent gland auricle relatively broad and ellipsoidal . . . *munda* (Slater & Wilcox)

– Pronotum completely shining even along extreme posterior margin; males with hind femora only moderately incrassate, unarmed below; metathoracic scent gland auricle elongate and slender 17

17. An elongate protrusion extending posteriorly from abdominal connexivum seven (fig. 1) 18

– No elongate lateral projection protruding from abdominal connexivum seven 19

18. Body very broad and flat, width of pronotum more than 1¼ times median pronotal length . . . . *forficuloides* Distant

– Body slender, not strongly broadened, pronotal width much less than 1¼ times pronotal length . . . . *elegans,* n. sp.

19. Males with elongate median spine projecting from posterior margin of 8th sternum . . . . *collaris* (Signoret)

– Males lacking a projecting spine from posterior margin of 8th sternum, the latter with serrate edge and median bulge, but lacking a distinct spine . . *collaroides* (Slater & Wilcox)

Toonglasa elegans, new species

Fig. 1

Description. Relatively robust, elongate, parallel sided. Head, anterior pronotal lobe, mesal portion of posterior lobe before transverse humeral bar and scutellum black. Posterior pronotal lobe laterally and posteriorly bright yellowish tan. Hemelytra chiefly pale yellow. Clavus, inner ½ to ⅓ of corium and entire membrane suffused with gray brown coloration. Abdomen bright red brown with contrasting pale yellow connexivum. All legs and first antennal segment bright yellow. Second and third antennal segments reddish brown mesally, becoming paler at proximal and distal ends. Fourth antennal segment dark chocolate brown. Pronotum completely shining on dorsal surface. Head chiefly shining above, but with pruinosity present on juga, at base of antenniferous tubercles and area around ocelli. Scutellum, propleuron below shining lateral bar, mesopleuron and anterior lobe of metapleuron gray pruinose. Mesosterum shining and polished. Clothed on dorsal surface with rather elongate semi-upright hairs.

Head non-declivent, tylus attaining middle of first antennal segment. Eyes moderately large, sessile. Vertex convex. Length head 0.76, width 0.81, interocular space 0.48. Lateral pronotal margins narrowing convexly from humeral angles to anterior margin; transverse impression shallow but complete; posterior margin evenly concave. Length pronotum 1.18, width 1.40. Scutellum with a very weak median ele-

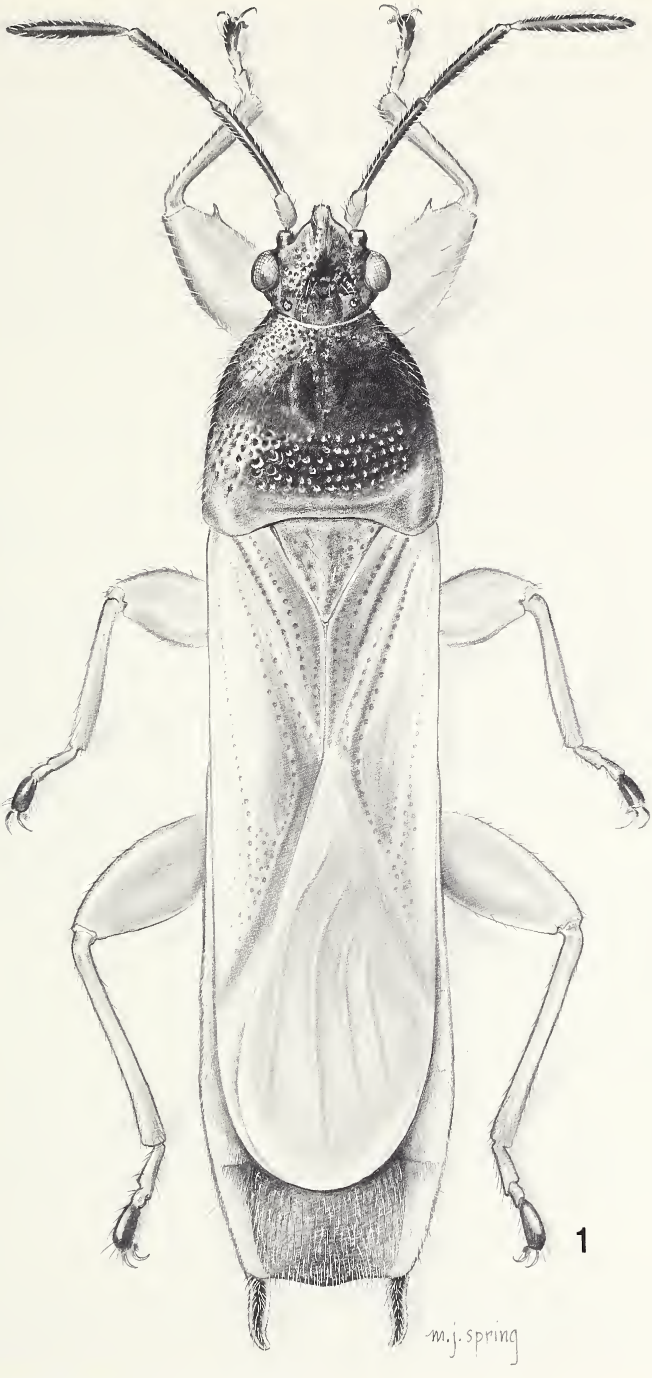


Fig. 1. *Toonglasa elegans,* n. sp., dorsal view.

vation. Length scutellum 0.62, width 0.62. Lateral corial margins parallel sided. Membrane extending midway over seventh abdominal tergum. Length claval commissure 0.68. Midline distance apex clavus-apex corium 1.52. Midline distance apex corium-apex abdomen 0.86. Metathoracic scent gland auricle curving anteriorly, short, rounded, posterior ½ shining, anterior ½ pruinose. Both fore and hind femora strongly incrassate; fore femur with a large ventral spine on distal ⅓; hind femora mutic. Connexiva of seventh abdominal segment produced posteriorly as a pair of elongate spines that greatly exceed posterior end of genital capsule. Labium reaching posterior margin of prosternum, exceeding fore coxae. Length labial segments I 0.42, II 0.34, III 0.36, IV 0.46. Antennae terete, fourth segment narrowly fusiform. Length antennal segments I 0.22, II 0.70, III 0.66, IV 0.82. Total body length 6.24.

Holotype. Male. MEXICO: *Veracruz:* Sontecomapan. 22.XII.1983 (H. Brailovsky). In UNAM.

Paratypes. 2 males, 4 females same data as holotype. 3 males, 2 females same locality 20–21.III.1985 (H. Brailovsky, E. Barrera). In UNAM and J. A. Slater collections.

Discussion. The type series does not differ appreciably from the holotype described above other than that most specimens have a somewhat more intensely darkened coloration mesally on the hemelytra that gives the insect the appearance of dark wings with pale yellow lateral stripes.

Although *elegans* resembles the much larger and broader *forficuloides* in having elongate connexival projections (Fig. 1) it is readily recognizable by its much smaller less broadened and flattened body, a much shorter labium and a pruinose rather than shining scutellum.

The type series including the nymphs described below were taken on *Bambusa longifolia* (Forun.) McClure.

Several nymphs that were taken with the type series plus a long series taken at the same locality by the junior author and E. Barrera on 21.III.1985 are remarkably colored. The thorax has a large black area before the wing pads and another covering TM7, TM8 and TM9 (see Slater, 1979, for code to nymphal sclerites). These dark areas together with the almost black fourth antennal segments contrast strikingly with the pale yellow color of the remainder of the body. In live specimens the abdomen may be lightly suffused with pale red. Other features of the fifth instar nymphs are as follows: Head and pronotum light tan, wing pads, abdomen and appendages almost white. TL7 reduced to a narrow stripe, but black and strongly sclerotized. SGA5 and SGA6 pale yellow, large and semi-circular, much larger than SGP5 and SGP6. TM sclerites present. Other dorsal sclerites present but small and pale yellow. SM sclerites 7, 8 and 9 large, black or very dark brown. SL7 and SL8 fused, black.

The dark band across the mesonotum and the darkened distal end of the abdomen in contrast to the otherwise pale coloration make these nymphs very distinctive.

Toonglasa prunimunda, new species

Description. Head and anterior pronotal lobe black. Thoracic pleura and sterna, abdomen, fourth antennal segment and posterior lobe of pronotum bright reddish brown. Scutellum and hemelytra nearly uniformly pale straw-yellow. Legs and first three antennal segments uniformly bright yellow. Membrane nearly uniformly smoky gray. Dorsal surfaces of head and pronotum largely shining and non-pruinose. Pruinosity present as follows: head dorso-laterally behind eyes, posterior half of ventral head surface, a complete collar-like strip across anterior area of pronotum, a narrow strip along extreme posterior margin behind shining humeral bar, entire propleuron and prosternum except for lateral shining bar, pruinosity present above this bar and covering lateral margins and extending conspicuously onto lateral portions of dorsal pronotal surface, entire scutellum, mesopleuron, metapleuron and metasternum. Mesosternum polished and shining. Dorsal surface with only a few inconspicuous short scattered hairs present.

Head non-declivent, tylus almost attaining distal end of first antennal segment. Eyes large, covering most of lateral surface of head, not produced on a shelf. Vertex moderately convex. Length head 0.58, width 0.64, interocular space 0.36. Pronotum with lateral margins straight from humeral angles to middle of calli, then narrowing convexly to anterolateral angles. Posterior margin very shallowly concave with coarse anastomosing punctures present on posterior pronotal lobe anterior to shining transverse bar. Length pronotum 0.94, width 0.58. Scutellum with an inconspicuous median elevation. Length scutellum 0.48, width 0.46. Length claval commissure 0.48. Midline distance apex clavus-apex corium 1.02. Midline distance apex corium-apex abdomen 1.30. Membrane reaching anterior margin of 7th abdominal tergum. Metathoracic scent gland auricle elongately elliptical, curving anteriorly. Fore femora incrassate with a single large spine ventrally on distal ⅓. Hind femora more strongly incrassate than fore femora, swollen and with an inconspicuous spinule near middle of ventral surface. Labium extending between fore coxae, remote from posterior margin of prosternum. Length labial segments I 0.26, II 0.20, III 0.22, IV 0.22. Antennae conventionally terete, fourth segment narrowly fusiform. Length antennal segments I 0.14, II 0.44, III 0.42, IV 0.58. Total body length 4.76.

Holotype. Male. MEXICO: *Oaxaca:* Chacalapa 6.II.1988 (E. Barrera, A. Cadena, E. Ramirez). In UNAM.

Paratypes. MEXICO: *Oaxaca:* 3 males, 4 females same data as holotype. 1 male, 2 females, km 3 Carr. Pochutla-Oaxaca 3.VI.1985 (E. Barrera). 2 females Chacalapa 2.VI.1987 (F. Arias). 7 males same data as above (H. Cervantes). 1 male, 2 females same data as above (E. Barrera). 6 males, 4 females Pochutla-Piedra Lumbre 2.VI.1987 (E. Barrera). 2 males, 2 females same data as above (L. Cervantes). 1 male, 2 females same data as above (F. Arias). 1 female Amozoc 4.III.1986 (E. Barrera). 1 female km 219 Call. 17s. Pto. Angel 19.VI.1984 (H. Velazco). 2 females km 17 Carr-Sayula-Cd. Aleman 28.V.1984 (A. Ibarra).

Discussion. This species is undoubtedly a member of the "*munda* complex" by virtue of the narrow pruinose strip across the posterior margin of the pronotum and the greatly enlarged and spined hind femora of the males. It is readily separable from *munda* by having the pruinosity extending well above the shining propleural bar and onto the dorsal surface of the pronotum. One female paratype has the reddish coloration of the holotype, another female has the anterior ⅔ of the pronotum and all of the head except the distal end of the tylus black. Slater and Brailovsky (1983) noted the same color dimorphism in *T. tumorosis* and did not believe that it was a teneral condition.

T. prunimunda was taken on the bamboo *Chusquea longifolia* Sus. together with *munda,* another example of more than one species of *Toonglasa* occurring on the same host plant.

Toonglasa tumorosoides, new species

Description. Very similar in general form, size and shape to *tumorosis.* General coloration dull, gray-black; becoming pale yellow laterally on corium posterior to distal end of claval commissure, base of membrane, entire abdominal connexivum, antennal segments one, two and three and legs. Body chiefly dull gray pruinose with pronotal calli outlined by a series of shining black dots forming a triangle. Entire posterior third of pronotum including extreme posterior margin bright shining yellow brown. Scutellum completely pruinose. Fourth antennal segment black. Membrane with exception of pale base completely smoky gray brown without pale area distally. Abdomen shining black. Clothed with a mixture of short but upright silvery and black hairs intermixed with decumbent silvery hairs.

Head non-declivent, eyes set well away from anterolateral angles of pronotum. Tylus extending to middle of first antennal segment. Vertex convex. Length head 0.54, width 0.70, interocular space 0.34. Pronotum conventionally shaped, transverse impression complete but shallow. Length pronotum 0.96, width 1.04. Scutellum lacking a median carina. Length scutellum 0.50, width 0.48. Length claval commissure 0.54. Corium with lateral margins completely straight. Membrane reaching onto base of seventh abdominal tergum. Midline distance apex clavus-apex corium 1.14. Midline distance apex corium-apex abdomen 1.44. Abdomen with a faint obsolete median keel on eighth abdominal sternum; seventh abdominal connexiva produced into short but distinct backwardly projecting spines. Mesal area of sterna five, six and seven swollen with spinose knobs as in *umbrata* and *tumorosis.* Metathoracic scent gland auricle elongately rounded, angled slightly anterolaterad. Fore femora moderately incrassate bearing a single ventral spine on distal third. Labium short, at most attaining anterior margin of fore coxae, second segment remote from base of head. Length labial segments: I 0.20, II 0.20, III 0.20, IV 0.24. Antennae slender, terete, fourth segment very narrowly fusiform. Length antennal segments: I 0.46, II 0.58, III 0.54, IV 0.64. Total body length 5.40.

Holotype. Male. MEXICO: *Chiapas:* Ocosingo-Chajul Reserva Montes Azules 10–16.VII.1987 (F. Arias, R. Barba, L. Cervantes). In UNAM.

Paratypes. Chiapas: 6 males, 9 females same data as holotype. 1 male same data as above (Arias); 7 males, 10 females Boca Lacantum Rio Usumacinta 25.V.1984 (M. Garcia); 5 males, 4 females km 27 Carr. Morelos-Malpaso 5.III.1988 (R. Barba, E. Barrera, A. Cadena). *Veracruz:* 2 males, 2 females (Minatitlan-Coatzacoalcos 20.VII.1987 (R. Barba & F. Arias). In UNAM and J. A. Slater collections.

Discussion. This species is very closely related to *tumorosis* differing primarily by the uniformly shining posterior half of the posterior pronotal lobe. In *tumorosis* the shining bar across the posterior pronotal lobe is relatively narrow leaving a pruinose strip across the posterior portion of the pronotum. There is relatively little variation in the type series; some specimens have the clavus and corium less darkened than in the holotype so that there is an appreciable amount of dull yellowish brown color present. In some males the median area of sternum seven lacks an elevated carina.

The legs are uniformly yellow in the entire series. One female from Boca Lacantum shows oligomery of the right antenna in which the first and second segments are normal but the third segment is fusiform and has a pale yellow basal third and a blackened distal two-thirds.

The specimens from Boca Lacantum were taken on *Bambusa longifolia* (Fourn.) McClure.

Toonglasa wilcoxae, new species

Description. Very elongate, parallel sided. Head, pronotum, scutellum, antennal segments three and four black. Femora, abdomen, first and second antennal segments reddish brown to testaceous. Shining bar across humeral area of posterior pronotal lobe and area posterior to it light reddish brown. Hemelytra in large part sordid yellow becoming darker along apical corial margin; membrane heavily infuscated with grayish. Head pruinose except for small area anterior to ocelli. Pronotum with dorsal pruinosity present, but with large shining glabrous nearly contiguous calli patches; transverse shining bar across humeri broad and complete but with a distinct pruinose area present along posterior margin of pronotum. Scutellum completely pruinose. Dorsal surface with a few short upright hairs. Thickly clothed on head and pronotum with decumbent silvery hairs, these especially prominent on pronotum laterad of shining calli area and across transverse impression.

Head nondeclivent, tylus reaching middle of first antennal segment. Eyes relatively small, set well away from anterolateral pronotal angles. Vertex moderately convex. Length head 0.74, width 0.88, interocular space 0.56. Pronotum conventionally straight from humeral angles to area of calli than conspicuously narrowing to anterior margin. Transverse impression broad and shallow. Posterior margin shallowly concave. Anterior lobe somewhat swollen, conspicuously elevated above posterior lobe. Length pronotum 1.30, width 1.50. Scutellum lacking a conspicuous median elevation. Length scutellum 0.54, width 0.62. Hemelytra brachypterous with clavus and corium distinct, membrane present, subacute, one membrane only partially covering inner portion of other, extending posteriorly onto anterior portion of abdominal tergum five leaving remainder of abdomen exposed. Length claval commissure 0.46. Midline distance apex clavus-apex corium 0.96. Midline distance apex corium-apex membrane 0.40. Midline distance apex corium-apex abdomen 3.00. Abdominal sterna three through seven each with numerous sharp conspicuous hooked spines mesally but these spines not placed upon elevated tumid projections or rounded elevations. Eighth abdominal sternum lacking a median keel. Seventh abdominal connexiva not produced posteriorly into acute projecting points. Metathoracic scent gland auricle slightly curving anteriorly, elongately elliptical, subtruncate distally. All femora moderately incrassate, fore femora with a single sharp acute spine ventrally on distal third. Labium extending between fore coxae, second segment reaching or slightly exceeding base of head. Length labial segments I 0.38, II 0.38, III 0.38, IV 0.34 (approx.). Antennae conventionally terete, fourth segment very narrowly fusiform. Length antennal segments I 0.24, II 0.80, III 0.64, IV 0.80. Total body length 7.00.

Holotype. Male. MEXICO: *Oaxaca:* Portillo del Rayo. 4.VI.1987 (F. Arias, E. Barrera, L. Cervantes). In UNAM.

Paratypes. MEXICO: *Oaxaca:* 2 females Portillo del Rayo 9.XI.1987 (E. Barrera). In UNAM and J. A. Slater collections.

Discussion. All specimens were collected from an unidentified species of bamboo. The female paratypes do not differ appreciably from the holotype other than lacking the spines on the abdominal venter and having the clavus and corium more infuscated to give a dark brown almost fumose appearance which accentuates the elevated shining radial vein. This species resembles *pusilla* in appearance particularly of the head, pronotum and scutellum, especially the pronotum with its large glabrous calli patches and general pruinosity pattern. It differs from *pusilla* by its much larger size and by the presence of numerous hooked spines on the venter of the abdomen as well as in the general coloration.

This is one of the few species of *Toonglasa* which is known as yet only in the brachypterous condition.

Toonglasa wilcoxae will key to couplet four in Slater and Brailovsky (1983), a couplet which contains *yushaniacola* and *tumorosis.* It differs from *yushaniacola* in lacking the raised median keel on sternum eight (stated as sternum seven erroneously in Slater and Brailovsky 1983), but agrees with this species in possessing a series of spines on the venter of the abdomen. *Yushaniacola* however has the calli patches conspicuously invaded with pruinosity so that the triangular shining areas are made up of a series of interrupted spots and blotches. The transverse shining bar is also much narrower in *yushaniacola* and the legs are bright yellow. *Tumorosis* is readily distinguishable by the small size, by the light yellow first, second and third antennal segments, and particularly by the sharply produced acute posteriorly directed spines projecting from the seventh abdominal connexiva. *Tumorosis* also has the spines on sterna five through seven placed on tumid elevations.

It is a pleasure to dedicate this unusual new species in memory of the late Mrs. Darlene Wilcox in recognition of her many contributions to the systematics of the Blissinae and especially to those of the genus *Toonglasa.*

Toonglasa reticulata, new species

Description. Body relatively short and robust. Head, anterior pronotal lobe, scutellum and fourth antennal segment black. Femora dark chocolate brown becoming light brown on distal ends. Posterior pronotal lobe, clavus and corium light tan. Membrane paler tan with veins dark chocolate brown. Pruinosity absent dorsally on head, present on pronotum over most of surface but leaving large shining calli patches and a broad transverse humeral band shining non-pruinose. Scutellum pruinose with a shining apex. Clothed above on head and pronotum with thickly placed elongate silvery decumbent hairs. These hairs present also on shining pronotal calli area. A definite strip of pruinosity along posterior margin of pronotum.

Head nondeclivent, tylus almost attaining distal end of first antennal segment. Eyes protrudent, shelf-like projections set well away from antero-lateral pronotal angles. Length head 0.48, width 0.66, interocular space 0.38. Pronotum with very shallow transverse impression, posterior margin shallowly concave, lateral margins straight to level of calli then moderately curving inward to anterior margin of pronotum. Length pronotum 0.82, width 0.98. Scutellum lacking a prominent median carina. Length scutellum 0.36, width 0.42. Hemelytra with lateral corial margins straight or very slightly convex on distal third. Length claval commissure 0.32. Midline distance apex clavus-apex corium 0.70. Midline distance apex corium-apex abdomen 1.54. Membrane extending over middle of seventh abdominal tergum. Metathoracic scent auricle narrowly elliptical angled moderately anterolaterad. All femora incrassate, fore femora more strongly so. Fore femur armed below with a single conspicuous nipple-like spine ventrally on distal third. Abdominal sterna three through seven with a series of short hook-like spines present mesally, these relatively inconspicuous and not set upon tumid elevations. Seventh connexivum not produced into a posteriorly directed spine. Eighth abdominal sternum lacking either a series of grooves and ridges or a median carina. Labium short reaching anterior coxae, second segment remote from base of head. Length labial segments I 0.18, II 0.16, III 0.14, IV 0.24. Antennae short, stout and slightly enlarged at distal ends. Fourth segment prominently fusiform. Length antennal segments I 0.14, II 0.40, III 0.30, IV 0.50. Total body length 4.10.

Holotype. Male. MEXICO: *Guerrero:* km 115 Coyuca de Catalan-Zihuatanejo 16.IV.1988 (L. Cervantes, A. Cadena, M. Garcia). In UNAM.

Paratypes. 3 males, 3 females same data as holotype. In UNAM and J. A. Slater collections.

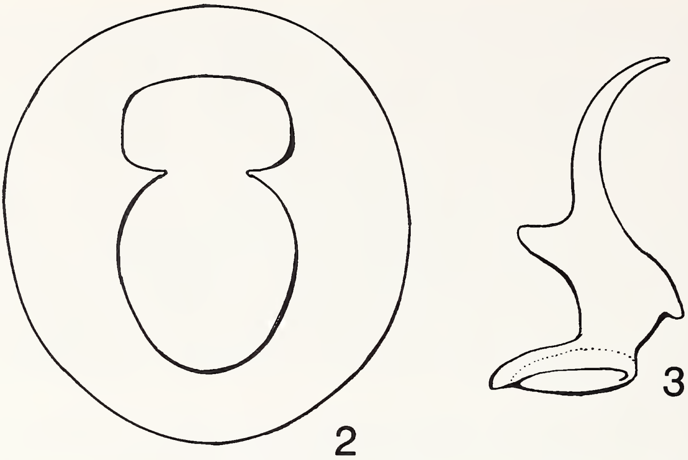
Discussion. There is relatively little variation in the type series, some specimens running somewhat darker than the holotype described above so that the posterior pronotal lobe, clavus and corium are a sordid brown. The shining apex to the scutellum is present in all specimens, in some cases occupying almost the entire distal half of the scutellum but usually confined to a small area near the apex. All specimens have distinctive reticulate or anastomosing veins present.

This species will key to *umbrata* in Slater and Brailovsky (1983). It however is not closely related to this species. In addition to the anastomosing membrane veins it is a much shorter stouter species clothed with elongate silvery hairs. Although not actually closely related to most other species in the genus it probably shares some synapomorphies with *thackstonae.*

This is the shortest, stoutest member of the genus known thus far.

Toonglasa bifida, new species
Figs. 2, 3

Description. Head, pronotum anterior to transverse shining bar, scutellum and a large elongate central distal spot on membrane black. Antennae chiefly black, becoming reddish brown at distal ends of first, second and third segments. Transverse humeral shining bar and area posterior to it on pronotum, all femora and fore tibiae dark red brown. Hemelytra with clavus reddish brown; corium dull yellow, slightly infuscated distally. Abdomen chiefly black with connexivum contrastingly red brown. Hind tibiae dull yellow. Dorsal surface covered with short but distinct hairs; hairs on antennae elongate, projecting strongly laterad from antennal surface and longer than antennal diameter. Femoral hairs also extremely elongate. Pruinosity present on head laterad of and behind ocelli, extending forward to base of antenniferous tubercles. Pronotal pruinosity covering greater portion of dorsal surface but with large shining non-pruinose triangular calli patches almost confluent mesally and with



Figs. 2–3. *Toonglasa bifida,* n. sp. 2. Genital capsule, dorsal view. 3. Paramere, lateral view.

a broad complete shining subbasal humeral bar, with a distinct strip of pruinosity along posterior margin. Scutellum and hemelytra completely pruinose.

Head non-declivent, tylus almost attaining distal end of first antennal segment. Eyes slightly stalked, set well away from anterolateral pronotal angles. Length head 0.58, width 0.70, interocular space 0.56. Lateral margins of pronotum nearly straight to level of calli then strongly narrowing to anterior margin; transverse impression broad and shallow. Anterior pronotal lobe more convex than posterior. Length pronotum 1.00, width 1.14. Scutellum with a low inconspicuous median elevation: surface coarsely punctate. Length scutellum 0.42, width 0.66. Hemelytra with lateral corial margins straight, membrane extending onto anterior edge of seventh abdominal tergum. Length claval commissure 0.36. Midline distance apex clavus-apex corium 1.00. Midline distance apex corium-apex abdomen 2.14. All femora clavate, fore femora most strongly so with a very large thick bifid acute spine distally on ventral third. Thoracic scent gland auricle elliptically lobate, not strongly angled anteriorly. Abdomen lacking a carina on eighth sternum, seventh connexiva not produced posteriorly, fifth, sixth and seventh sterna lacking raised elliptical spinose tumid areas. Labium short, reaching between but not beyond fore coxae, second segment remote from base of head. Length labial segments I 0.20, II 0.20, III 0.16, IV 0.16 (approx.). Antennae relatively short, terete, fourth segment conspicuously fusiform. Length antennal segments I 0.16, II 0.44, III 0.40, IV 0.56. Total body length 5.48.

Holotype. Male. VENEZUELA: La Mucuy 200 mts. (Edo. Merida). C. Bordon 13.VIII.1978. In UNAM.

Paratypes. 1 male, 1 female same data as holotype. In UNAM and J. A. Slater collections.

Discussion. This species is somewhat anomalous within the genus *Toonglasa* in that the body is relatively much more robust and the bifid spine on the forefemur is reminiscent of species of *Patritius* Distant. Nevertheless in all other basic features it appears to be most closely related to species of *Toonglasa.* The paramere has a strongly produced inner projection (Fig. 2) and the sperm reservoir is small with a narrow curving pair of wings similar to the condition found in a number of other species of *Toonglasa. T. bifida* will key to *barrerai* in Slater and Brailovsky (1983) but is readily distinguishable by a number of characteristics especially the bifid forefemoral spine and black distal area on the membrane. The pronotal pruinosity in *bifida* extends well onto the dorsal surface of the anterior pronotal lobe whereas in *barrerai* this is not the case. The body is also relatively more robust.

Toonglasa pulchella, new species

Description. Elongate, slender, parallel sided. Head, pronotum, clavus, a large discal macula on wing membrane, abdomen and fore femora black. Antennae dark, for the most part dull brown to chocolate brown with fourth segment almost black. Tylus and first antennal segment dull yellowish. Corium pale yellow to almost white, strongly contrasting with clavus and dark distal third of corium, membrane also white with exception of a very large central dark macula which reaches apical corial margin along center of margin. Abdominal connexiva reddish brown, tibiae and tarsi sordid yellow. Head pruinose, with a small shining area anterior to ocelli. Pronotum pruinose except for very large nearly confluent polished shining trianguloid calli patches and an extremely broad complete subbasal transverse bar. Extreme posterior margin of pronotum narrowly pruinose. Scutellum completely pruinose. Clothed with decumbent silvery hairs, these very thick on pronotum and head.

Head non-declivent, tylus almost attaining distal end of first antennal segment. Eyes not strongly protrudent but set well away from anterolateral pronotal angles. Length head 0.70, width 0.68, interocular space 0.42. Pronotum with a broad shallow complete transverse impression, posterior margin very shallowly concave. Length pronotum 0.96, width 1.10. Scutellum with at most a very low inconspicuous median elevation. Length scutellum 0.40, width 0.50. Hemelytra with lateral corial margins straight. Membrane extending to posterior third of sixth abdominal tergum. Length claval commissure 0.38. Midline distance apex clavus-apex corium 0.90. Midline distance apex corium-apex abdomen 2.02. Metathoracic scent auricle elongately elliptical, conspicuously curved anteriorly. All femora incrassate, fore femora most strongly so, with a single sharp spine ventrally on distal third. Abdominal sterna five, six and seven lacking spinose tumid areas. Seventh connexivum not produced into acute posteriorly projecting spines. Eighth abdominal sternum lacking a series of grooves and ridges across posterior margin. Labium short, at most reaching anterior margin of fore coxae, second segment remote from base of head. Length labial segments I 0.24, II 0.18, III 0.20, IV 0.24. Antennae terete. Length antennal segments I 0.18, II 0.48, III 0.46, IV 0.62. Total body length 5.20.

Holotype. Male. MEXICO: *Colima:* Colima 16.VII.1985 (Harry Brailovsky). In UNAM.

Paratypes. MEXICO: *Michoacan:* 1 female, 14 km al Sur de Uruapan, 29.VII.1988 (M. Garcia); 1 female, km 93 Carr. Uruapan-Playa Azul, 1,300 mts., 27.V.1988 (A. Cadena, L. Cervantes). In UNAM and J. A. Slater collections.

Discussion. The two female paratypes do not differ appreciably from the holotype in most respects but have the first antennal segment and the legs light yellow. This is a handsome, vividly marked species. It runs to *thackstonae* in Slater and Brailovsky

(1983) but does not appear to be closely related. In contrast to *thackstonae* where the pubescence, while similarly silvery, covers a large central calli area this species has the calli completely shining, polished and glabrous. Also the subbasal transverse shining bar is much broader in *pulchella* occupying most of the posterior pronotal lobe. It also differs from *thackstonae* in having a completely dark gray to black clavus which contrasts strikingly with the almost white adjacent corium. The clavus, in fact, is concolorous with the dark scutellum. In *thackstonae* the corium is uniformly pale to the apex whereas in *pulchella* the distal third of the corium is distinctly darkened and while *thackstonae* may have a brownish stripe or band running through the membrane it does not have a large black macula on the white membrane.

In some respects *pulchella* resembles *barrerai* but the latter has ridges and grooves on the eighth abdominal sternum which are lacking in *pulchella* and the scent gland auricle in the present species is more strongly curved anteriorly than in either of the other two discussed above.

This species is perhaps related to *discalis* from Cuba because of the dark membrane patch but the pruinosity pattern is completely different in these two species.

In general habitus *pulchella* resembles *wilcoxae,* particularly in the general appearance of the pronotum with its large shining glabrous calli and broad transverse shining humeral bar. Both species have dark antennae and males at least have dark legs and infuscated membranes of the hemelytra. However, *pulchella* lacks the ventral abdominal spines of *wilcoxae,* has a dark rather than pale clavus and a much more strongly anteriorly curved metathoracic scent gland auricle. The head and thoracic pruinosities however are very similar in the two species.

Toonglasa nigra, new species

Body elongate, head and thorax slender, abdomen broadly elliptically expanded. Almost uniformly black throughout including appendages. Wing membrane pale yellow with a dark median spot that attains apical corial margin. Abdominal connexiva becoming dark red brown laterally. Tibiae light reddish brown with tarsi yellowish, strongly contrasting with dark chocolate brown to black femora. Dorsal surface bearing a few scattered moderately elongate upright hairs interspersed with a few decumbent deciduous hairs but body to a considerable extent appearing subglabrous. Head shining mesally and completely on tylus, but laterad of eyes including juga, pruinose to posterior one-half of eye. Pronotum largely pruinose with large shining broadly contiguous non-pruinose calli patches and a complete broad shining transverse humeral band. Posterior margin of pronotum very narrowly pruinose. Scutellum pruinose but with a conspicuous elevated shining median carina.

Head non-declivent, tylus reaching middle of first antennal segment, eyes relatively small, sessile, set moderately far from anterior margin of pronotum. Vertex convex. Length head 0.80, width 1.00, interocular space 0.68. Antenniferous tubercles slightly hooked inward. Pronotum with lateral margins sinuate, almost as broad across calli as across humeral angles. Transverse impression obsolete. Length pronotum 1.18, width 1.40. Scutellum with a conspicuous median carina. Length scutellum 0.60, width 0.70. Hemelytra micropterous with clavus and corium fused but suture line still evident. Hemelytral pads acuminate. Corium reaching middle of abdominal tergum two, membrane occurring as a lobate pad along apical margin of corium, apex of membrane reaching almost to posterior end of second abdominal tergum. Length corium 1.06. Wing pads widely separated from one another throughout length. Length mesothoracic wing pads 1.26. Abdomen with ovipositor separating sixth abdominal sternum and extending partially into fifth sternum to cause posterior margin of that segment to be strongly concave. Metathoracic scent gland auricle elongate almost transversely straight but slightly angled posteriorly. Femora relatively slender. Fore and middle femora more incrassate than hind femora. Fore femora with a single sharp acute spine distally on ventral third. Labium extending well between fore coxae, second segment reaching base of head. Length labial segments I 0.40, II 0.40, III 0.34, IV 0.52. Antennae remarkably robust for genus, terete, clothed with upstanding hairs as long as diameter of segment. Length antennal segments I 0.30, II 0.70, III 0.50, IV 0.82. Total body length 7.52.

Holotype. Female VENEZUELA: *Guarico:* La Palmita, 28.XII.1979 (C. Bordon). In UNAM.

Discussion. Although unfortunately known only from a single female specimen which precludes understanding its systematic position within the genus this specimen is so distinct that we feel it desirable to describe it to call attention to the presence of this species in Venezuela. *T. nigra* will key in Slater and Brailovsky (1983) to *yushaniacola* but is not actually at all closely related to that species. In addition to a striking difference in color, *yushaniacola* is a predominately reddish brown species, with the head pruinose except the tylus anteriorly and a small area in front of the ocelli. It also has quadrate shining areas of the pronotal calli well separated from one another and with a portion of the surface pruinose, and with a completely pruinose scutellum. *Toonglasa yushaniacola* also has very slender antennae, nonhooked antenniferous tubercles, bright yellow legs and a metathoracic scent gland auricle that is angled anteriorly.

While the micropterous condition of this specimen probably affects the shape of the pronotum and may result in the confluent shining pronotal calli the large conspicuous relatively thick antennae, shape of the metathoracic scent gland auricle, body coloration all indicate that we are dealing with a undescribed taxa. Males of this unusual species will be very desirable to discover if they have sexually dimorphic features so prominent on many male members of this genus.

Toonglasa barrerai Slater & Brailovsky

Toonglasa barrerai Slater & Brailovsky, 1983:530–531.

Distribution: Known only from Mexico.

Type locality: Mexico, Guerrero, 5 km from Chilpancingo (Chilpancingo-Omilteme road).

Additional distributional data: 27 males, 23 females. JALISCO: Autlan (km 172 Guadalajara-Barra de Navidad road). MICHOACAN: km 20 Aguililla-Dos Aguas road; km 17. Coalcoman-La Nieve road; km 93 Uruapan-Playa Azul road; Charando. COLIMA: km 16. Atenquique-Manzanillo road. NAYARIT: km 47 Tepic-Puerto Vallarta road. GUERRERO: km 67 Taxco-Alpuyeca road. OAXACA: 20 km Southeast from Dominguillo; Cuicatlan. Biology: This species was originally taken on leaves of *Arthrostylidium longifolium* (Fourn.) E. G. Camus. We now are able to report it on the leaves of *Bambusa aculeata* (Rupr.) Hitchcock. Both of these are slender species of bamboo.

Toonglasa forficuloides Distant

Toonglasa forficuloides Distant, 1983:392. Supp. 392.

Distribution: Known only from Mexico.

Type locality: Omilteme, Guerrero, Mexico. Reported by Slater and Brailovsky (1983) from localities in Guerrero.

Additional distributional data: 78 males, 73 females. JALISCO: Autlan; Plan de Barrancas; La Venta de Nochistlan. GUERRERO: Teloloapan; Acahuizotla; Juxtlahuaca; km 60 Ciudad Altamirano-Zihuatenejo road; km 67 Taxco-Alpuyeca road; Iguala (Estacion de Microondas Tiuribe); Acatempan; Chapa. MICHOACAN: km 35 Tepalcatepec-Coalcoman road; km 17 Coalcoman-La Nieve road; Tzitzio; km 93 Uruapan-Playa Azul road; km 48 La Guardia-Caracuaro. COLIMA: km 16 Atenquique-Manzanillo road.

Toonglasa tumorosis Slater & Wilcox

Extarademus tumorosis Slater & Wilcox, 1966:67.

Distribution: Originally described from Panama and Guatemala and subsequently reported from Guerrero and Oaxaca by Slater and Brailovsky (1983).

Type locality: Panama, Caldera 1,200 ft.

Additional distributional data: 74 males, 47 females. GUERRERO: Atoyac. VERACRUZ: Ocotal-Texisapa road. OAXACA: km 219 Puerto Angel-Oaxaca road; 4 km S. from Toltepec; Amuzgos; km 17 Sayula-Ciudad Aleman road. CHIAPAS: km 42 Motozintla-Comitan road; Jaltenango (Finca Prusia); km 31 Revolucion Mexicana-Concordia road; km 224 Tuxtla Gutierrez-Ciudad Cuauthemoc road; km 167 Arriaga-Tapachula road; km 235 Comitan-Ciudad Cuauthemoc road.

Biology: Slater and Brailovsky (1983) noted the habitat in Guerrero but were unable to establish the host plant. We are now able to report it breeding on the leaves of the slender bamboo *Chusquea longifolia* (Fourn.) McClure.

Toonglasa tylosis (Slater & Wilcox)

Extarademus tulosis Slater & Wilcox 1966:67–68.

Distribution: Known only from Mexico.

Type locality: Mexico: Tamazunchale (intercept. Laredo, Texas).

Additional distributional data: 28 males, 31 females. PUEBLA: Villa Avila Camacho. VERACRUZ: Papantla; Los Tuxtlas; Tlapacoyan.

Biology: Collected on the leaves of the wide and spinose bamboo, *Bambusa guadua* H. & B.

Toonglasa munda (Slater & Wilcox)

Extarademus mundus Slater & Wilcox 1966:65–67.

Distribution: Known only from Mexico.

Type locality: Mexico, 17 mi S. Loma Bonita, Oaxaca.

This species is apparently more variable in size and coloration than has previously been realized. The Boca Lacantum (Chiapas) series listed below has one male that agrees closely with the holotype in being robust with a somewhat swollen black anterior pronotal lobe that contrasts with the yellow posterior lobe. Both the clavus and corium are bright yellow with suffused brown stripes along the rows of punctures and along the apical corial margin. The membrane of the front wing is completely dark brown. The other four males are smaller, relatively slender and parallel sided. The posterior pronotal lobe is dark red, becoming black mesally on two of the specimens. All of these males have dull yellowish brown hemelytra without distinctly darker stripes and in all of these specimens the membrane of the forewing is pale, almost hyaline.

Slater and Brailovsky (1983) noted the strong sexual dimorphism in *munda.* This is true of the Chiapas series of five females. All agree with the four males discussed above in being slender and elongate and in having the posterior pronotal lobe dark red to black, rather than yellow. One female has the hemelytra pale as in the males above, but the other four have a relatively pale clavus and corium with distinct dark stripes along the rows of punctures and with the membrane of the forewing dark.

Three days after the Chiapas series was taken Messrs. Barrera and Garcia collected six specimens of *Toonglasa* in Oaxaca (km 17 Sayula-Ciudad Aleman road) on *Chusquea longifolia.* Three of these males are indistinguishable from *munda* morphologically but are very small with almost uniformly pale hemelytra. Two have the pronotum black except for the shining transverse bar across the humeral area, the third has the posterior pronotal lobe dark red as in most of the Chiapas series. The remaining three specimens (a male and 2 females) are specimens of *prunimunda.*

Despite the surprizing variability present, all of these specimens have the same pruinosity pattern, no obvious genitalic differences and the same type of hind leg development and sexual dimorphism. We conclude that for the present they must be considered to represent a single variable species.

Additional distributional data: 123 males, 109 females. VERACRUZ: Ocotal-Texisapa road; Minatitlan-Coatzacoalcos road; Coatzacoalcos. SAN LUIS POTOSI: Chapulhuacan-Tamazunchale road. TABASCO: San Manuel. OAXACA: Pochutla-Piedra Lumbre road; km 3 Pochutla-Oaxaca road; Tuxtepec-Arroyo Choapan road; Chacalapa; km 214 Puerto Angel-Oaxaca road; km 17 Sayula-Ciudad Aleman road. CHIAPAS: Boca Lacantum (Rio Usumacinta); Ocosingo-Chajul road (Reserva Montes Azules).

Biology: Slater and Brailovsky (1983) reported a single male on *Bambusa aculeata* (Rupr.) Hitchcock. However the long series above was taken on the leaves of two slender bamboos, *Olmeca recta* Soderstrom and *Chusquea longifolia* (Fourn.) McClure.

Toonglasa thackstonae Slater & Brailovsky

Toonglasa thackstonae Slater & Brailovsky 1983:531–532.

Distribution: Known only from Mexico.

Type locality: Mexico, Guerrero, 11 km from Chilpancingo (Chilpancingo = Chichihualco road).

Additional distributional data: 187 males, 167 females. JALISCO: 17 km SW from Autlan; Jocotepec. GUERRERO: Teloloapan; Iguala (Estacion de Microondas Tiuribe); km 67 Taxco-Alpuyeca road; km 50 Coyuca de Catalan-Zihuatanejo road; Chapa. MICHOACAN: Charando; km 35 Tepalcatepec-Coalcoman road; km 96 Maravatio-Morelia road. OAXACA: 10 km N. of Candelaria Loxicha; Cuicatlan. NAYARIT: km 47 Tepic-Puerto Vallarta road; Puerto de los Mazos.

Biology: Taken in large numbers on the leaves of two slender bamboos: *Guadua spinosae* (SW) McClure and *Bambusa aculeata* (Rupr.) Hitchcock.

Toonglasa umbrata (Distant)

Ischnodemus umbratus Distant, 1893:391.
Ischnodemus cahaboenensis Distant, 1893:391.
Ischnodemus macer Van Duzee, 1921:114.

Distribution: The most widely distributed member of the genus. It occurs from the central United States (Iowa and Nebraska) south through Mexico and Central America at least into Brazil. In Mexico it has been previously reported by Slater and Brailovsky (1983) from Nayarit, Jalisco, Veracruz, Estado de Mexico, Oaxaca, Tabasco and Quintana Roo.

Type locality: Guatemala.

Additional distributional data: MEXICO—109 males, 87 females. CHIHUAHUA: km 23 El Sueco-Silla Ahumada road. SONORA: km 55 Guaymas-Ciudad Obregon road. DURANGO: km 35 Durango-Mazatlan road. TAMAULIPAS: km 22 Soto La Marina-La Pesca road. VERACRUZ: Conejos; Los Tuxtlas; km 84 Ciudad Aleman-Acayucan road; Ocotal-Texisapa road. JALISCO: La Ventana de Nochistlan; Ocotlan. GUERRERO: Acahuizotla. TABASCO: San Manuel. CAMPECHE: km 54 Campeche-Merida road; Bolanchen de Rojas; Castamay; El Tormento; Santa Cruz. MICHOACAN: Aguililla. OAXACA: Toltepec; km 65 Tuxtepex-Oaxaca road; Pluma Hidalgo; Matatlan (Estacion de Microondas Nueve Puentes). CHIAPAS: km 20 Tapachula-Puerto Madero road; km 167 Arriaga Tapachula road; km 27 Morelos-Malpaso road; km 50 Palenque-Ocosingo road. YUCATAN: Kabah.

Biology: This is the only species of *Toonglasa* that is known thus far to breed upon grasses other than bamboos. Slater (1976) and Slater and Brailovsky (1983) report breeding upon *Andropogon glomeratus* (Walt.), *Bothriochloa intermedia* (R. Br.) A. Camus and *Hyparrhenia rufa* (Naes) Stapf.

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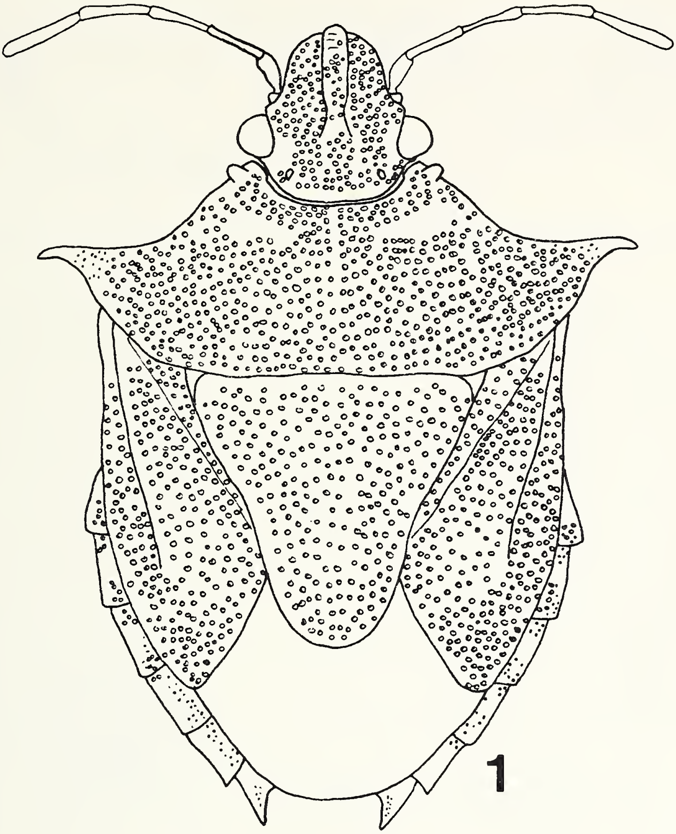
MENUDO, A NEW GENUS OF PENTATOMIDAE (HETEROPTERA) FROM PUERTO RICO

DONALD B. THOMAS, JR.

Agriculture Research Service, U.S. Dept. Agriculture,
Apartado Postal 544, Tuxtla Gutierrez, Chiapas, Mexico

Abstract.—A new pentatomid genus and species, *Menudo femoralis,* is described from Puerto Rico. The new genus superficially resembles the African genus *Aspavia,* but its true alliance appears to be with the Latin American genera near *Padaeus* or *Agroecus.*

Among a series of pentatomid specimens collected by Elbert L. Sleeper in Puerto Rico I found two, collected at different dates and localities, representing an undescribed genus. A subsequent search by my colleague David A. Rider uncovered three more specimens, also from Puerto Rico, in the collection of the United States National Museum. The genus is similar, but probably not related, to the African genus *Aspavia* Stål, especially with respect to the structure of the pronotum, the possession of a spine at the superior apex of each of the femora, and the form of the metapleural scent gland orifice and evaporatorium. The specimens differ from *Aspavia,* and from nearly all New World Pentatomini, by having the bucculae continuous behind the oral groove. Bucculae united posteriorly is a character-state found in most, but not all, asopine pentatomids. However, the new genus, which I propose to name *Menudo,* lacks the crassate rostrum and the genitalic structures (parandria and thecal shield) diagnostic of the asopines (McDonald, 1966). Although Kirkaldy (1909) considered united bucculae to be diagnostic of the Asopinae, a number of genera with united bucculae are scattered throughout the Pentatomidae, e.g., *Placocoris* Mayr (Pentatominae), *Brachystethus* Laporte (Pentatominae), *Tahitocoris* Yang (Podopinae), *Edessa* F. (Pentatominae), and *Parastrachia* Distant (Parastrachiinae). I place *Menudo* in the nominate subfamily and tribe Pentatomini. In the keys to the Western Hemisphere genera of Pentatomini (Rolston et al., 1980) the new genus falls into section 1; those lacking a tubercle or spine on the base of the abdomen. In the conspectus of section 1, exclusive of South America (Rolston and McDonald, 1984), the new genus quickly keys to a small group of genera including *Loxa* Amyot & Serville and allies, which have the superior apex of the femora spinose. I suspect that the actual relationships of the new genus lies among genera related to *Padaeus* Stål and *Agroecus* Dallas. This latter group includes some obscure South American genera, some of which I have not seen, but whose descriptions would exclude this new genus. The pygophore of the male specimen is unusual in that it bears a series of five pegs on each lateral margin. I know of no other pentatomid genus with this feature, although in some *Padaeus* species the lateral ridge of the pygophore does bear a single erect spine. The parameres in *Padaeus,* as well as the arrangement and proportions of the different male genitalic structures, are similar to those of *Menudo.* In both, the pygophoral capsule is deep, the proctiger is prominent and bulbous, and the parameres are elongate, bent, and laterally compressed. In *Aspavia,* by contrast,



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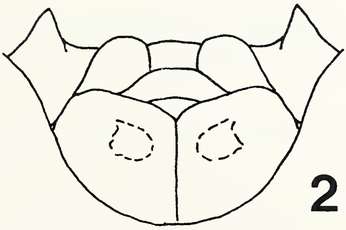
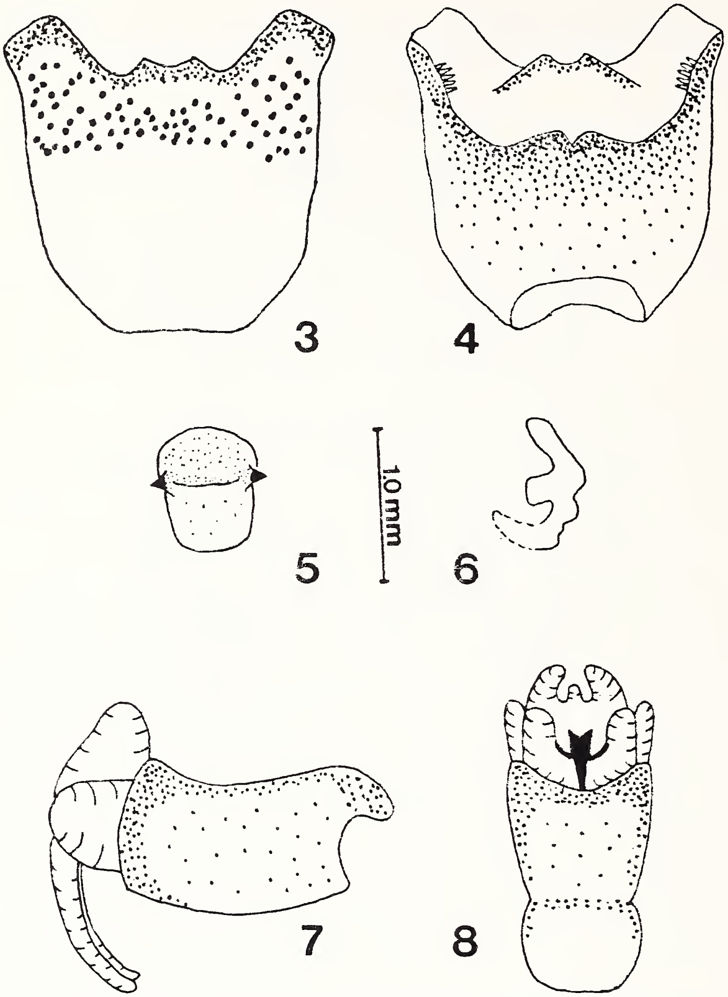


2

Figs. 1–2. *Menudo femoralis,* n. sp. 1. Habitus, dorsal aspect. Venation of hemelytral membrane (not shown) simple, transparent. 2. Female genitalia, ventro-posterior aspect.



Figs. 3–8. Male genitalia. 3. Pygophore, ventral view. 4. Pygophore, dorsal view. 5. Proctiger, ectal view. 6. Left paramere, ento-lateral view. 7. Aedeagus, lateral view. 8. Aedeagus, dorsal view.

the pygophoral cup is shallow, the proctiger is diminutive and the parameres are short and thick.

Menudo, new genus

Diagnosis. Third (second visible) abdominal sternite lacking mesial tubercle or spine. Ostiolar rugae short, auriculate. Each femur terminating dorsally in short spine (longest on metafemora); inferior surface unarmed, neither spines nor tubercles present. Width of scutellum at distal end of frena about $^4/_7$ of basal width. Anterolateral pronotum with margin obtuse, not dentate; weakly rugulose because of coarse punctures. Eyes proximal to anterior angle of pronotum. Bucculae elevated and continuous behind oral groove; first rostral segment projecting slightly behind bucculae. Tylus slightly but distinctly longer than juga. Pro- and mesosternum with flat, pilose carina mesally.

Menudo femoralis, new species

Description. Dull brown with dense black punctation dorsally and ventrally. Length from tip of tylus to apex of abdomen 5.5 mm. Width across humeri 4.4 mm (Fig. 1).

Head. Tylus slightly but distinctly longer than juga, tip of tylus rounded; lateral margins of juga evenly sinuate. Length of head from imaginary line connecting ocelli to tip of tylus 1.2 mm; width across anteocular angles 1.0 mm. Antennae yellow, segment I almost attaining apex of head, segment V the longest. Bucculae elevated and continuous behind. Rostrum in repose attains base of abdomen, segment I slightly longer than bucculae, segment II the longest, longer than III and IV combined.

Thorax. Anterolateral margins of pronotum obtuse; punctures larger and coarser on margin than on disc. Anterior angles with short, rounded tooth. Each humerus produced into curved, outwardly directed spine. Pronotum without pronounced angle posteriorly near basal angle of scutellum. Apex of scutellum broadly rounded, concolorous with disc. Apex of each corium subrectilinear, outer apical corner angular; veins of membrane simple. Pro- and mesosternum with flat, pilose mesial carina. Scent gland auricle short, ca. ⅛ of distance to metapleural margin, its apex elevate; evaporatorium restricted to much less than ½ the distance to metapleural margin. Femora and tibia strongly black maculate; tibia subprismatic; apex of each femur terminating in short spinous projection.

Abdomen. Base strongly tumid mesially but lacking spine or tubercle. A row of broad, black spots mesally on each ventral segment. Connexiva alternate, middle third of each segment paler than anterior and posterior thirds, angles obtuse except 8th sternite terminating in long angular spine.

Genitalia. Basal plates (first gonocoxites) of female broad, expanded, strongly punctate with subcentral rounded tumescence. No spiracles evident on paratergite VIII (Fig. 2).

Pygophoral capsule of male deep, opening oriented dorso-posteriorly; ventral margin deeply concave in ventral view, bisinuate mesially (Fig. 3); inferior ridge present as ental continuation of the bisinuate margin (Fig. 4); genital plates (parandria) lacking; exterior ventral surface coarsely punctate; lateral margins bearing a series of five peglike spines on each side. Proctiger bulbous and bearing a spur on each side at about the middle (Fig. 5). Parameres laterally compressed, "F"-shaped (Fig. 6). Aedeagus with endophallic duct short, vesica short and stout, flanked by medial penial lobes; thecal shield lacking; conjunctiva with pair of short membranous dorsal lobes, short mesial membranous lobe, and pair of long, membranous, ventral appendages (Figs. 7, 8).

Types. Holotype: Male, labeled: (a) Maricao PR Fish Hatchery, VIII-8-11-61. (b) Collected by Flint, Spangler. Deposited United States National Museum.

Allotype: Female, labeled: data same as holotype. Deposited United States National Museum.

Paratypes: Female, labeled: (a) Arecibo P.R. June 1940, Coll. G. Lomboglia. (b) Gen. ? species n. ?? Det. HG Barber. Deposited United States National Museum. Female, labeled: (a) Puerto Rico: Arecibo, 8.0 km E. Jayuya, 1812/6633, 762 m, B&S (TropDecid), XII-5-80. E. L. Sleeper. Deposited in collection of author. Female, labeled: (a) Puerto Rico: Mayaguez, 8.0 km SW Maricao, 1807/6657, 850 m, B&S (TropDecid), XII-9-80. E. L. Sleeper. Deposited in collection of author.

ACKNOWLEDGMENTS

I wish to express my gratitude to Elbert L. Sleeper for the gift of pentatomid specimens collected in Puerto Rico. L. H. Rolston and D. A. Rider provided critiques of the manuscript. I am especially grateful to David A. Rider for searching the U.S. National Museum collection for specimens of *Menudo* and for bringing to my attention the similarity between the new genus and *Aspavia.*

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NEW SPECIES OF *CANTHONELLA* CHAPIN FROM HISPANIOLA (COLEOPTERA: SCARABAEIDAE: SCARABAEINAE)

Michael A. Ivie and T. Keith Philips
Department of Entomology, Montana State University,
Bozeman, Montana 59717

Abstract.—*Canthonella howdeni,* n. sp. and *C. baorucensis,* n. sp. are described from the Sierra de Baoruco of Pedernales Province, Dominican Republic. A key is provided to distinguish them from previously described West Indian congeners. Diagnostic characters of the head, labium, legs and male genitalia are illustrated for the new species and *C. isabellae* Matthews.

The scarabaeines of the Greater Antilles constitute a small (29 species), taxonomically isolated, and highly endemic fauna. A perusal of the literature indicates that this fauna is well known, having been reviewed by Matthews (1966). Only a few taxa have been described since that time (2 species by Matthews, 1969; 1 species by Howden, 1976; and a genus for already described species by Simonis, 1981). Several faunal papers on West Indian scarabs (sens. lat.) have been published since Matthews (Howden, 1970, 1978; Cartwright and Chalumeau, 1978; Chalumeau, 1983; and others).

On a recent expedition to the Dominican Republic (15 August to 15 September 1988), we collected 11 species of scarabaeines, but surprisingly only 5 of these were among the 9 described and 1 undescribed species recorded from Hispaniola (Matthews, 1966, 1969). Below, we described 2 new species of *Canthonella* Chapin and add to the characters known for Matthews' *C. isabellae.* The other undescribed species collected, all *Canthochilum* spp., will be described later.

Descriptions are modeled after Matthews (1966, 1969) to facilitate recognition of the species and maximize comparative information. Both new species share the characters of the genus *Canthonella* as defined by Matthews (1966). Within the West Indies, Hispaniola appears to be the center of diversity of this genus, with a total of 4 known species. Cuba and Puerto Rico, both much better collected than Hispaniola, have only one species each (Matthews, 1966).

The new species were collected at Las Abejas (the beehives), a local name for an area of Parque Nacional El Acceitillar, with south-eastern exposure in the Sierra de Baoruco of Pedernales Province. It is densely forested, with mixed pine and broad-leaved sclerophyll forest on aluminous-lateritic soils overlying limestone. An area of high botanical and entomological endemism (Howard, 1973; Schwartz, 1989), the forest is thick with lianas and epiphytes, and contains a remnant of the native mammal fauna [the huitia (Capromyidae)] as well as feral pigs.

Matthews (1966) indicated that the members of *Canthonella* are euryphagous coprophages, with *C. parva* recorded as feeding on bird, snail and anthropochorus mammal dung (Matthews, 1965). Virtually all of the specimens of both new species were taken in pitfall traps baited with human dung. We placed a variety of unbaited and fruit-baited pitfall and flight intercept traps in the area, and the single dung baited trap, located in dense forest with deep leaf litter, accounted for 103 of 105 total specimens.

Holotypes, allotypes and paratypes of both species are placed in the National Museum of Natural History, Washington. Additional paratypes are deposited in our collections and those of H. Howden, B. Ratcliffe, P. Lago, B. Gill, F. Chalumeau, the British Museum (Natural History), Muséum National d'Historie Naturelle (Paris), and Museo Nacional de Historia Natural (Santo Domingo). Vouchers for the records of *C. isabellae* Matthews are in our collections.

Matthews (1966) provided a key to the 4 species of West Indian *Canthonella* known to him. The new species described below will key to couplet 3, where they will fit neither choice. The following couplets should be substituted for couplet 3. Male genitalia should always be used to confirm identifications in this genus, but the external characters used below appear quite trustworthy.

3. Elytral macula yellow-orange, reaching base of elytron; 8th stria strongly punctate . . . . *C. isabellae* Matthews
3′. Elytral macula whitish-yellow, not reaching base of elytron; 8th stria not strongly punctate 4
4. Elytral macula not reaching 3rd interval, not narrowed on 5th; labium rounded-truncate anteriorly. Cuba . . . . *C. pygmaea* (Harold)
4′. Basal elytral macula extending onto 3rd interval, narrowed on 5th; labium obtusely produced anteriorly. Hispaniola 5
5. Elytron with triangular macula at apex of interstriae 1, 2, and 3; a smaller (occasionally obsolete) macula at apex of stria 5; 3.3–4.8 mm . . . . *C. baorucensis,* n. sp.
5′. Elytron immaculate in apical ½; 2.3–3.4 mm . . . . *C. howdeni,* n. sp.

Canthonella baorucensis, new species

Figs. 1, 3, 5, 8, 10, 12

Diagnosis. The maculation of the elytral apex, the bearded labial palpimeres, and the aedeagus will distinguish this species.

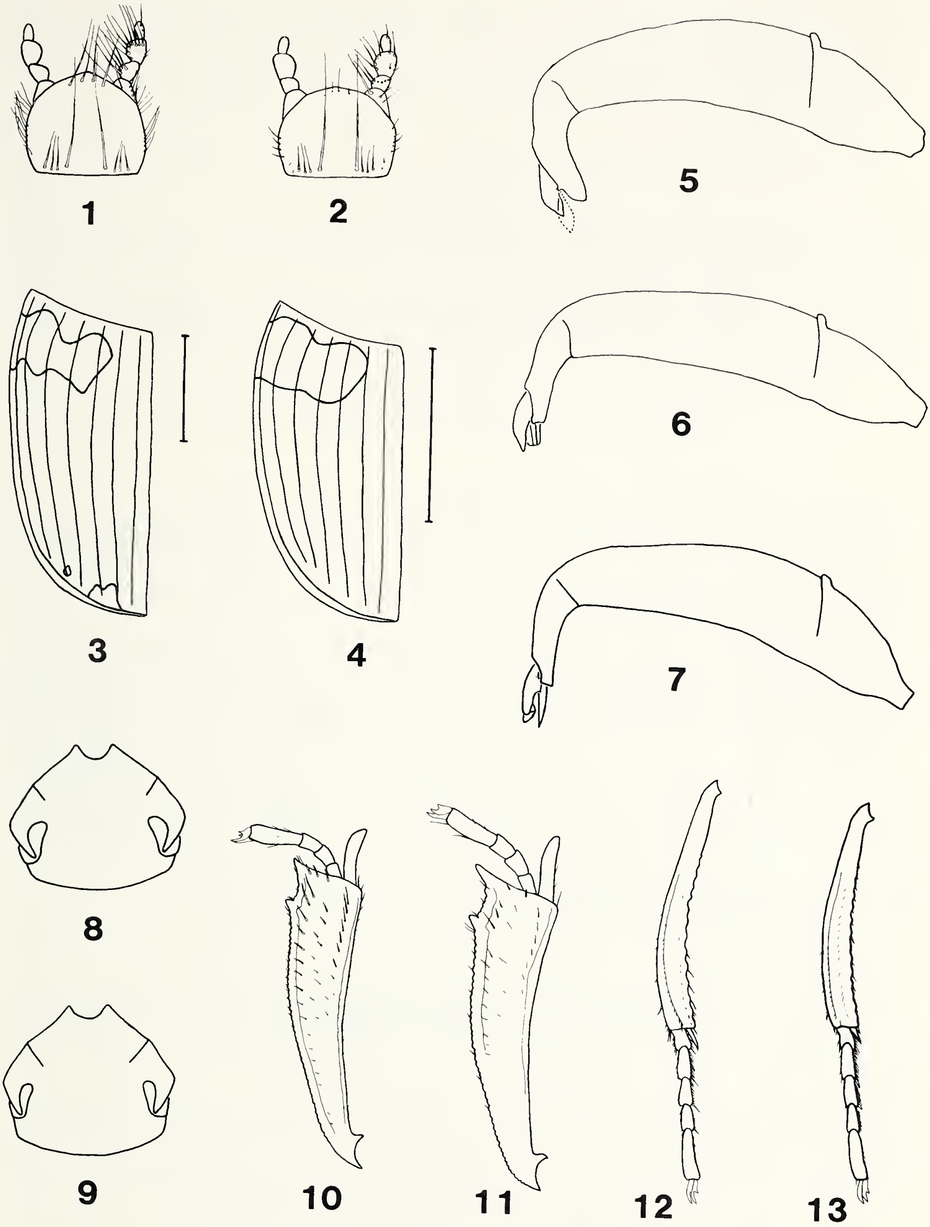
Description. Elongate oval, finely pilose, shining black except maculae as follows: whitish-yellow transverse spot from 8th stria to between striae 2 and 3, not reaching base of elytron, narrowed between striae 4 and 5 (Fig. 3); epipleuron whitish-yellow; apical triangular spot on intervals 2, 3, 4 (and rarely 5), anterior angle on 3, base on 2, 3, 4; round apical spot on intervals 5 and 6, occasionally obsolete.

Eyes dorsally separated by 8× maximum width of dorsal lobe (Fig. 8). Labium obtusely produced medially, palpi with segments 1 and 2 bearded with long setae medially, segment 2 larger than 1, 3 small (Fig. 1).

Pronotum as wide at base as base of elytra, lateral margins diverging anteriorly for ⅘ of length, abruptly bending inward at obtuse angle and converging for anterior ⅕.

Elytral striae 1–7 impunctate, consisting of 2 fine adjacent lines, stria 8 subpunctate. Interstriae flat, conforming to general shape of elytron. Fore tibia transversely truncate apically; with 2 acute teeth externally, serrulate between and proximal to them (Fig. 10). Metatibia as in Figure 12. Aedeagus as in Figure 5.

Sexual dimorphism. Males differ from females in the following: males with interior



Figs. 1–3. 1, 3, 5, 8, 10, 12. *Canthonella baorucensis.* 2, 4, 6, 9, 11, 13. *C. howdeni.* 7. *C. isabellae.* 1, 2. Labium. 3, 4. Elytral pattern. 5, 6, 7. Aedeagus. 8, 9. Dorsal view of head. 10, 11. Protibia and tarsus. 12, 13. Metatibia and tarsus.

margin of metatibia serrate (Fig. 12), each serration with an oblique, stout seta projecting from distal face (this character is variable in degree, with 4 of 51 males having the serration obsolete or nearly so; it does not appear to correlate with size); apical spine of protibia stout; visible sternite 6 narrowed medially.

Length 3.3–4.8 mm.

Holotype male and allotype female labeled: "DOMIN.REP.: Pedernales; Province, Las Abejas; ca. 35 km N Cabo Rojo; 26 AUG-09 SEP 1988, 1,250 m; dung-pitfall trap/M. A. Ivie, T. K. Philips & K. A. Johnson colrs."

Paratypes: 48 males, 25 females, same data as holotype. Two males, same data, except in fight intercept trap.

Etymology. Named for the Sierra de Baoruco of the south-western Dominican Republic where this species was discovered.

Canthonella howdeni, new species

Figs. 2, 4, 6, 9, 11, 13

Diagnosis. The elytral maculation and aedeagus will distinguish this species.

Description. Elongate oval, finely pilose, shining black, except with whitish-yellow spot on elytron from 8th stria to between 2 and 3, not reaching base of elytron and narrowed between striae 4 and 5 (Fig. 4); epileuron whitish-yellow adjacent to this macula, apical half of elytron immaculate.

Eyes dorsally separated by 8× maximum width of dorsal lobe (Fig. 9). Labium with apex slightly raised and obtusely produced; palpi with segments 1 and 2 bearded with long setae internally, segment 2 larger than 1; segment 3 small (Fig. 2).

Pronotum as wide at base as base of elytra, lateral margins diverging anteriorly for $\frac{4}{5}$ of length, smoothly curved inwardly in anterior $\frac{1}{5}$. Elytral striae 1–6 impunctate, consisting of 2 fine parallel lines, striae 7 and 8 faintly subpunctate to impunctate, interstriae flat, conforming to shape of elytron. Fore tibia transversely truncate apically, with 2 acute teeth externally; serrulate between and proximal to teeth (Fig. 11). Metatibia as in Figure 13. Aedeagus as in Figure 6.

Sexual dimorphism as in *C. baorucensis,* with male metatibial serration weak to obsolete in 4 of 31 males.

Length 2.3–3.4 mm.

Holotype male and allotype female labeled: "DOMIN.REP.: Pedernales; Province, Las Abejas; ca. 35 km N Cabo Rojo; 26 AUG–09 SEP 1988, 1,250 m; dung-pitfall trap/M. A. Ivie, T. K. Philips & K. A. Johnson colrs."

Paratypes: 30 males, 31 females, same data as holotype.

Etymology. Named in honor of Professor Henry F. Howden of Carleton University, whose interest in West Indian coleopterology, as well as his encouragement and help with our careers, makes it a pleasure to dedicate this species to him.

Canthonella isabellae Matthews

Fig. 7

Matthews (1966) had a single specimen when he described this species, and was unable to illustrate the aedeagus, important for the diagnosis of species in this genus. We were able to collect a series of this species at 3 localities in Pedernales Province:

13.5 km N Cabo Rojo, 21 AUG 1988, 140 m, flight intercept trap; 20 km N Cabo Rojo, 365 m, Las Mercedes turn-off, 21–22 AUG 1988, dung baited pitfall trap; and at 24 km N Cabo Rojo, 610 m, 20 AUG–09 SEP 1988, in flight intercept trap. We take this opportunity to illustrate the male genitalia (Fig. 7) as an addition to the knowledge of this attractive species.

ACKNOWLEDGMENTS

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NOTES ON THE NATURALIZATION OF TWO SPECIES OF EUROPEAN BYRRHIDAE (COLEOPTERA) IN NORTH AMERICA

PAUL J. JOHNSON[1]
Department of Plant, Soil and Entomological Sciences,
University of Idaho, Moscow, Idaho 83843

Abstract.—The North American distributions and adventive nature of *Simplocaria semistriata* (F). and *Chaetophora spinosa* (Rossi) are reviewed. Previous inferences regarding their status as European immigrants is supported, within the context of C. H. Lindroth's criteria for identification of non-native organisms. Notes on the host mosses, life history, and habitats of both species are provided.

During studies on the systematics aand ecology of the Byrrhidae, it became apparent that two North American species appeared to be adventive. Although these species, *Simplocaria semistriata* (F.) and *Chaetophora spinosa* (Rossi), have been recorded from North America, and numerous and widely disseminated specimens occur in various collections, there has been little recognition of their immigrant status. Except for Leng (1917) and Lindroth (1957), reports of their immigration into North America are lacking, and no documentation of their extended geographic distribution is available. Therefore, it is my intent here to further evidence and support the immigrant status of both species, as proposed by Leng and Lindroth.

Simplocaria semistriata (F.)

Simplocaria is primarily a Palearctic genus with most of the species occurring in central and southeastern Europe. The metallica-group of species is native from Europe through the high latitudes of eastern Asia, and northern and montane North America. The semistriata-group is apparently restricted to mid-latitude low-montane and lowland environments through Europe to eastern Asia, with *S. semistriata* seeming to be the most recognized and widespread (e.g., Johnson, 1966; Paulus, 1979). Paulus treated the taxonomy of the central European species, but the genus as a whole requires review. *Simplocaria semistriata* is the only member of the semistriata-group recorded in North America.

While studying trans-Atlantic biotic distributions, Lindroth (1957) suggested that *S. semistriata* may have been introduced into North America, and noted its occurrence in Newfoundland as synanthropic. He based his conclusion on the previously unknown existence of this species in North America; its general abundance and

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[1] Mailing address: Department of Entomology, University of Wisconsin, Madison, Wisconsin 53706.

distribution in northern Europe, including port areas; its ground-dwelling habits; and the similarity of its North American occurrence to that of a wide variety of other immigrant invertebrates and plants.

Newfoundland specimens collected by Lindroth and in the collections of the Museum of Comparative Zoology, Cambridge, and the Canadian National Collection, Ottawa, have been examined and were found to be correctly determined by Lindroth. More recently collected Newfoundland specimens have been seen from the collections of Memorial University of Newfoundland and Canadian National Collection. Although North American specimens in the U.S. National Museum collection date from 1913, the species had not been treated as a member of the North American fauna before Lindroth's study.

In autumn 1983, a large series of the beetle was collected by the author at Walden Pond State Park and other nearby sites in Concord, Middlesex County, Massachusetts. At these sites, numerous adults were observed feeding, mating, and ovipositing on mats of the abundant pioneer moss *Dicranella heteromalla* (Hedw.) Schimp. *Atrichum angustatum* (Brid.) BSG was frequently mixed with *D. heteromalla,* but feeding on this moss by either adults or larvae was never observed in the field or laboratory. These mosses were found amongst scattered, weedy herbs on otherwise barren soil at trail margins and between the large exposed roots of living *Quercus rubra* L. and *Acer saccharum* Marsh.

In Scotland, *S. semistriata* has been observed feeding on the moss *Mnium hornum* Hedw. (R. Crowson, *in litt.*). Mosses of the genus *Mnium* are typically found on perennially moister microsites than are *D. heteromalla* and *A. angustatum,* and are abundant throughout North America.

Sexually active adults of *S. semistriata* were present in early October, and the population remained active until severe frosts. Specimens collected in late autumn or winter failed to mate or oviposit, but did feed. Extensively abraded, perambulating and feeding specimens were found on warmer (air temp. >3°C) days in February and April on sunlit and snow-free moss patches. A late-second instar larva was found within a mat of *D. heteromalla* in mid-April. Live adults were not found during late spring and summer. It appears that overwintering is accomplished by the first instar larva and senescing adults.

Records for this species are provided here and summarized in Map 1. These localities, except from Newfoundland, represent previously unpublished State or Province records: *CANADA:* BRITISH COLUMBIA—Burnaby Mt.; NEWFOUNDLAND—Cow Head; Avalon Penninsula, Portugal Cove; Cochrane Pond Park; Petty Hn.; Catalina T.B.; St. John's; Long Pond; NOVA SCOTIA—Truro; Cow Bay; ONTARIO—Waterloo; QUEBEC—Ile d'Anticosti, Pointe Nord; 15 km E Lachute; Lucerne; Parc Gatineau; Drummondville; Ste-Clothilde. *UNITED STATES:* CONNECTICUT—Bolton; MAINE—Houlton; MARYLAND—Prince Georges Co., Anacostia River flood; MASSACHUSETTS—Barnstable Co., Nauset Marsh; Middlesex Co., Concord, Walden Pond State Park, Hapgood Wright Forest; MINNESOTA—St. Paul; NEW HAMPSHIRE—Rockingham Co., Odiorne Point St. Pk; Strafford Co., 4 mi SW Durham; Durham; Somersworth; NEW YORK—New York; Fishkill; Cayuga Co., Ledyard; Ithaca, Warren farm; Lister Co., Stoneridge; Staten Island, Grant City; OHIO—Harrison Co., 2 km N Flushing; VERMONT—Bennington Co., Big Equinox Mtn.

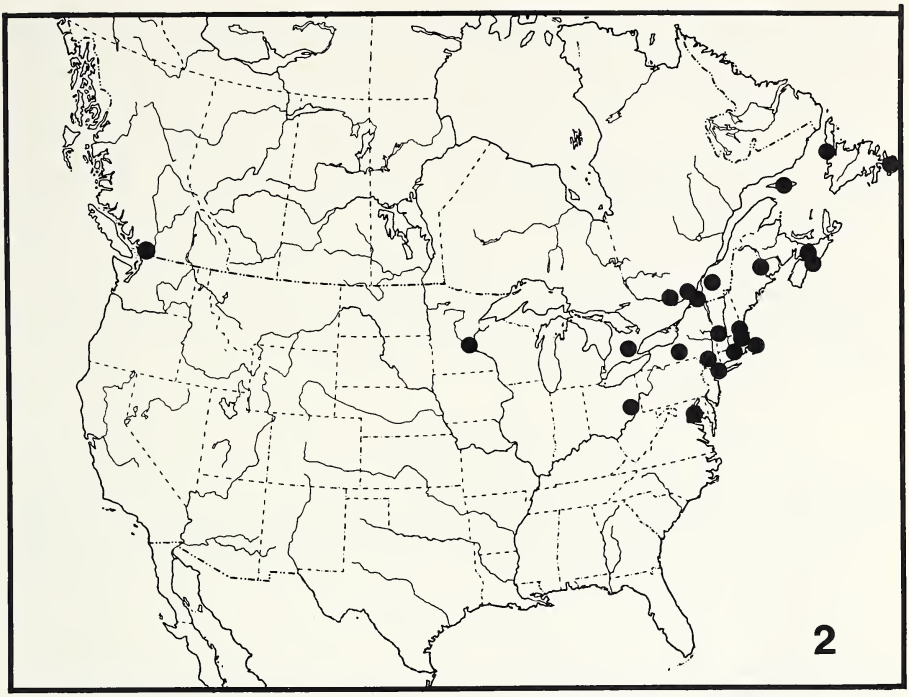
Map 1. Known distribution of *Simplocaria semistriata* (F.) in the United States and southern Canada.

Chaetophora spinosa (Rossi)

Chaetophora spinosa, formerly in *Syncalypta* (Johnson, 1978), seems to be a relatively well known syncalyptine byrrhid occurring throughout much of Europe. The genus, in a broad sense, seems most diverse in tropical lowland, monsoonal environments in Southeast Asia, Central and South America, and western Africa. Except for *C. spinosa, Chaetophora* taxonomy has never been adequately reviewed, and numerous specimens representing undescribed species have been examined. *C. spinosa* is the only species of the genus known to occur in Europe and North America, with previous supposed congeners now assigned to *Curimopsis.*

The first North American records of this species were provided by Leng (1917) from Batavia, New York, and Suffield, Connecticut. At that time, Leng commented on its probable introduced status; he later listed the species as such (Leng, 1920) and gave its distribution as Europe, North America, New York, and Connecticut. Leng (1928) reported the species from the New York localities of Rochester, Batavia, McLean, Genesee Co., and Windsor. Otherwise, this species has not been accurately reported in North America. Additional records are presented below.

One reason *C. spinosa* has not been recognized as an immigrant may be confusion existing between species of *Syncalypta* and *Simplocaria.* For example, Arnett (1973, and earlier editions) incorrectly cited this species as "*Syncalypta tessellata* [sic] (LeConte, 1850), throughout Canada, Connecticut, and New York." This is an un-



Map 2. Known distribution of *Chaetophora spinosa* (Rossi) in the United States and southern Canada.

fortunate confusion with *Simplocaria tesselata* (LeConte), and by including Connecticut and New York in the distribution he may have been confounding this species with *S. semistriata.* This mistake has been perpetuated in research and reference collections I have visited, where North American specimens of both *C. spinosa* and *S. semistriata* have been determined as *Simplocaria* or *Syncalypta* "*tessellata.*"

Chaetophora spinosa occurs primarily in disturbed, moist habitats, with silty topsoils or exposures. Most frequently, these sites are anthropogenic. The habitats I have examined typically contain large expanses of moss protonemata and algae, which appear to constitute the primary hosts. On banks of the Kootenai River and railway and highway embankments in northern Idaho, large populations of this beetle were associated with the mosses *Pohlia atropurpurea* (Wahl.) H. Lind., *Dicranella varia* (Hedw.) Schimp., and *Aloina brevirostris* (Hook. & Grev.) Kind., although only the former two, with a *Nostoc* sp. of alga, have been confirmed as hosts. The Kootenai River site is characterized by cement rip-rap overlain by riverine silt, while the other sites are embankments cut into deep glacial clay-silts. Elsewhere, other gross habitat associations include unpaved roadways, gardens, and agricultural fields. Specimens have also been collected in-flight from late afternoon through dusk.

North American localities for *C. spinosa* include the following (excluding Leng's records), and are summarized on Map 2; all are previously unpublished State or Province records: *CANADA:* BRITISH COLUMBIA—Creston; ONTARIO—Brittania; Prince Edward Co., Brimley; Eastview; Pt. Pelee; Ottawa; Long Point; Jordan; Mer Bleue; Arnprior; Kinburn; QUEBEC—Hanefield; Aylmer; Hull; Knowlton; Gatineau Pk., Ramsey Lk.; 4 mi W Masham; Brome; Cascapedia; Duchesnay; Magog. *UNITED STATES:* CONNECTICUT—Portland; IDAHO—Bonner Co., 11 mi E Priest River; Boundary Co., Copeland bridge at Kootenai River; MAINE—Paris; Augusta; MASSACHUSETTS—Northboro; Lexington; Tyngsboro; Natick; Framingham; Arlington; Fall River; Nahant; NEW HAMPSHIRE—Plymouth; Rumney; Meriden; Plainfield; Orford Center; Strafford Co., 3 mi SE Dover; Coos Co., Dalton; 1 mi NE Colebrook; Carroll Co., 1 mi N Wanalancet, 2.5 mi NW Wanalancet; NEW YORK—Meadowdale; Cayuga Co., Twn of Ledyard; Tompkins Co., Town of Ulysses; Ithaca, Savage Farm; Ithaca, Taghanic; Penn Yan; Ithaca, Warren Farm; OHIO—Harrison Co., 2 km N Flushing; Crawford Co., Bucyrus.

DISCUSSION

Lindroth (1957) provides the most complete treatment of trans-Atlantic biotic distributions with regard to the introduction of European organisms into North America. This and his subsequent faunal history of Newfoundland (Lindroth, 1963) remain the best original attempts at analyzing the causative circumstances of human-induced biotic introductions into North America. Lindroth defined 5 criteria for evaluating the possible introduced status of an organism. Although Brown (1940) had briefly introduced many of the same aspects, he did not elaborate and document his conclusions as thoroughly as did Lindroth. Larson and Langor (1982) and Morris (1983) have accepted and supported Lindroth's criteria in their studies on adventive Newfoundland insects.

Lindroth's following criteria of introduction seem to be adequately fulfilled for establishing the immigrant status of both *S. semistriata* and *C. spinosa*:

1) Historical—Specimens of both species were not recorded in North America until the 20th century. For *S. semistriata,* the earliest records are from Nova Scotia in 1913; for *C. spinosa,* Leng's 1917 record from New York is the first.

2) Geographical—The bicentric distributions in North America of both *S. semistriata* and *C. spinosa,* and the superposition of early locations with port areas follow the same patterns as those documented by Lindroth (1957) for numerous invertebrates and plants of confirmed introduced status. Lindroth (1963) considered such patterns "unnatural" and to belie climatic or host restriction reasons for the organisms' distribution.

3) Ecological—*S. semistriata* has been collected from ballast and imported nursery products on at least two occasions, in New York City, and St. Paul, Minnesota. Although no records of *C. spinosa* are known from import shipments, the species has been repeatedly collected in urban, suburban and developed rural environments. Both species inhabit cultural steppe, an environmental situation containing numerous introduced insects, as noted recently for Carabidae by Larson and Langor (1982) and Spence and Spence (1988). A semi-synanthropic relationship appears to define such an association.

To this criterion, the community patterns of species may be added. As emphasized by Lindroth (1957, 1963), and more recently by Spence and Spence (1988), the occurrence of certain suites of carabid beetle species in cultural steppe is repetitious. Even though detailed investigations on the community integrity and habitat correlations for *C. spinosa* and *S. semistriata* are incomplete, the cultural steppe pattern seems evident for these beetles. Habitat restrictions are known through much of the Byrrhidae, including *S. semistriata* and *C. spinosa.*

4) Biological—Lindroth (1957, 1963) discussed host specificity under this criterion. This factor may not apply to *C. spinosa* or *S. semistriata,* as their known hosts, though few, are taxonomically unrelated, and are considered naturally Holarctic (e.g., Ireland, 1982; Crum and Anderson, 1981).

5) Taxonomic—Neither *S. semistriata* nor *C. spinosa* have closely related species in North America. *Simplocaria* is otherwise represented in North America by only two species, *S. tesselata* LeConte and *S. remota* Brown, both members of the metallica-group. *Simplocaria semistriata,* of the semistriata-group, has close congeners only in Eurasia. Congeners of *C. spinosa* are all tropically distributed. No other *Chaetophora* in the Americas are known from north of Veracruz, Mexico.

Based on the above evidence, it appears that *S. semistriata* and *C. spinosa* have been introduced from northwestern Europe, and probably from Great Britain (see Lindroth, 1957). The ecological impact of these immigrants on the native bryophyte flora and fauna, especially during the earliest seres, is unknown.

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BIOLOGY AND RECOGNITION OF *XYLOTRECHUS SCHAEFFERI* SCHOTT, AN ENIGMATIC LONGHORN IN NORTHCENTRAL AND EASTERN NORTH AMERICA, WITH A DESCRIPTION OF THE LARVA (COLEOPTERA: CERAMBYCIDAE)

E. Richard Hoebeke[1] and Jeffrey P. Huether[2]

[1]Department of Entomology, Cornell University,
Ithaca, New York 14853, and
[2]443 Turk Rd., Geneva, New York 14456

Abstract.—The clytine cerambycid *Xylotrechus schaefferi* Schott, a rare species in North American collections, is found to breed in the hard, dry, closed cones of pitch pine (*Pinus rigida*) and jack pine (*P. banksiana*) in northcentral and eastern North America. This represents only the second known North American cerambycid to breed exclusively in coniferous cones. Larvae bore through the central axis, scales and seeds of the host cone. Presumably, one generation is produced annually, with the adult flight period occurring from June–August. The eumenine vespid wasp *Ancistrocerus adiabatus* was found to use the empty larval galleries in pitch pine cones as nesting sites. The female of *X. schaefferi* is redescribed, while the male and larva are described, illustrated, and characterized for the first time. External and internal cone damage is also illustrated by photographs.

Among the several hundred insect species that attack the reproductive structures of coniferous hosts, some are chronic pests that destroy cones and seeds while others periodically cause only minor damage or cosmetic defects to cones (Coulson and Witter, 1984). The principal pests include cone beetles of the genus *Conophthorus* (Scolytidae) which attack and bore into the base or supporting stems of immature pine cones, and cone moths [*Dioryctria* spp. (Pyralidae), *Eucosma* spp. (Olethreutidae) and *Cydia* spp. (Tortricidae)] which attack cones by boring galleries through the scales and seeds.

Old, hard and dry cones of conifers provide a less than attractive food resource, but nonetheless, are occasionally mined by various wood-boring insects, including a few Cerambycidae (Coleoptera) which riddle the cone interior and destroy the seeds. The majority of the comparatively few species of Cerambycidae whose larvae make galleries in "seeds and seed-pods" (*sensu* Duffy, 1953) are found in dead fallen cones of Coniferae. Larvae of some non-North American cerambycids are known to attack healthy green cones, feeding on the internal woody tissue of the scales and central axes, while other species are capable of attaining maturity in cones (for references see Duffy, 1953).

Paratimia conicola Fisher, the roundheaded cone borer, is the "only North American longicorn [whose larva is] known to feed regularly in cones," attacking hard, dry cones of at least two species of western North American pines [knobcone pine, *Pinus attenuata* Lemm. and shore pine, *P. contorta* var. *contorta* Dougl. (cited as *P. bolanderi*)] (Craighead, 1923; Keen, 1952, 1958; Linsley, 1962). Eggs of *P. conicola* are deposited at the base of young cones, and larvae feed in the pithy central axis and in seeds and scales. Keen (1952, 1958) also reports the occasional occurrence of larvae of *Phymatodes nitidus* LeConte in redwood (*Sequoia*) cones. Its larvae typically bore in dead or dying branches of cupressaceous trees (Linsley, 1964).

In spring of 1982, an undergraduate student at Cornell University, conducting an independent research project in the Department of Natural Resources, chose to study the "pine barren" communities of Long Island, New York. She was specifically interested in the parameters that contribute to dwarfism in pitch pine, *Pinus rigida* (J. P. Lassoie, pers. comm.). Her studies and observations led to the discovery of numerous cones on the trees exhibiting damage indicative of some wood-boring insect. Examples of these damaged cones were subsequently submitted to the Insect Diagnostic Laboratory at Cornell for diagnosis. Upon opening cones, one of us (ERH) discovered larvae of the family Cerambycidae boring in the central axes, scales and seeds. Interestingly, no eastern North American cerambycid was previously known to breed in the cones of pine. Thus, to learn the identity of this longhorn beetle, the junior author (JPH) began collecting hundreds of damaged and undamaged, unopened cones of pitch pine from several localities on Long Island, New York, and in the pine barrens of New Jersey during 1983–1987. JPH was successful in rearing numerous specimens of an unrecognized species of the cerambycid genus *Xylotrechus* that were subsequently identified by ERH as *X. schaefferi* Schott, a longhorn species rarely encountered in North American collections, and whose biology and habits were previously unknown.

In this paper, we summarize the biology and habits of this enigmatic cerambycid based on laboratory and field observations, provide a description and dorsal habitus of the adult, and describe and illustrate the mature larval stage. Adult emergence holes in pitch pine cones and larval damage to cone interiors are illustrated by photographs.

Rearing and field observations. On 9 May 1983, an initial search was made by JPH for pitch pine cones with emergence holes along a power line cut 0.3 km N of the junction of NYS Routes 31 and 27, at Riverhead, New York (Suffolk Co.). Approximately 30% of the trees produced cones that did not open (=serotinous, strains having cones which only open with the heat of a fire, see Windisch, 1986). A sweep of the area revealed numerous emergence holes on individual unopened cones of serotinous trees. One hundred and thirty-five cones were collected, placed in five gallon plastic pails, and kept at room temperature (20–24°C). Of the 135 cones taken, 19 had emergence holes. Fifteen holes were located in the apical ⅓ of the cones and 4 near the cone central axis. From the remaining undamaged cones, 3 male *X. schaefferi* emerged, one each on 18 June, 28 June, and 30 June. One specimen emerged from the apical ⅓ of the cone and the other 2 from the basal ⅓. The remaining cones were placed at 12–14°C for the winter and again later removed to room temperature. No further adults were reared from these cones.

The following year on 6 March 1984, 1,096 cones were collected from a site located 0.3 km S of the junction of NYS Routes 31 and 27, Riverhead, New York. Emergence holes were readily visible on cones of those trees supporting unopened cones. Of 80 cones with old emergence holes, 9 holes were located on the apical ⅓, 13 at the cone center, and 58 on the basal ⅓. Also of these 80 cones, 3 had 2 emergence holes each. Again, all cones were kept at 20–24°C in plastic rearing pails. Six adults were reared, 1 male on June 20, a male/female pair on 21 June, 1 male on 9 July, and 2 males and 1 female on 14 July. Two mature larvae, that chewed their way through the cone exterior and dropped to the bottom of the plastic pail, were killed and preserved for descriptive purposes.

During the period 26–27 May 1984, an additional 868 cones were taken from trees at the Riverhead sites with damaged cones and set up for rearing. Between 7 July and 20 August, another male and 2 female beetles were reared. Also, 3 eumenine vespid wasps, *Ancistrocerus adiabatus* (Saussure), emerged from cones collected at the Riverhead site. Nests of *A. adiabatus,* a transcontinental and widespread species in southern Canada and the United States, have been reported from pre-existing cavities, such as borings in twigs, stems and wood, galls of other insects, old mud-dauber nests, empty sawfly cocoons, and rubber tubing (Krombein et al., 1979). These wasps were undoubtedly using vacant larval galleries in cones as nesting sites.

In 1985, 1,478 cones from the Riverhead, New York site yielded 11 specimens (7♂♂, 4♀♀). On 23 April 1987, 896 cones were collected from trees in the pine barrens of New Jersey (Burlington Co.), and between 1 August and 10 October, 20 adults (9♂♂, 11♀♀) were reared. At the same Burlington Co. site (N side of Rte. 72, 0.1 mi E of 10 mile marker) on 19 August 1987, JPH observed and collected 2 adult beetles landing on pitch pine needle bundles. On 2 June 1988, 876 cones were collected at the Burlington Co., New Jersey site and produced 7 individuals (3♂♂, 4♀♀) between 28 August and 16 September.

Other stands of pitch pine from central New Jersey to Cape Cod, Massachusetts to Albany, New York were checked for cone damage. Eighteen localities in all were investigated. Between 100 and 1,000 cones from each location were examined for emergence holes. An extensive stand of dwarf pitch pine along Rte. 539, 3–10 miles S of Whiting, New Jersey (Ocean Co.) was examined but no cone damage was noted. Also in New Jersey along Rte. 547 and 4 miles N of Lakehurst, along Rte. 70 and 1 mile W of Lakehurst, and along Rte. 72 at milepost 20 in Ocean Co., a few serotinous trees exhibited cones with exit holes. In Massachusetts, along Rte. 195 at Wareham (Plymouth Co.) and along Rte. 2 (Worcester Co.) from Athol to Shirley, slightly opened cones with exit holes were found. In Connecticut, in a pitch pine stand near Oneco (Windham Co.) along Rte. 14, damaged unopened cones were also observed.

Museum records. After successfully rearing *X. schaefferi* from pitch pine cones, we turned our attention the the major insect collections of eastern United States with hopes of finding additional specimens and associated rearing data. With one exception, no specimens, identified or otherwise, were found between 1983 and 1988. However, in 1989 three identified specimens were discovered in the Canadian National Collection (Ottawa) with 3 provincial records: *Ontario:* Malaci, Aug. 1938; *Quebec:* Fort Coulonge, 7-18-19; and *Manitoba:* Marchand, 6-5-69, reared ex jack pine cones (*Pinus banksiana*). No other collection records are known to us.

The same Quebec record above (Fort Coulonge) was recently cited in a paper by LaPlante (1989) in which he reported *X. schaefferi,* along with 13 other cerambycid species, new for the province of Quebec.

Beetle and host distribution. The potential geographic range of *X. schaefferi* can be anticipated to closely overlap that of its known hosts, *P. rigida* and *P. banksiana* (Fig. 1). *Pinus rigida* is found from New Brunswick to Lake Ontario, south into the Atlantic states to northern Georgia, and west into West Virginia, Tennessee and Kentucky, while *P. banksiana* occurs from Nova Scotia westward to the Northwest

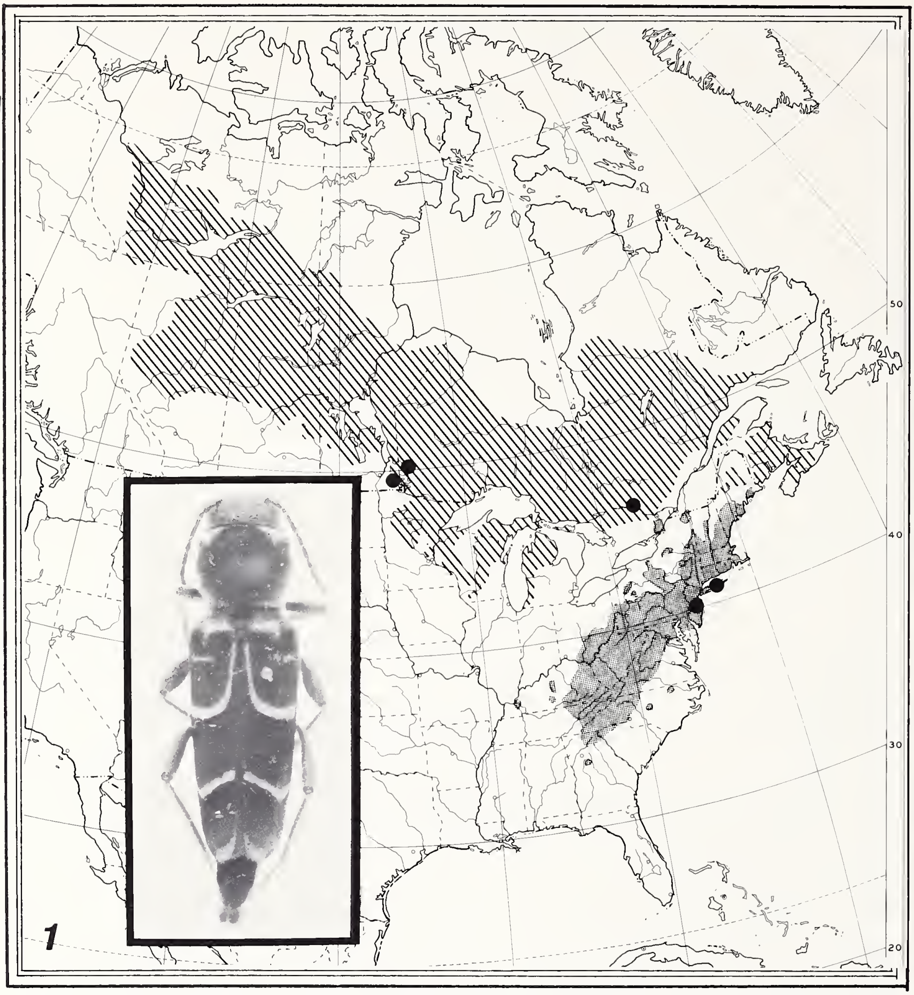


Fig. 1. Known geographic range of *Xylotrechus schaefferi* (black dots) in eastern North America; and that of its coniferous hosts, pitch pine (*Pinus rigida*—stippled area) and jack pine (*P. banksiana*—crosshatched area) (after Little, 1971). Insert, female habitus of *X. schaefferi.*

Territories and British Columbia, south to northern New England, New York, Michigan, northern Illinois and central Minnesota (Brown, 1975). Brown also notes that the habitat of these pines is very similar, with both species thriving on barren sandy sites and rocky ridges, and often extending over vast tracts of barren lands and sand dunes. The compact cones of both pines remain on the branches for a decade or more.

Host plants, damage and seasonal history. The larval stages of *X. schaefferi* are rather specialized in their habits—feeding in the hard, dry, closed cones of pitch pine, *Pinus rigida* (based on rearing data by JPH) and of jack pine, *P. banksiana* (based on ecological label data associated with an identified specimen in the Canadian

National Collection, Ottawa). We hypothesize that *X. schaefferi* requires closed, compact cones to successfully complete its development. Future detailed observations might show that other pine species with similar closed cones would also serve as adequate hosts. The larvae bore through the hard, dry, closed cones of the host tree after the cones have matured, destroying much of the interior of the cone (see Fig. 3). Our observations indicate that usually a single larva occupies a cone, based on the presence of single emergence holes in most cones examined. However, as many as three exit holes have been observed on a single cone. Pupation presumably takes place inside the cone in a pupal cell. The adult emerges by chewing its way to the exterior. Exit holes are generally found in the basal ⅓ of the cones; however, some will exit from the tip of the cone or near the center (see Fig. 2).

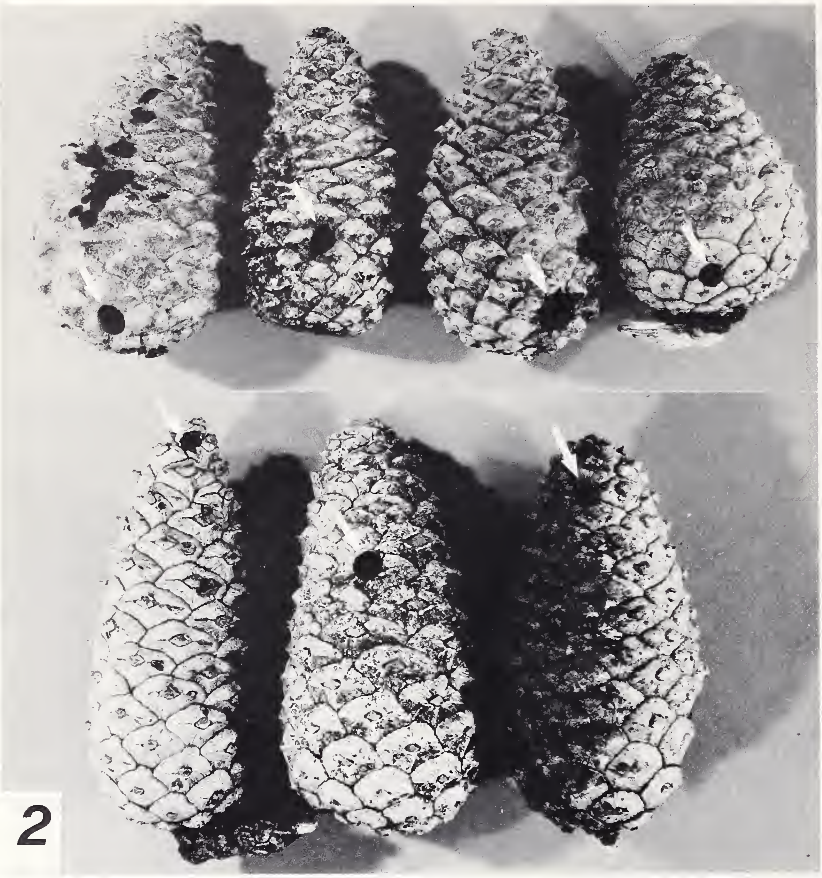
Although this species has now been reared several times, we feel these records and observations are still insufficient to reconstruct the seasonal history. The data suggest that one generation is produced annually and that adults are active June–August, flying among the foliage of the host trees.

Xylotrechus schaefferi Schott

Xylotrechus schaefferi Schott, 1925, J. New York Entomol. Soc. 33:224; Hopping, 1932, Ann. Entomol. Soc. Amer. 25:540; Linsley, 1964, Univ. Calif. Publs. Entomol. 22:117. Type ♀ examined, deposited in the collection of the American Museum of Natural History (New York).

The following adult description, taken in most part from Linsley (1964), serves as an adequate representation of the species:

Female (Fig. 1, insert). Form moderately robust; integument dark brown; vestiture fine, whitish and yellowish. Head coarsely punctate and shining above, thinly clothed with erect and suberect grayish hairs, denser and more appressed at sides of face; frontal carina prominent, V-shaped; antennae brown, surpassing elytral humeri. Pronotum a little broader than long, not as wide as base of elytra, sides obtuse at middle, apex wider than base, base shallowly constricted, surface granulate-punctate, disk transversely rugulose at middle, pubescence obscure, thin, pale, appressed, longer and more erect at sides, a dense patch of yellow hairs above on each side of apical margin, a similar patch on each side on basal margin, a patch of yellow hairs below adjacent to external angulation of coxal cavities; prosternum finely punctate and transversely rugulose, thinly clothed with grayish or whitish appressed pubescence intermixed with longer erect pale hairs; metasternum and episterna of metathorax finely, rather densely punctate, thinly clothed with long suberect and erect hairs, a patch of yellow pubescence along posterior margin of episterna. Elytra nearly 2⅓ times as long as basal width; surface dark brown, margins paler brown; pubescent bands narrow, yellow, consisting of a transverse posthumeral spot, an arcuate antemedian line extending back along suture from a point behind scutellum to a basal ⅓ and curving laterally toward sides and slightly forward toward but not quite to margin, a postmedian line extending obliquely back from suture across about ⅗ of elytral width and then curving toward margin subparallel to antemedian line, and a small apical patch at suture; apices obliquely truncate. Legs slender, brown; femora finely punctate, thinly pubescent. Abdomen with sternites thinly clothed with long erect and suberect pale hairs, condensed into a narrow whitish band along posterior



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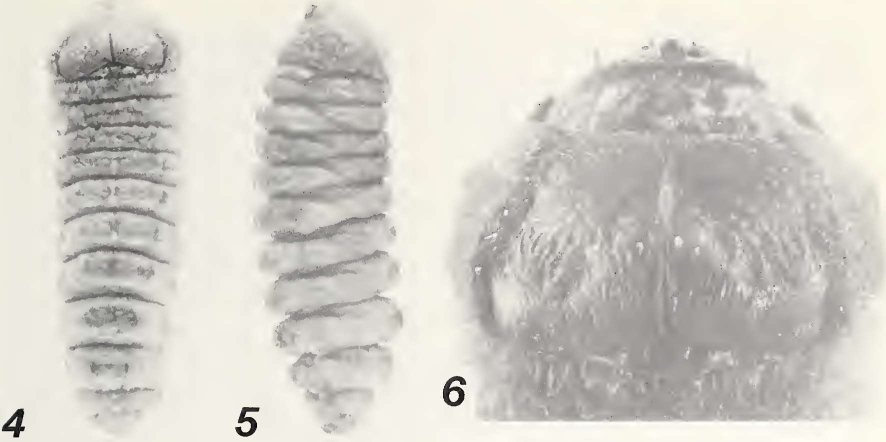
Figs. 2–3. Adult and larval *Xylotrechus schaefferi* damage to pitch pine cones. 2, Adult emergence holes indicated by arrows. 3, Larval galleries (at arrow) and damage to cone interiors.



Figs. 4–6. Larva of *Xylotrechus schaefferi.* 4, Dorsal aspect. 5, Lateral aspect. 6, Pronotal plate, closeup.

margins of segments; fifth sternite rounded at apex. Length 8.8–12.7 mm ($\bar{x}$ = 11.2 mm, N = 18).

Male. Indistinguishable from female in details of vestiture and color. Head with two large, prominently defined, finely granulate-punctate, oval areas (Figs. 7, 8) on the vertex above the compound eyes. These areas, defined posteriorly by a finely raised ridge, extend to the margin of the pronotum and are sometimes partially concealed by the pronotum. Length 7.4–11.3 mm ($\bar{x}$ = 9.8 mm, N = 16).

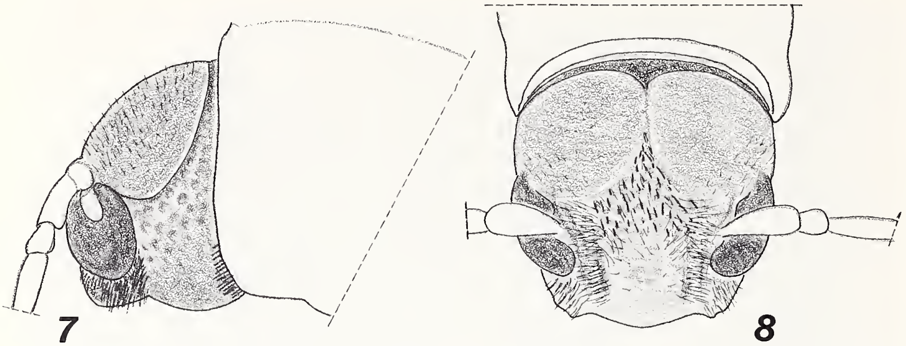
Specimens examined: 31♂♂, 19♀♀. Specimens reared from cones of pitch pine, *Pinus rigida.* Localities and dates of collection are discussed under the section "Rearing and Field Observations." Voucher specimens are deposited in the collections of Cornell University (Lot #1191) and Jeffrey P. Heuther.

Remarks. Hopping (1932), in the course of revising the Clytini of boreal America, never examined specimens of *X. schaefferi* and noted that "apparently only the type is known." Based on Schott's (1925) original description, Hopping placed *X. schaefferi* in "the *undulatus* group in spite of the fact that the mid-elytral fascia is not undulatory." The *undulatus* group (*sensu* Hopping) is comprised of the species *undulatus* Say, *lengi* Schaeffer, *fuscus* Kirby, *abietis* Van Duzee (=*albonotatus* Casey), *bowditchi* Hopping, *mormonus* LeConte, and also *schaefferi.* The known host list of the *undulatus* group is comprised of only conifers—*Pseudotsuga, Tsuga, Pinus, Picea* and *Abies.* All, with the exception of *X. schaefferi,* breed in the wood or under the bark of their coniferous hosts. However, J. Cope (San Jose, CA) informs us (*in litt.*) that *X. mormonus* utilizes *Salix* (willow) as a host and should not be in the *undulatus* group, but instead placed in the *insignis* group.

DESCRIPTION OF LARVA OF *XYLOTRECHUS SCHAEFFERI*

Figs. 4–6

Form (Figs. 4, 5). Robust, contracted, subcylindrical, tapering to last few abdominal segments; integument rather dull, sparsely covered with fine, long, erect, pale setae.



Figs. 7–8. Head of male *Xylotrechus schaefferi.* 7, Lateral aspect. 8, Frontal, dorsal aspect.

Head (Fig. 6). Trapezoidal, gradually tapering anteriorly; mouth-frame corneous, black; labrum rather thick, suborbicular, blackish, widest behind middle, with long, fine, pale setae; mandibles robust, tapering to apex, dull black; first antennal segment thick, about equal to length of third segment, second segment short, shorter than I or II, accessory appendage of segment III very distinct; on either side one small, distinct ocellus nearly contiguous with base of antenna.

Prothorax (Fig. 6). Rectangular, at least twice as wide as long; pronotal plate wider than long, median suture deeply impressed in basal half; anterior portion on either side of median suture glossy, coarsely, but sparsely punctured, pale ochraceous; posterior half adjacent to median suture, posterior margin and posterior angles darker brown, more coarsely rugulose (Fig. 6), surface between rugae very finely granulate thus appearing dull; velvety pubescence absent. Legless.

Abdomen. With large, transverse, flat, very finely granulate ampullae; perimeter of ampullae lacking velvety pubescence. Spiracles broadly to narrowly oval, peritreme thin; first and last spiracles slightly larger than those of segments II–VII.

Specimens examined: 3 larvae (in alcohol). Deposited in collection of Cornell University (Lot #1191).

Larval diagnosis. According to Craighead (1923), known larvae of *Xylotrechus* species are recognized by the following diagnostic combination: body legless (except *X. convergens* which possesses a minute spine in place of legs); head capsule with one ocellus on either side; process of palpifer very small; posterior area of pronotum velvety pubescent or not, as also the perimeter of abdominal ampullae; median suture of pronotum impressed behind; ventro-lateral sutures a mere notch; sternellar fold distinct at extremities, passing spiracles; and body form robust, contracted.

Larvae of *X. schaefferi* are distinguishable from the majority of other known *Xylotrechus* larvae by the lack of velvety pubescence on the posterior pronotal plate and on the perimeter of the abdominal ampullae. Following Craighead (1923), *X. schaefferi* is similar to both *X. convergens* LeConte and *X. nauticus* Mannerheim. It differs from *X. convergens* in being legless, and from *X. nauticus* by the suborbicular labrum and by its eastern North American distribution. It also differs from the two latter species by its breeding in cones of *Pinus* spp.

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GENERIC REASSIGNMENT OF *ANISOSTENA TESTACEA* PIC (COLEOPTERA: CHRYSOMELIDAE: HISPINAE)

C. L. Staines, Jr.
3302 Decker Place, Edgewater, Maryland 21037

Abstract.—*Anisostena testacea* Pic, 1934 from Argentina is redescribed and transferred to *Sumitrosis* Butte, 1969. A revised key of *Sumitrosis* occurring in Argentina is presented.

Pic (1934) described *Anisostena testacea* from Argentina. Blackwelder (1946), Monrós and Viana (1947), Papp (1953), Uhmann (1957), Descarpentries and Villiers (1959), and Uhmann (1964) all followed this generic placement.

The bodies of *Anisostena* Weise species [type species *Charistena elegantula* Baly designated by Monrós and Viana (1947)] are elongate, subcylindrical, and parallel-sided. The head is small, with the front not prominent, and the vertex sulcate or micropunctate. The pronotum is transverse, convex, and is not margined. The elytra are parallel-sided, not widened apically with apices evenly rounded. The legs have clearly curved mesotibiae. The prosternum is not prolonged and does not conceal any part of the mouth.

I have examined the holotype of *A. testacea* and found it to belong to the genus *Sumitrosis* Butte [type species *Hispa rosea* Weber designated by Butte (1969)]. The bodies of *Sumitrosis* species are not elongate and are wide at the humeri. The head has eyes which are more or less swollen and a finely granulose, deeply sulcate vertex. The pronotum is transverse, the lateral margins are obtusely subangulate at middle, slightly narrowing apically and obliquely more so basally. The elytra are elongate-ovate with apices cojointly rounded. The legs have straight or slightly curved mesotibiae.

For the following description, measurements were taken with an ocular micrometer. Total length is from the anterior margin of the pronotum to the elytral apex. Pronotal length is from the base to the apex of the pronotum. Pronotal width is along the midlength. Elytral length is from the elytral base to the apex. Elytral width was taken at the humeri.

Sumitrosis testacea (Pic), **New Combination**

Description of holotype. Head. Vertex alutaceous; sides of head smooth; median sulcus faint; clypeus punctured; antennal segment I transverse; II–III cylindrical; IV–VI transverse; VII–X transverse, wider than preceding; XI pointed at apex. *Pronotum.* Covered with large, shallow punctures, those on apical margin and a few punctures in angles and along lateral margins most distinct, others are difficult to see except when specimen is turned obliquely; lateral sides margined; base margined; basal impression present; surface alutaceous between punctures; pronotal length 0.65 mm; width 0.7 mm. *Scutellum.* Triangular. *Elytron.* 8 puncture rows, a row may overlap an adjacent row; puncture row 1 entire; row 2 with puncture gaps, punctures on basal half alternate with those in row 1, on apical half they are opposite; rows 3–4, 5–6, and 7–8 with most punctures intermingled; punctures alternate on basal half, opposite on apical half; punctures oval except apical punctures in rows 7–8 which are round; scutellar row composed of 2 punctures; lateral and apical sides margined; humerus rounded, alutaceous; elytral length 1.81 mm; width 1.0 mm. *Legs.* Yellow, tarsi darker. *Venter.* Pro-, meso-, and metasterna yellow; abdomen black, except pale apex of last abdominal sternum. *Total length.* 2.58 mm.

Larval host plant. Unknown.

Immature stages. Unknown.

Distribution. Argentina.

Specimens examined. Holotype (label data largely illegible)—ARGENTINA: Olrquit (?) Corrientes (?)/gytcennes (?) de articles/type (yellow label)/TYPE (red label)/Museum Paris Coll. M. Pic (blue label)/Anisostena testacea n. sp. (MNHN). Total 1.

Discussion. This species is very rare in collections. Monrós & Viana (1947) did not locate any material for their revision of the Argentina Hispinae, they merely quoted Pic's short description. An examination of the collections of the California Academy of Sciences, Florida State Collection of Arthropods, and the U.S. National Museum failed to locate additional specimens.

The key to the *Sumitrosis* species (as *Anoplitis*) of Argentina in Monrós & Viana (1947) is modified below to include *S. testacea.*

KEY TO THE *SUMITROSIS* OF ARGENTINA

1. External apical angles of elytra with triangular lamina; antennae testaceous; legs yellow; pronotum trivittate; body color testaceous; elytra with black maculae .... *difficilis* (Monrós & Viana)

– External apical angles of elytra rounded, without lamina 2

2(1). Body color blue-black; pronotum with central yellow vitta; elytra with lateral yellow maculae .... *chacoensis* (Weise)

– Body color yellow or testaceous 3

3(2). Head and antennae black; pronotum with two black maculae on disc; elytra yellow with black maculae .... *bruchi* (Uhmann)

– Head and antennae testaceous 4

4(3). Lateral margins of pronotum convergent anteriorly; pronotum with central longitudinal vitta .... *fuscicornis* (Weise)

– Lateral margins of pronotum parallel 5

5(4). Pronotum trivittate; elytra maculate .... *picta* (Weise)

– Pronotum without vittae; elytra immaculate .... *testacea* (Pic)

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HYDROPTILIDAE (TRICHOPTERA) OF COSTA RICA: THE GENUS *MAYATRICHIA* MOSELY

Steven C. Harris[1] and Ralph W. Holzenthal[2]

[1]Aquatic Biology Program, Department of Biology, University of Alabama,
Tuscaloosa, Alabama 35487, and
[2]Department of Entomology, University of Minnesota,
St. Paul, Minnesota 55108

Abstract.—The genus *Mayatrichia* is represented in Costa Rica by three species, *M. ayama* Mosely, *M. rualda* Mosely, and *M. illobia,* new species. The new species, also known from Ecuador, is described and illustrated. Distribution records, maps, and a key are provided for known Costa Rican species of *Mayatrichia.*

Comprehensive faunistic surveys of Trichoptera have been conducted in much of the Holarctic region, but such surveys have been infrequent in the Neotropics. Through the efforts of O. S. Flint, Jr., Smithsonian Institution, faunal lists have been prepared for the Antillean islands of Puerto Rico (1964), Jamaica (1968a), and Dominica (1968b). Several European workers, notably L. Botosaneanu, Institute of Taxonomic Zoology, Amsterdam, have studied the fauna of Cuba (Botosaneanu, 1979; Kumanski, 1987). The caddisfly fauna of Mexico is being surveyed by J. Bueno-Soria, Universidad Nacional Autónoma de México, and his students (Bueno-Soria and Flint, 1978). In South America, pioneering work by Flint has produced faunal lists for Surinam (Flint, 1974a) and Chile (Flint, 1974b) as well as species descriptions and keys for more restricted watersheds (e.g., Flint, 1981). In 1986, Holzenthal began the first extensive survey of the caddisfly fauna of Costa Rica. To date, almost six months of field research in Costa Rica has resulted in an initial checklist (Holzenthal, 1988) and thousands of specimens from over 100 separate collections at 90 different localities throughout the country.

Costa Rica, although small in area, is rich in physiographic diversity, with a series of large central mountain ranges and 19 Holdridge life zones, including transitional provinces (Tosi, 1969). The combination of Costa Rica's very dissected topography and high rainfall make for a diverse array of aquatic habitats. The caddisfly fauna of Costa Rica is reflective of this physiographic diversity and apparently has the quality of most tropical biotas in that it is speciose and contains a high proportion of endemics. Of the approximately 400 caddisfly species now known from Costa Rica, more than half appear to be endemic. Unfortunately, as is the case in much of the Neotropics, intensive land development is irreparably affecting entire Costa Rican watersheds; few of the country's drainage basins can be considered virgin. The Costa Rican caddisfly inventory is providing information about aquatic insect faunas for watershed conservation and management programs and against which future changes to particular watersheds can be compared.

This paper marks the initiation of a series of papers dealing with Costa Rican Hydroptilidae, or microcaddisflies. The Hydroptilidae, although one of the most speciose trichopteran families, is little known for much of the Neotropics, including Costa Rica. Because of the small size of microcaddisflies, adults are generally 2–5 mm in total length, they are often neglected by collectors and inadequately described. Of the approximate 250 described Neotropical Hydroptilidae, less than 30 have been recorded from Costa Rica previously. Certainly, these totals represent a small percentage of the actual Neotropical and Costa Rican hydroptilid fauna. In fact, since the initiation of the Costa Rican caddisfly inventory, we have collected and identified 125 Costa Rican microcaddisfly species of which 74 are new to science, including at least two new genera. With this work on the genus *Mayatrichia* Mosely, we begin a synopsis of the hydroptilids of Costa Rica. Additional, ongoing collecting will add both new distribution records and undescribed species, but we feel these additions will be relatively minimal and can be treated in a planned summary paper dealing with an overview of the entire Costa Rican microcaddisfly fauna. We prefer to make these names available now, in part to alert scientists, especially conservationists, to the diversity of Costa Rica's microcaddisflies.

Terminology in this and subsequent papers will follow that presented by Marshall (1979) and her paper should be consulted for an overview of the family. New taxa described in our series may challenge aspects of Marshall's phylogenetic hypotheses and our reinterpretations will be treated where appropriate. Type material will be deposited at the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (NMNH), the Instituto Nacional de Biodiversidad, Costa Rica (INBIO), and the University of Minnesota Insect Collection, St. Paul (UMSP). All specimens of previously described species upon which new records are based are from UMSP, except where indicated.

Mayatrichia Mosely

Mayatrichia Mosely 1937:182. Type species: *Mayatrichia ayama,* by original designation.

The New World genus *Mayatrichia* contains six previously described species: *M. acuna* Ross 1944 from Texas and Utah, *M. aliena* Kumanski 1987 from Cuba, *M. ayama* Mosely 1937 widespread in North America east of the western continental divide south to Costa Rica, *M. moselyi* Blickle and Denning 1977 from Utah, *M. ponta* Ross 1944 from Oklahoma, and *M. rualda* Mosely 1937 from Mexico and Costa Rica. Ross (1944) provided a key to males of *M. ayama, M. ponta,* and *M. acuna. Mayatrichia ayama* and *M. rualda* were recorded from Costa Rica by Bueno and Flint, 1978. The Cuban species, *M. aliena,* was tentatively assigned to the genus, but it is probably not congeneric (Kumanski, 1987). We here describe an additional Neotropical species from Costa Rica and Ecuador and provide additional distribution records for *M. ayama* and *M. rualda* in Costa Rica.

Mayatrichia adults can be recognized by having 0-2-4 tibial spur formula, presence of ocelli, and triangular metascutellum (Blickle, 1979). Diagnostic features of the male genitalia are the prominent posterolateral processes of segment IX, the broad inferior appendages, and the tubular phallus (Marshall, 1979). Females have simple, tubular genitalia, with a prominent bursa copulatrix. Wiggins (1977) provided a detailed description of the larva and case of *M. ponta* and Ross (1944) provided the same for *M. ayama.* In North America, larvae are found on rocks in rapid stretches of often large streams and rivers where they apparently feed on fine organic material

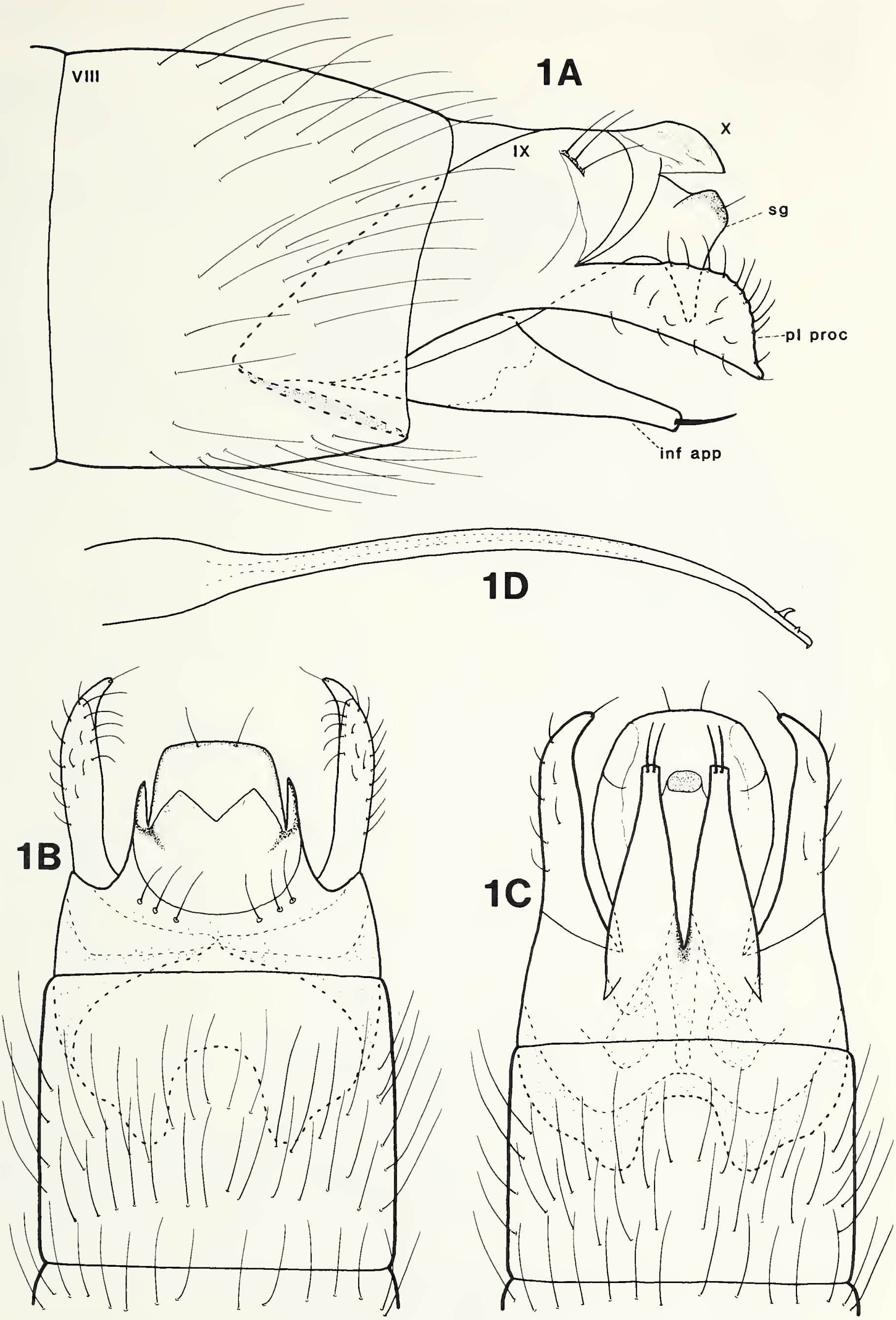
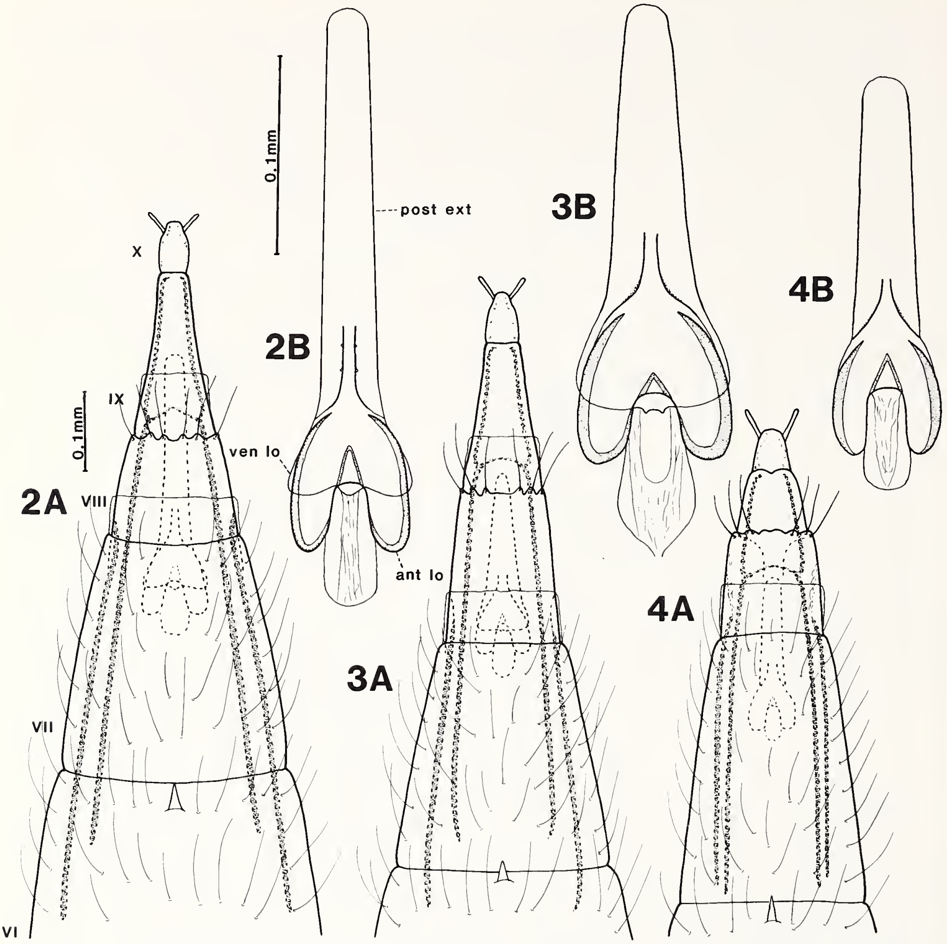


Fig. 1. *Mayatrichia illobia,* n. sp., male genitalia: A, lateral; B, dorsal; C, ventral; D, phallus, lateral. Abbreviations: VIII, IX, X = abdominal segments VIII, IX, X, respectively; sg = subgenital plate; pl proc = posterolateral process of abdominal segment IX; inf app = inferior appendage.



Figs. 2–4. *Mayatrichia* spp. female genitalia: A, terminal abdominal segments, ventral; B, bursa copulatrix, ventral. 2, *M. rualda*. 3, *M. ayama*. 4, *M. illobia*. Abbreviations: VI–X = abdominal segments VI–X, respectively; ven lo, ant lo, post ext = ventral lobe, anterior lobe, and posterior extension, respectively, of bursa copulatrix. Scale = 0.1 mm.

(Wiggins, 1977). In Costa Rica, adults were collected alongside medium-sized, moderately flowing, midelevation streams (e.g., Río Singrí, Río Guineal) as well as lower elevation, slower flowing, more turbid streams and rivers (e.g., Río Ceibo, Río Puerto Viejo) (Fig. 5).

Mayatrichia illobia, new species
Figs. 1, 4, 5

Diagnosis. In overall appearance, this species appears most similar to *M. rualda*. Both species have the inferior appendages tapering in ventral aspect and bearing 2

Fig. 5. Distribution of *Mayatrichia illobia,* n. sp., *M. ayama* Mosely, and *M. rualda* Mosely in Costa Rica.

terminal setae, but in the new species these appendages lack a basodorsal lobe. Also, the posterolateral processes of segment IX of *M. illobia* lack a pronounced posteroventral lobe. Finally, the phallus of *M. illobia* has a conspicuous subapical spine-like projection at its apex, not seen in *M. rualda.* The female can be distinguished by the absence of a ventral lobe on the bursa copulatrix.

Male. Length 2.1–2.4 mm. Color brown in alcohol. Antennae 18 segmented. Sternum VI with short posteromesal process. Segment IX annular; with narrow posterolateral processes, in lateral view, each with ventral margin straight, entire, dorsal margin rounded; segment IX with numerous folds and ridges dorsolaterally; in dorsal view, tergum IX emarginate on posterior margin with group of three setae laterally, anterior margin with deep mesal incision. Tergum X membranous, hood-like in lateral view; in dorsal view with posteromesal incision. Inferior appendages tapering distally in both lateral and ventral views, apices bearing two stout setae; basodorsal process absent. Subgenital plate with posteromesal process directed ventrally; in ventral aspect oblong, with membranous folds laterally, bearing pair of setae on posteromesal margin. Phallus long and narrow, apex with two small apical spine-like projections, and long subapical dorsal spine.

Female. Length 2.0–2.8 mm. Antennae 18 segmented. Similar in color and appearance to male. Sternum VI with short posteromesal process. Segment VIII with posterior margin ringed with stout setae; internally bearing two pairs of lateral sclerotized rods, inner pair connecting with lateral rods of segment IX and extending to end of segment VII, outer pair originating near anterior margin of segment VIII and extending to tips of inner rods. Segment IX with posterior margin slightly emarginate; internally bearing pair of lateral rods extending to middle of segment VIII. Segment X short, rounded, bearing pair of anterolateral papillae. Bursa copulatrix with pair of anterior lobes and narrow posterior extension.

Holotype. Male. Costa Rica: Puntarenas: Río Guineal, ca. 1 km (air) E Finca Helechales, 9.076°N, 83.092°W, el. 840 m, 22.ii.1986, Holzenthal, Morse, Fasth (NMNH).

Paratypes. COSTA RICA: Limón: Río Telire and small trib., SE Suretka, 9.554°N, 82.892°W, el. 48 m, 1.ii.1986, Holzenthal, Morse, Fasth, 1 male (UMSP); Puntarenas: same as holotype, 1 male (NMNH); Puntarenas: Río Singrí, ca. 2 km (air) S Finca Helechales, 9.057°N, 83.082°W, el. 720 m, 21.ii.1986, Holzenthal, Morse, Fasth, 1 male (INBIO); San José: Río General, ca. 1 km S San Isidro, 1.vii.1967, P. J. Spangler, 16 males, 7 females (NMNH); San José: Río General, Pacuare, 1.vii.1967, Flint and Ortiz, 4 males (NMNH); ECUADOR: Pastaza: Puyo (27 km N) Estacion Fluviometrica, 4.ii.1976, P. Spangler et al., 1 male (NMNH).

Etymology: Latin, without lobes, referring to a distinguishing character of both the male and female genitalia.

DISTRIBUTION RECORDS FOR *MAYATRICHIA* IN COSTA RICA

Fig. 5

Mayatrichia ayama Mosely 1937:182, fig. 30, male, Mexico: Guerrero (BMNH); Ross 1944:160, 279, figs. 557–560, 929; Bueno-Soria and Flint 1978:202; Blickle 1979: 56, fig. 11.

Records. ALAJUELA: Río Pizote, ca. 5 km N Dos Ríos, 10.948°N, 85.291°W, el. 470 m, 9.iii.1986, Holzenthal and Fasth, 79 males; Río Pizote, ca. 5 km (air) S Brasilia, 10.972°N, 85.345°W, el. 390 m, 12.iii.1986, Holzenthal and Fasth, 291 males. GUANACASTE: 10 mi NW Liberia, Río Ahogados, 25.vii.1965, P. J. Spangler, 22 males, 24 females (NMNH); Las Cañas, Río Corobici, 26.vii.1967, O. S. Flint, Jr., 9 males, 2 females (NMNH); Quebrada Garcia, 10.6 km ENE Quebrada Grande, 10.862°N, 85.428°W, el. 470 m, 8.iii.1986, Holzenthal and Fasth, 2 males; Río Tempisquito, ca. 3 km S route 1, 10.790°N, 85.552°W, el. 75 m, 6.iii.1986, Holzenthal and Fasth, 71 males; Río Tizate, 7.2 km NE Cañas Dulces, 10.773°N, 85.449°W, el. 275 m, 28.vi.1986, Holzenthal, Heyn, Armitage, 18 males; Río Mena, 4.2 km W Santa Cecilia, 11.059°N, 85.448°W, el. 260 m, 11.iii.1986, Holzenthal and Fasth, 1 male; Río Los Ahogados, 11.3 km ENE Quebrada Grande, 10.865°N, 85.423°W, el. 470 m, 7.iii.1986, Holzenthal and Fasth, 1 male. HEREDIA: Est. Biol. La Selva, Río Puerto Viejo, 10.440°N, 84.012°W, el. 30 m, 19.vi.1986, Holzenthal, Heyn, Armitage, 1 male. LIMON: Río Uatsi, ca. 8 km W Bribri, 9.62°N, 82.90°W, el. 60

m, 25.iii.1987, Holzenthal, Hamilton, Heyn, 1 male. PUNTARENAS: Río Ceibo, route 2, ca. 6 km W road to Buenos Aires, 9.149°N, 83.377°W, el. 250 m, 20.ii.1986, Holzenthal, Morse, Fasth, 1 male.

Distribution. CANADA (Alberta to Quebec); UNITED STATES (east of western continental divide); MEXICO (Guerrero, San Luis Potosí, Tabasco, Veracruz); HONDURAS; COSTA RICA (Alajuela, Guanacaste, Heredia, Limón, Puntarenas).

Mayatrichia rualda Mosely, 1937:183, fig. 31, male, Mexico: Chiapas (BMNH); Buenos-Soria and Flint 1978:202.

Records. GUANACASTE: Río Tizate, 7.2 km NE Cañas Dulces, 10.773°N, 85.449°W, el. 275 m, 28.vi.1986, Holzenthal, Heyn, Armitage, 1 male; P.N. Rincón de la Vieja, Quebrada Zopilote, 10.765°N, 85.309°W, el. 785 m, 3.iii.1986, Holzenthal, 1 male. PUNTARENAS: Río Guineal, 1 km (air) E Finca Helechales, 9.076°N, 83.092°W, el. 840 m, 21.iii.1986, Holzenthal, Morse, Fasth, 27 males; same locality, but 4.viii.1987, Holzenthal, Morse, Clausen, 2 males; Río Singrí, ca. 2 km (air) S Finca Helechales, 9.057°N, 83.082°W, el. 720 m, 21.ii.1986, Holzenthal, Morse, Fasth, 74 males.

Distribution. MEXICO (Chiapas); COSTA RICA (Guanacaste, Puntarenas).

KEY TO ADULTS OF NEOTROPICAL *MAYATRICHIA* (EXCLUSIVE OF *M. ALIENA*)

1. Males 2
– Females 4
2. Inferior appendage in ventral aspect wide at apex and bearing 5 or 6 setae (Ross, 1944, fig. 929B), in lateral view with prominent basodorsal lobe (Ross, 1944, fig. 929A) .... *M. ayama* Mosely
– Inferior appendage in ventral aspect narrow at apex and bearing 2 setae (Fig. 1C; Mosely, 1937, fig. 31c), in lateral view with basodorsal lobe absent or indistinct 3
3. Posterolateral process of abdominal segment IX with prominent ventral lobe on posterior margin (Mosely, 1937, fig. 31a); inferior appendage with basodorsal lobe .... *M. rualda* Mosely
– Posterolateral process of abdominal segment IX without ventral lobe on posterior margin (Fig. 1A); inferior appendage without basodorsal lobe .... *M. illobia* Harris and Holzenthal
4. Bursa copulatrix with ventral lobe, posterior extension elongate (Figs. 2B, 3B); outer sclerotized rods of abdomen longer than inner rods (Figs. 2A, 3A) 5
– Bursa copulatrix lacking ventral lobe, posterior extension short (Fig. 4B); outer sclerotized rods of abdomen shorter or equal in length to inner rods (Fig. 4A) .... *M. illobia* Harris and Holzenthal
5. Bursa copulatrix with posterior extension narrow and over 2 × as long as anterior body (Fig. 2B) .... *M. rualda* Mosely
– Bursa copulatrix with posterior extension triangular, about equal in length to anterior body (Fig. 3B) .... *M. ayama* Mosely

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THE LIFE HISTORIES AND BEHAVIOR OF THE PATAGONIAN-FUEGIAN WHITE BUTTERFLIES *HYPSOCHILA MICRODICE* AND *H. GALACTODICE* (LEPIDOPTERA: PIERIDAE)

Arthur M. Shapiro
Department of Zoology, University of California,
Davis, California 95616

Abstract.—The life histories of *Hypsochila microdice* from the Fuegian steppe and *H. galactodice* from western Patagonia are investigated in order to clarify species limits in a genus showing little genitalic differentiation. The only previously-reared species is the crucifer-feeding *H. w. wagenknechti,* from north-central Argentina. The larva and pupa of *H. microdice* are quite different from that species and its host plants in nature are two indigenous species of vetches (*Vicia,* Leguminosae); it can be reared on *Trifolium.* The larva and pupa of *H. galactodice* are more like *H. w. wagenknechti,* although the pupa shows a strong superficial resemblance to sympatric populations of the *Tatochila mercedis* complex. The host plant in nature is *Tropaeolum incisum* (Tropaeolaceae) and it can be reared on crucifers. These differences demonstrate that neither *galactodice* nor *wagenknechti* can be conspecific with *microdice,* and that evolutionary radiation in life history has far outpaced genitalic differentiation in *Hypsochila.*

This is the seventh in a series of papers describing the life histories of the Pierini of the Andean region. This group has undergone extensive radiation and speciation from the Sierra Nevada de Santa Marta to Tierra del Fuego in cool to cold, often alpine climates, and is viewed as critical for understanding the origin and evolution of the high-Andean and Patagonian biota (Brown, 1987; Descimon, 1986; Shapiro, 1989). In order to do a proper phylogenetic analysis it has proved necessary to rear as many taxa as possible; about a third of the named entities have so far been reared at least in part. Previous papers in this series have covered *Reliquia santamarta* Ackery (Shapiro, 1978a), *Tatochila x. xanthodice* Lucas (Shapiro, 1978b), the entire *Tatochila sterodice* Staudinger and *autodice* Hübner species-groups (Shapiro, 1979), *Pierphulia rosea annamariea* Field & Herrera (Shapiro and Courtney, 1986), *Tatochila d. distincta* Joergensen (Shapiro, 1986a), and *Hypsochila w. wagenknechti* Ureta (Courtney and Shapiro, 1986a).

The genus *Hypsochila* Ureta consists of six described and one undescribed entity. The described species are all known only from Argentina and Chile, while the seventh species is from much farther north in southern Ecuador and northern Peru. This implies that additional discoveries are likely in the highlands of Peru and Bolivia. Adult *Hypsochila,* as noted by Courtney and Shapiro (1986a), present characters suggesting possible intermediacy between the genus *Tatochila* Butler and the series of genera centered on *Phulia* Herrich-Schaeffer, which are confined to the central Andean altiplano and display a variety of unusual and derivative character-states. The early stages of the first *Hypsochila* reared, *H. w. wagenknechti,* also resemble *Phulia* in three characters: failure of the larva to eat the eggshell, a sluggish, silk-spinning larval lifestyle, and reduction of the pupal prominences. None of these is, however, phylogenetically conclusive, especially until more taxa can be reared for comparison.

Field and Herrera (1977) had only widely-scattered, small samples of adults, mostly Chilean, of the various nominate species of *Hypsochila,* leading to uncertainty in drawing species boundaries. Uncharacteristically for butterflies, there appear to be no reliable genitalic characters in either sex in *Hypsochila,* so species have been recognized primarily by habitus. Field and Herrera indeed wrote (*op. cit.,* p. 5): "Five of the six species of *Hypsochila* (that is, all but *H. penai*) are very closely related and could be considered subspecies of a single widely-distributed species. However, since two of these species are known to fly at the same time in at least two of the same localities, and since almost nothing is known of the natural history of any species in this genus, we . . . have allowed these five taxa to stand as species." The taxa which they record as co-occurring are *H. galactodice* Ureta and *H. huemul* Peña, in the Chilean Province of Malleco and in western Neuquén, NW Argentine Patagonia.

To complicate matters further, once large series of Argentine material were assembled it became evident (Shapiro, 1990) that no easy distinction between *H. w. wagenknechti* and *H. galactodice* could be made on adult characters. These taxa appear to be altitudinally interdigitated in western Neuquén. Undeterminable specimens are known from several locations in that Province, including the isolated pre-Andean, volcanic Cordón del Viento. The best diagnostic character cited by Field and Herrera proves to be unreliable. ("This species (*galactodice*) differs from all other *Hypsochila* . . . in having the black spot at the end of the discal cell on both surfaces (of the forewing) unusually large," p. 10. But early spring material from NW Patagonia often has the spot as in *wagenknechti,* and the difference is directly reproducible by rearing with and without diapause.) A few undoubted *wagenknechti* in long series from the central cordillera in San Juan and Mendoza could be misclassified as *galactodice,* and *galactodice*-like phenotypes occur, astonishingly, in the *puna* of Jujuy along with *H. w. sulfurodice* Ureta (Shapiro, 1990). It was hoped that rearing *galactodice* would help clarify its status vis-à-vis *wagenknechti.*

At the same time, by rearing *H. huemul* sympatric with *galactodice* one could attempt to test the hypothesis that these were in fact separate species. Phenotypically, the *Hypsochila* exclusive of *penai* and the undescribed entity cluster in two groups: *wagenknechti* (including *sulfurodice*) + *galactodice,* and *huemul* + *microdice* Blanchard + *argyrodice* Staudinger. A reasonable working hypothesis might be that these correspond to two partly sympatric, polytypic species. This was partially falsified by detailed distributional data showing *argyrodice* and *microdice* could not be conspecific (Shapiro, 1990). In the austral spring of 1988 I was able to study the entire life-history of *H. galactodice* in the Argentine Provinces of Río Negro and Chubut, south of the problematic zone of contact with *wagenknechti,* but was unsuccessful in finding *huemul.* However, the seemingly very closely-related *microdice* (which is morphologically extremely close to *huemul,* completely allopatric, and likely to be conspecific with it) was easily collected and studied in the steppe of NE Tierra del Fuego.

The early stages of *H. microdice* and *galactodice,* especially the pupae, are remarkably different from each other, and both differ significantly from *H. w. wagenknechti* though as expected, *galactodice* is much closer to it than is *microdice.* Moreover, the two entities differ at the ordinal level in host plant, and *microdice* deviates dramatically from the normal host associations of the Pierini. These unexpectedly large differences leave no doubt that much more evolution has occurred in *Hypsochila* than is apparent from adult morphology. Adult behavior is also strikingly different, and *H. galactodice* deviates from typical hilltopping in restricting its epigamic aggregation to sites suitable for oviposition.

The following descriptions of morphology are based on eggs and larvae collected from the field and obtained from captive, wild-collected females of each species as follows: *H. microdice,* vicinity Río Grande, National Territory of Tierra del Fuego, Argentina, 24–27 November 1988; *H. galactodice,* between San Carlos de Bariloche and Pilcaniyeu, Río Negro, 14–16 November 1988 and vicinity Esquel, Chubut, 16–18 November 1988. Material was reared initially under uncontrolled (ambient) field conditions, subsequently at Davis under 14L:10D at 27°C, or refrigerated as noted. It was necessary to change host plants in the course of rearing, but little mortality resulted. Color descriptions were prepared from life and from freshly preserved material. Vouchers of all stages are retained at Davis. Colors are described with reference to the standard system of Kornerup and Wanscher (1978). Only color names in quotation marks are from that source.

Hypsochila microdice

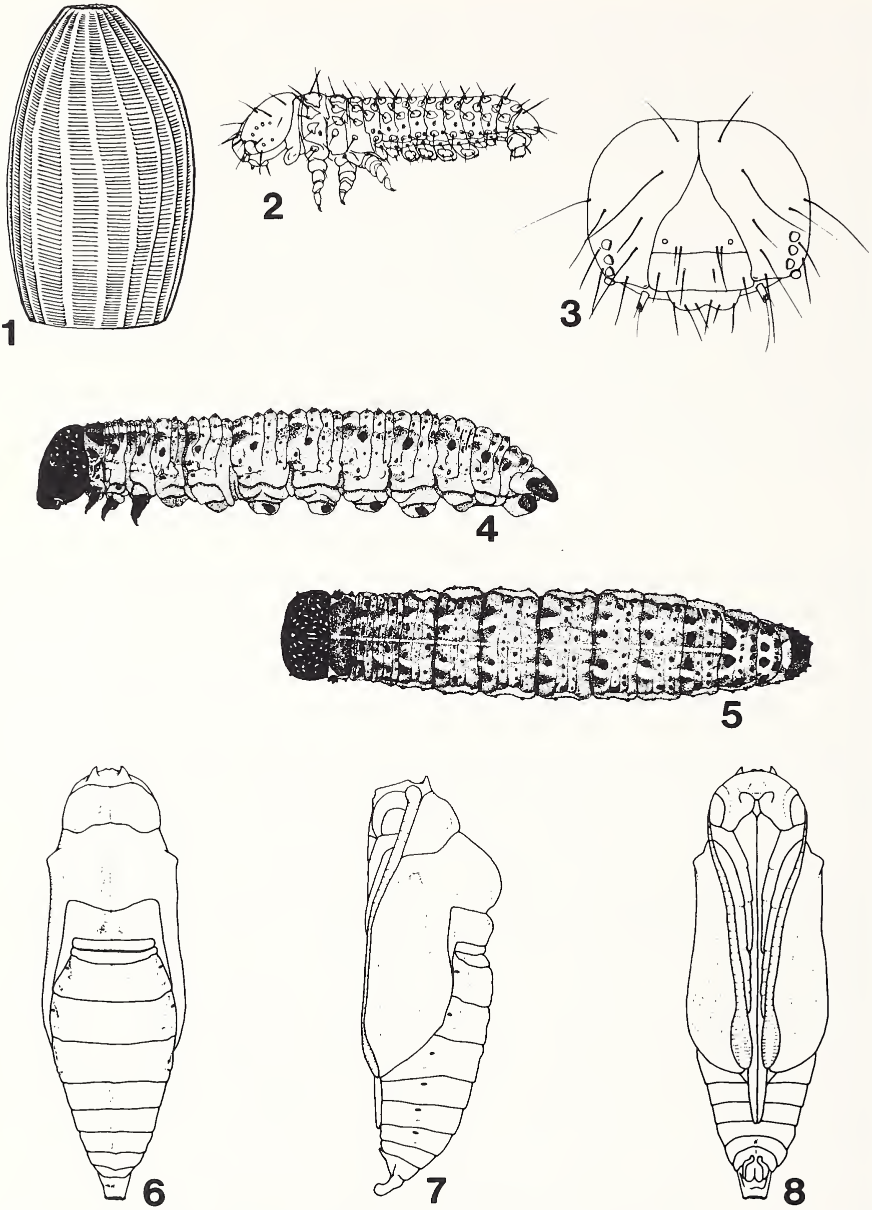
Egg (Fig. 1). Erect, fusiform, 0.85 × 0.35 mm, the chorion sculptured as figured, with about 16–17 vertical and numerous horizontal ribs; the vertical ribs forming a vaguely beaded corona encircling the micropylar region. Light orange (6A6) when laid, turning slate gray ±10 hr before hatch. Laid singly on leaves or stems of the host. The larva eats a hole below the apex when emerging, but otherwise does not consume the eggshell. Time to hatch, 7 days.

Larva: First instar (Figs. 2, 3). At hatch 0.95 mm. Light orange (6A5) with head apparently unmarked black, no obvious pattern anywhere. Tubercles very large, black, bearing stout black primary setae. Body darkening slightly after feeding. Excavates pits in leaves and stems. Duration of instar: 2 days.

Second instar. After molt 1.6 mm long. Similar, with only a very indistinct pattern, the tubercles proportionally smaller, the head vaguely mottled with yellowish; ocelli and true legs black; prolegs concolorous with body, crochets blackish. Length of instar, 3 days.

Third instar. After molt 2.7 mm long. Slate gray ("greenish gray," 26C2) with distinct pale yellow (5A5) dorsal and subdorsal lines; the ground color paler below the spiracles, with hints of paired yellow spots in a spiracular row; tubercles black; primary setae black, secondary setae numerous, whitish; cervical and anal shields prominent, black. Consumes leaves, resting on stem between feeding bouts. Length of instar, 7 days.

Fourth instar. After molt 5.0 mm. Ground color bluish slate ("Paris blue, steel blue," 21F7), venter charcoal ("dark blue," 21F4), head black with vague yellow-gray ("pale yellow," 1A3) mottling; the usual *Tatochila-Hypsochila* body pattern, with a strong white middorsal line, subdorsal lines orange-yellow (5A7) interrupted posteriorly on each segment by the ground color, producing a checkered effect with the appearance of dark rings at the posterior end of each segment; an orange spot (6A6) on either side of each spiracle (and in corresponding positions where there is no spiracle). Time to molt, 10 days.



Figs. 1–8. *Hypsochila microdice,* Río Grande, Tierra del Fuego. 1. Egg. 2. Newly hatched larva showing tubercles and setae. 3. L_1 head capsule. 4. Mature larva (L_5), lateral view. 5. L_5, dorsal view. 6. Pupa, dorsal view. 7. Pupa, lateral view. 8. Pupa, ventral view.

Fifth instar (Figs. 4, 5). After molt 12.0 mm, reaching 20 mm. Ground color as before, tubercles not contrasting, the white secondary setae very conspicuous early in the instar, less so later; a narrow but distinct white middorsal line; each segment bearing a large ("melon yellow," 5A6) spot midway between the middorsal line and the spiracles, corresponding to the subdorsal line; this spot edged both dorsally and laterally with black, the lateral edging broader anteriorly on each segment; the posterior ends of the yellow spots variably, sometimes strongly, orange-tinged. The overall effect is vaguely suggestive of a double row of eyespots on either side of the middorsal line, strongly contrasting with the dark ground—a visual effect not previously seen in the Andean Pierini. Bright orange-vermilion ("reddish orange, flame red," 7A8) spots on either side of the spiracles or in corresponding positions when the spiracle absent; below these spots a band of slate ("patina green," 28C5); venter, prolegs and true legs all black. Collar slate with conspicuous tubercles; head black with black tubercles, the entire capsule mottled finely in pale orange; ocelli black. The larva is very active. It basks in sunlight at 20°C but conceals itself at 27°. It does not spin any silk until ready to prepupate. Uniquely among known Andean Pierini, it rolls up and drops from the host if disturbed. Time to prepupation, 10 days. Final several fecal pellets pink.

Prepupa. Usually vertical, head up, attached as usual by a silken thoracic girdle and by the anal prolegs. The larva, as usual, wanders for several hours before spinning its silken pad. Color as in the last instar but becoming dingy and grayish, the yellow and orange fading and the tubercles becoming more contrasty. Time to pupation 36 hr.

Pupa (Figs. 6–8). Length 15 mm; width at girdle 4.2 mm. Attached as in prepupa. Very compact, obtect, the abdominal prominences nearly obsolete. Front of head and appendage-cases buff ("pale orange," 5A3), the antennae and wing-veins lightly black-dotted; top of head creamy white; body gray-brown ("nougat," 5D3), the dorsal thoracic keel creamy white; on each abdominal segment a whitish subdorsal line at each side, the middorsal line only minimally raised or carinate; tubercles dark and contrasting; cremaster gray. Tongue-case reaching ½ the length of the ventral abdomen. The most distinctive feature of the pupa is the reduction of the frontal prominence to a small, dark tubercle, sometimes bifurcate; supraocular prominences somewhat reduced, black. The pupa, unlike *H. w. wagenknechti,* does not appear to mimic a bird dropping. Except for the extreme reduction of the frontal prominence, which creates the impression of a very broad, flat head, it recalls in form (not color) the pupa of *Pontia callidice* Hbn. from the Alps.

Eyes, wings and body pigmented in that order; white appearing in the wings 36 hr, black 20 hr before eclosion. Meconium bright reddish pink. Only non-diapause pupae were obtained; time to eclosion 13 days.

Behavior. The first (presumably post-diapause) brood was observed, with the spring flora near its peak of bloom in late November. At Río Grande, adults occur at high density (38 collected, many more seen on 26 November) in steppe dominated by the bunchgrasses *Festuca gracillima* Hooker, *F. magellanica* Lam., *Agropyron fuegianum* (Speg.) Kurtz, *Festuca pyrogea* Speg. and *Stipa chrysophylla* Desv. on flat or gently undulating terrain. These grasses do not form a continuous cover; the interstices present bare soil, moss, lichen, and a variety of flowering herbs. The males patrol in a manner reminiscent of male *Pontia protodice* Bdv. & LeC. in North America, investigating other butterflies but not flying a repetitive beat (Scott, 1975) or being associated with any fixed territory. Their flight is extremely strong and direct, always less than 1 m above the ground, usually below 0.5 m, and with very strong winds (≥40 km/hr) the flights are very short (15–30 sec) and only 0.25 m above the ground. If caught in sudden turbulence or gustiness they dive down into the wind and settle immediately on bare ground or in the lee of a grass tussock. Brief (<30 sec) male-male chases were observed. Remarkably, although *Tatochila theodice staudingeri* Field was very abundant at the site, virtually no interspecific interaction between these similar-sized white butterflies was observed. At Loma Negra, in more pronounced relief, males were found concentrated in the lee of a hill; the SW wind on the exposed side was sufficient to keep all butterflies down.

Females are less strong fliers than males and were more often seen to rise above the boundary layer and be blown away. Flight was observed in both sexes with air temperature (at 0.5 m) of 13°C or greater, though with a strong wind it felt much colder even in strong sunshine. The highest T observed was only 18.7°. *H. microdice* begins flying very quickly when the sun comes out, and puts down equally quickly when a cloud passes, but will fly in diffuse light (as through anvil cirrus). Both sexes thermoregulate with the wings open from 45–60° from the vertical, occasionally even more. Only one individual was ever seen observed with wings closed over the back while visiting a flower. Lateral basking was not seen.

Both sexes visit flowers of *Primula magellanica* Lehm. (Primulaceae) and *Oxalis enneaphylla* Cav. and *O. magellanica* Forster (Oxalidaceae) but were not seen at any others, although a native pink, *Silene magellanica* (Desr.) Boc. (Caryophyllaceae) and the introduced dandelion, *Taraxacum officinale* Weber (Compositae) were very abundant. I observed consistently that *Primula* was visited in preference to *Oxalis* with light wind, but the reverse when strong winds were blowing. *Primula* flowers are ±10–15 cm above the ground and whip around in wind, while *Oxalis* flowers at ground level and offers a more secure perch. The implication is that *Primula* offers better rewards than *Oxalis.*

Both sexes are very closely attached to the bunchgrass steppe with *Primula* and *Oxalis* and if pursued toward other habitats, including bogs or highly disturbed or heavily grazed sites without bunchgrass, they will turn around and fly back into the steppe. A few males were seen flying over dry crowberry (*Empetrum*) heath on a rocky outcrop at Loma Negra. None was ever seen in close-cropped, heavily grazed turf.

Several teneral individuals of both sexes were found between 1000–1300 hr but I was unsuccessful in seeking their pupal cases among the tangled litter of dry grass and other dead vegetation.

The host plants are the native vetches *Vicia bijuga* Gillies ex Hooker & Arn. and *V. magellanica* Hooker (Leguminosae). These are small, delicate, perennial herbs which both trail on the ground among clumps of bunchgrass and ascend by twining within them. They are inconspicuous and "grasslike" in appearance when not in flower, but in fact constitute an enormous biomass. At Loma Negra *Lathyrus magellanicus* Lam., a somewhat larger perennial vetch, also occurs and may be used. Eggs are laid singly on leaves or stems, but oviposition is difficult to observe as the female acts quickly in a confusing matrix of litter and vetch shoots. However, at least four different females were observed laying.

The larva is easily reared on white clover, *Trifolium repens* L. (Leguminosae). This plant is widely naturalized in Tierra del Fuego, mostly on grazed meadows from which bunchgrass has disappeared, but it has not been colonized although females will oviposit on it in cages.

Two crucifers occur in the *H. microdice* habitat at Río Grande: *Thlaspi magellanicum* Comm. ex Poiret and *Draba magellanica* Lam. Neither is common enough to support a population of the butterfly at Río Grande, but both were tested as oviposition substrates in cages, along with *Cardamine glacialis* (Forster) D.C., which is common in the Cordón Martial where *H. microdice* has been collected, and the following non-crucifers which occur at Río Grande: *Primula magellanica; Oxalis enneaphylla; Perezia pilifera* (D.Don.) Hooker & Arn., *P. magellanica* Lag., *P. recurvata* (Vahl.) Less., *Hypochoeris incana* (Hooker & Arn.) Macloskie, *Leucheria hahnii* Franch., *Nassauvia darwinii* (Hooker & Arn.) Hoffman & Dusén, and *Senecio magellanicus* Hooker & Arn. (all Compositae). None elicited even a single oviposition.

Hypsochila galactodice

Egg. Erect, fusiform, reddish orange ("flame red," 7A8), morphologically indistinguishable from the egg of *H. w. wagenknechti* (Courtney and Shapiro, 1986a), 0.9 × 0.35 mm; laid singly or occasionally in small clutches on leaves, petioles, stems and buds of the host, on either upper or under surfaces. The larva does not eat its eggshell. Time to hatch, 5–6 days.

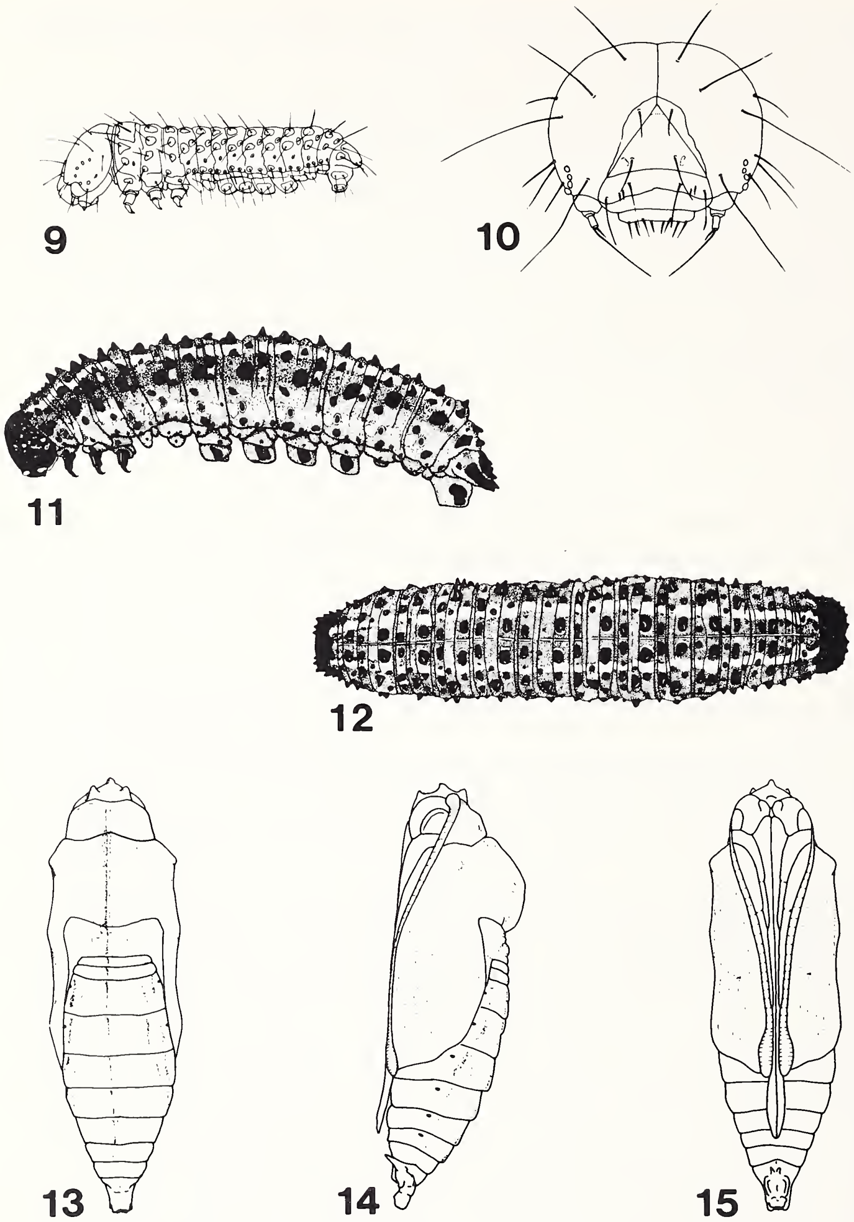
Larva: First instar (Figs. 9, 10). At hatch 1.0 mm at rest. Body buffy gray ("pale orange," 5A3) with head dark brownish-black; body becoming gray-green (26C3) after feeding, with the usual pattern barely indicated; paler below the spiracles and on venter; tubercles in three sizes, the largest very large, bearing stiff black primary setae, some glandular. Excavates pits in leaves and buds. Time to molt, 2–3 days.

Second instar. After molt 2 mm long; body olivaceous ("grayish green," 29D6) with head black, pattern of three faint yellow lines as before. Duration of instar, 3 days.

Third instar. After molt 3.3 mm long. Head gray (26C1), lightly mottled in black; ocelli black; an indistinct yellow (2A6) collar; a faint middorsal line of the same yellow; dorsum otherwise steel blue ("dark turquoise," 24F8) containing tubercles of three sizes, black, bearing black primary or whitish secondary setae; a broad subdorsal yellow line, bordered below by slate gray ("grayish turquoise," 24E3) above the spiracles; spiracles (or spiracle positions where absent) framed by pairs of bright orange ("reddish orange," 7A7) spots which may be connected by a fine orange line; below these light gray (26C1) shading into grayish green (26B3) on the venter; spiracles and true legs black; prolegs concolorous with the light gray shading above, with the venter below; crochets black. The larva does not construct a silk pad except prior to molting, and is more active than *H. w. wagenknechti*; feeds on leaves. Duration of instar, 4–5 days.

Fourth instar. After molt 5.5 mm. Pattern as in third instar; the subdorsal lines now more or less orange-tinged, especially on the anterior segments; head blue-black (24F8) flecked with orange and black; prolegs blue-black; collar indistinct, yellow with no hint of red or orange. The larva is somewhat less active than previously but still does not spin a silk pad except for molting. Duration of instar, 6–7 days.

Fifth instar (Figs. 11, 12). After molt 14.5 mm, reaching 20 mm. Head blue-black



Figs. 9–15. *Hypsochila galactodice,* northwest Patagonia. 9. Newly hatched larva showing tubercles and setae. 10. L_1 head capsule. 11. Mature larva (L_5), lateral view. 12. L_5, dorsal view. 13. Pupa, dorsal view. 14. Pupa, lateral view. 15. Pupa, ventral view.

with variable mottling in black and orange (6A6). Ground color intense bluish slate ("grayish turquoise," 24E5), tubercles black, in three sizes, the largest strongly conical, bearing either black primary or white secondary setae; cervical and anal shields black but highly variable, sometimes reduced. A very faint yellow (3A5) middorsal line; subdorsal lines conspicuous, butter yellow (3A6), appearing interrupted due to the apparent framing of two pairs of spots by black tubercles on each segment although the yellow is actually continuous. Spiracular line containing the usual red-orange (7A8) paired spots on each segment; spiracles black. Venter slate green ("dull green," 29D4), including prolegs; crochets black. Duration of instar 10 days; last several fecal pellets pink.

The fifth-instar larva does spin and rest on a silk pad, as in *H. w. wagenknechti.* It feeds by day and night in short bouts of several minutes. As usual, it leaves the host and wanders for several hours prior to prepupation.

Prepupa. Usually vertical, head up, attached as usual; with time the pattern becomes less distinct and the tubercles more so; just before the molt the blue-green hemolymph can be seen through the translucent sides of the thorax in the wing-case positions. Time to pupation, 36 hr.

Pupa (Figs. 13–15). Length 18.5 mm, width at girdle 5.2 mm. Attached as in the pupa, normally head up. Initially slate-blue (24E5), assuming the final color within ±5 hr. Body and appendage-cases buffy gray ("grayish orange," 5B3), the wing-cases perhaps slightly more ochreous; antennae and veins lightly black-dotted; top of head and thoracic keel creamy white; tubercles black, contrasting; pale subdorsal and stigmatal lines, the flaring suprastigmatal prominences and dorsal abdominal keel very weak; apical prominence only slightly smaller than supraoculars, all three black; proboscis-case slightly beyond the middle of the ventral abdomen; cremaster gray. The pupa is remarkably similar to that of *Tatochila mercedis mercedis* Esch. or *T. m. sterodice* Stgr. and looks very different from that of *H. w. wagenknechti.*

Eyes, wings and body pigmented in that order in the pharate adult commencing 36 hr before eclosion. Meconium bright reddish pink.

This species has a facultative diapause. Approximately half the pupae reared under essentially uncontrolled conditions eclosed in 19–26 days. The remainder were refrigerated at 2°C at age 30 days and tested for readiness to eclose at 60, 90, 120 and 150 days. None developed before 150 days, at which point four metamorphosed within 8 days.

Behavior. Unlike *H. microdice* but like *H. w. wagenknechti,* this species is a vigorous hilltopper (Shields, 1967; Courtney and Shapiro, 1986b). It may, however, be unique among butterfly hilltoppers studied to date in that its sexual rendezvous sites are restricted to localities where the females can—and do—oviposit.

At Bariloche and near Pilcaniyeu it occurs in rolling foothill topography in shrub-steppe dominated by *neneo* (*Mulinum spinosum* Pers., Umbelliferae), *cardoncillo* (*Eryngium paniculatum* Camb. & Domb., Umbelliferae), *quinchamalí* (*Quinchamalium chilense* Mol. ex Lam., Santalaceae), *Codonorchis lessonii* (D'Urv.) Lind. (Orchidaceae), and various bunchgrasses. At Esquel the same plants occur but the site overall is grassier. In both sites the butterflies were largely confined to the warmer N and (in morning) NE slopes of the hills, from about half-way up to the summits. Male flight is exceedingly fast and direct, from 0.5–1.5 m above the ground, with very little nectaring observed (mostly on dandelions). Both sexes body-bask as in *H. w. wagenknechti,* and no lateral basking was seen.

At Esquel males were already flying on 17 November at 0823 hr with the air temperature (at 0.5 m) 12.8°C in full sun with light wind. At this time all the males appeared to be ascending from the lower flanks of the hill, where they presumably spent the night. By 1100 hr the wind had reached 40 km/hr and activity had decreased noticeably, with most of the butterflies concentrated on the lee (NE) side of the hill; by 1400 none was flying though they could be flushed from the ground (and would rise straight into the wind and be blown away). Male-male chases were very frequent and long (1–3 min), often involving 3 or 4 animals. The usual up-down loop with a period of 10–20 min and arrival in small groups were observed. Only one courtship was seen; the male approached a sitting female, which took flight; both were lost from view in about 3 min after a rapid and confusing pursuit.

At both Bariloche and Esquel two other white Pierini co-occur with *H. galactodice*: *Tatochila mercedis sterodice* and *T. autodice-blanchardii* Butler intergrades (Shapiro, 1986b). The former is almost entirely restricted to relatively flat terrain where its hosts, various native and weedy crucifers, occur. One interspecific chase was observed (initiated by a male *galactodice* and lasting ±1 min). *Tatochila autodice/blanchardii* and *H. galactodice* use the same host plant in the same site, sometimes ovipositing on the same individual plants, and fly synchronously—but as with *H. microdice/T. theodice staudingeri,* remarkably no interspecific interactions were observed. The orange-and-black Nymphalid *Yramea laothonioides* Blanchard hilltops in the same sites with no apparent interaction.

Host plant and egg distribution. At both sites, the only host utilized by *H. galactodice* appears to be *Tropaeolum incisum* (Speg.) Sparre (Tropaeolaceae). This perennial herb grows in patches of bare soil, often near rodent burrows and on steep slopes. Many ovipositions were observed. The female lands on the plant near the base, curves the abdomen under, lays a single egg, then flies briefly (5–10 sec) before repeating the procedure—often on the same plant. Up to 4 successive eggs were seen placed on the same plant, in each case with a brief flight intervening; the eggs were scattered on different leaves. At Esquel a single plant bearing 5 eggs was found in which 4 were directly adjacent and the fifth 3 cm away on another leaf. This suggests at least the possibility that clutches may be deposited sequentially without flight, as sometimes occurs in *H. w. wagenknechti* (Courtney and Shapiro, 1986b).

Several hills without *Tropaeolum* were visited at both sites. Only 4 male *H. galactodice* were seen altogether in such localities. At Esquel there were no *Hypsochila* on the next hill to the study hill, which was some 200 m higher and had no *Tropaeolum* at all. Thus mating and oviposition appear to be concentrated on the same hills. One female was found in the railroad switch-yard at Bariloche among *T. m. sterodice,* where crucifers are common but there are no *Tropaeolum*; she was nectaring at a dandelion.

Eggs are laid on leaves, stems, pedicels and buds, mostly on the under surfaces. The egg distributions are strongly clumped (Table 1). At both sites the vast majority of eggs were placed on plants on the upper half of the hill—even though plants were both more numerous and larger lower at both. Egg censusing is remarkably easy on *Tropaeolum* due to its glaucous blue-green color and trailing but not twining, leafy

Table 1. Egg distributions of *Hypsochila galactodice* on plants of *Tropaeolum incisum* at two Patagonian sites. At Esquel plants from the top and bottom halves of the hill are censused separately. All three distributions are highly clumped when compared to a Poisson (variance/mean ratio test, $P < 0.01$ in all cases).

Number of eggs/plant	Number of plants		
	Bariloche	Esquel (top of hill)	Esquel (bottom)
0	56	84	113
1	3	8	10
2	2	3	2
3	2	3	1
4	6	4	0
5	2	1[a]	0
6	4	1	0
7	2	0	0
8	2	0	0
9	0	0	0
10	1	0	0
11	0	0	0
12	0	0	0
13	0	1	0
>13	0	0	0
Total number of eggs:	111	49	17
Total number of plants:	80	102	125
Mean number eggs/plant:	1.39	0.48	0.14
Mean number eggs/plant with any eggs:	4.60	2.58	1.31

[a] Includes cluster of 4 adjacent ova plus one separate egg 3 cm away.

habit. The plants were not measured, but on the upper slopes larger plants appeared more likely to have received multiple ovipositions.

Both Esquel and Bariloche larvae were transferred to, and developed normally on, a variety of crucifers: *Cardamine glacialis* (Foster) D.C. (native), *Lepidium perfoliatum* L., *L. bonariense* L., *Coronopus didymus* (L.) Sm., *Brassica geniculata* (Desf.) J. Ball, *B. campestris* L., and *Rapistrum rugosum* (L.) All., all weedy. They would not eat *Vicia bijuga* and *magellanica,* the hosts of *H. microdice*; *Trifolium repens*; or the native Legume *Astragalus arnottianus* (Gill.) Reiche.

DISCUSSION

Genitalic morphology and the uncertainty of Field and Herrera (1977) not-withstanding, *Hypsochila microdice* and *H. galactodice* differ as much in life history and behavior as do any two valid species of Pierini. They both exhibit derived pupal morphology, albeit in different ways—*microdice* in the near-loss of the frontal prominence, *galactodice* in being virtually indistinguishable from some *Tatochila.* Both are also unusual in having great individual variability in larval tuberculation; no two *galactodice* larvae examined had identical cervical and anal shields, and individual variation overwhelmed any population difference between Esquel and Bariloche. The specific distinctness of *wagenknechti* and *galactodice* is now keyed primarily to pupal morphology, since there seem to be no reliable adult characters. The pupae of these two taxa are more different than those of the siblings *Pontia protodice* and *P. occidentalis* Reakirt in western or *Pieris* "*napi*" *oleracea* Harris and *P. virginiensis* Edwards in eastern North America.

The Andean Pierini have responded to extreme climates by repeatedly evolving long, narrow wings, open-wing basking postures, and similar wing patterns, including sexual dimorphisms. As a result convergence obscures phylogenetic relationships again and again in this group. The far-Austral *H. microdice* recalls in habitus the endemic Colombian *Reliquia santamarta* and in other ways shows similarities to *Phulia*. The obtect *microdice* pupa recalls the typical pupa of the *Phulia* series of genera (cf. *Pierphulia,* Shapiro and Courtney, 1986), but also that of the Coliadine genus *Nathalis* Bdv., also of Andean origin (Shapiro, 1980). At the same time *microdice* has developed an unusual larva that looks and acts more or less like a Noctuid cutworm and curls and drops like a Noctuid (or a *Colias*) when disturbed, exhibiting a nearly ocellate pattern derived through modification of the subdorsal lines. All of these are highly derivative states.

No one could have predicted that the far-Austral *Hypsochila* would shift from mustard-oil containing plants (Cruciferae and Capparidaceae, order Capparales; Tropaeolaceae, generally put in Geraniales) to Leguminosae (Fabales), with no known biochemical or phylogenetic connection. Yet *Tatochila distincta* in the puna of northwestern Argentina has also shifted onto *Astragalus* (Leguminosae), though it can be reared on crucifers (Shapiro, 1986a). And it should not be forgotten that the 3 largest branches of the Legumes are important Pierid hosts, associated with Coliadinae and Dismorphiinae (including the highly aberrant Palearctic *Leptidea*); the only other major Pierid host association, largely tropical, is with the Loranthaceae (Ehrlich and Raven, 1964).

The notion that good species of insects in general and butterflies in particular should have genitalic differences dies hard. The sibling species of *Lethe* (Satyridae) studied by Cardé, Shapiro and Clench twenty years ago (1970) are about as different genitalically as the *Hypsochila* reported upon here, but much less different in life history and behavior. Within the Andean Pierini, *Tatochila m. mercedis* is genitalically differentiated from the three other taxa in the complex with which it hybridizes freely (Porter and Shapiro, 1990), which are more unlike one another in wing pattern than any differs from *mercedis,* but do not differ in genitalia at all. The *Hypsochila,* like the *Tatochila,* appear to reflect a ferment of variability: in various Andean pierines wing pattern, venation, life history, larval and pupal morphology all show extraordinary plasticity at times bordering on decanalization. Much of this is likely to be of very recent (Pleistocene-Holocene) origin (Shapiro, 1990), though the groups themselves are certainly older. Certainly the lack of genitalic differentiation in *Hypsochila* has been a very poor predictor of biology; wing pattern has been much better, and Field and Herrera were indeed wise to be conservative and call everything a species.

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LIFE HISTORY OF *DOHRNIPHORA CORNUTA* (BIGOT) (DIPTERA: PHORIDAE), A FILTH-INHABITING HUMPBACKED FLY

Jeffrey K. Barnes

Biological Survey, New York State Museum,
The State Education Department, Albany, New York 12230

Abstract.—The literature on the life history and immature stages of *Dohrniphora cornuta,* a synanthropic, filth-inhabiting, humpbacked fly, is reviewed and summarized, and observations on laboratory rearings are presented. Adult females and larvae consume many kinds of dead and decaying animal and plant tissues, but apparently both are facultative predators of insects when other foods are not available. Adult males are apparently nectar feeders, and they are much shorter lived than females. Pest status, reproductive behavior, and life history parameters are compared with other phorid species, and the evolution of non-genitalic sexual structures is discussed.

Dohrniphora cornuta (Bigot) is one of the more conspicuous and widespread species of Phoridae, although Schmitz (1951) stated that in Europe adults are found only during warm periods, and the species seems to prefer warmer regions. According to Borgmeier's (1968) world catalog, its distribution is cosmopolitan, and it has masqueraded under at least 13 species names and 4 generic names. Many anecdotal reports of food sources and breeding sites have appeared in the literature, and they leave little doubt that Schmitz (1951) was correct in referring to the larvae as indiscriminate saprophages, although they sometimes exhibit facultative predatory behavior. Medical, veterinary, and economic aspects of the species' life history are evident from its generally synanthropic tendencies (Bohart and Gressitt, 1951; Schmitz, 1951; Weiss, 1911) and from reports of adult females biting man (Schmitz, 1938, 1951) and of larvae causing myiasis in cattle (Patton, 1922), living in human excrement (Skidmore, 1978) and other types of filth (Bohart and Gressitt, 1951), and helping to stabilize psychodid populations through predation and competition in a trickling filter sewage bed (Kloter et al., 1977). Recently, specialists at a United States Food and Drug Administration laboratory in Los Angeles, California, performed a filth extraction procedure on hermetically sealed barbecue sauce imported from the Republic of China that yielded an adult phorid, which was identified as a male *D. cornuta* by B. V. Brown (University of Alberta) (J. Madenjian, pers. comm.).

Larvae of *Dohrniphora cornuta* have been found in many kinds of decaying plant and animal tissues. Disney (1983) reported the species breeding in compost, and Kloter et al. (1977) reported larvae feeding on fresh cow manure and the film that develops in sewage beds. Reports have been published of larvae found in decaying onions (Johannsen, 1935), of specimens reared from cow peas (Malloch, 1912), and of the species breeding in rotting rice bran (Disney, 1983). Schmitz (1951) made mention of larvae found in melons and wasp nests. Jones (1918) reported the species breeding in insect remains in pitcher plants (*Sarracenia flava* L.), and he reared the species on dead grasshoppers (Bohart and Gressitt [1951] reported that *D. cornuta* has been reared from living grasshoppers, but they did not cite a reference). Brues (1924) reported on a large series of specimens collected from a box of termite-eaten papers that also contained a rat's nest and concluded that larvae develop in dacaying animal matter, but Borgmeier (1925) collected an adult specimen from a *Eutermes* nest and surmised that the species is termitophilic. Bigot (1890) reported on specimens bred from a tachinid parasite of the silkworm, but Townsend (1893) doubted the veracity of this claim. Specimens have been bred from dead snails (Schmitz, 1915; Brues, 1925), soured milk (Schmitz, 1917), a rotting egg of the great tit (*Parus major cinereus* Viellot) (de Meijere, 1938), and tainted flesh of dead rodents (Weiss, 1911).

In their report on the filth-inhabiting flies of Guam, Bohart and Gressitt (1951) mentioned that *D. cornuta* is especially attracted to decaying molluscs, and like its associate, *Megaselia scalaris* (Loew), its omnivorous tastes and domestic habits make it a likely transmitter of pathogens. They characterized the species as somewhat scarce on carrion and as a secondary invader, appearing after certain sarcophagids, calliphorids, and *M. scalaris.* Brues (1928) found the adults, along with adults of *M. scalaris,* to be frequent visitors to the flowers of *Aristolochia elegans* M. T. Masters in a Cuban garden. Flowers of some members of that genus produce fetid odors.

Of all these reports, only the one by Kloter et al. (1977) gives definitive results of field studies and laboratory rearings of this species. They found that *D. cornuta* larvae tend to embed themselves in the sewage film covering the stones in a trickling filter bed, often becoming completely immersed for long periods while feeding. This burrowing disturbed the anchorage of psychodid larvae, causing their washout by sewage effluent. *D. cornuta* larvae also preyed upon eggs, larvae, and pupae of *Psychoda alternata* Say in laboratory tests, but only when a culture medium for both species, consisting of fresh cow manure with dry yeast, was not provided. In the filter bed, psychodid larvae were easy prey because they clustered permanently in large numbers while only partially buried in the sewage film. While attacking their prey, *D. cornuta* larval mouthparts were protruded and flexed posteroventrally, allowing the phorid to grip its prey against its serrate sternal spatula. Kloter et al. (1977) described the immature stages of *D. cornuta* and illustrated the sternal spatulae and lateral tubercles of first, second, and third instars, the cephalopharyngeal skeleton and four anterior segments of third instars, and the puparium. Some of these illustrations were copied by Ferrar (1987).

Several other authors have also described or illustrated immature stages of *D. cornuta,* and some of the more important contributions are reviewed here. Jones (1918) described and illustrated the egg, third instar and its cephalopharyngeal skeleton, and the puparium, and Cole (1969) reproduced his figures. Patton (1922) illustrated the mature larva and the puparium and its respiratory horns, and Teskey (1981) and Peterson (1987) illustrated the third instar posterior spiracles and the puparium. Schmitz (1941) presented a photograph of the pupal respiratory horns, and he (1938, 1949) described the egg and the third instar and compared them with immatures of other congeneric species. Disney (1983) illustrated the third instar, and Johannsen (1935) illustrated its cephalopharyngeal skeleton. Bohart and Gressitt (1951) presented an illustration of the puparium, and Kaneko and Furukawa (1977) gave detailed illustrations of the third instar and the puparium. De Meijere (1938) illustrated the fine structure of the pupal respiratory horns and described it in detail.

The purpose of this paper is to present observations made while rearing *D. cornuta* through its entire life cycle in the laboratory, and thus to contribute to our understanding of the natural history of a potential disease carrier and our knowledge of the large but little known family Phoridae.

MATERIALS AND METHODS

Rearings were kept in ambient laboratory conditions of 23 ± 1°C and at least 11 hours of artificial light per day. Paired males and females were held in individual, clear plastic, cylindrical vials (5.0 × 8.5 cm) fitted with fine wire mesh caps. Mass rearings were held in large (19.0 × 14.0 × 10.5 cm) clear plastic boxes in which ventilation holes were cut and outfitted with wire mesh. A layer of moist cotton was placed at the bottom of each rearing container, and food items consisting of fresh and tainted beef liver and a mixture of honey, brewer's yeast, and dehydrated milk mixed in proportions that yielded a thick but tacky aggregate were placed on the cotton. The cotton in the vials was changed every 3–4 days, and the eggs were counted under a dissecting microscope. To obtain eggs of the same age for mass rearings of larvae, glass dishes containing a layer of dry cotton with a piece of tainted liver in the center were placed for a short period in the larger rearing boxes, which contained many gravid females. Four separate mass rearings were observed daily to determine times of molting and puparium formation. Puparia were dropped into individual, glass, 4-dram vials, and they were observed regularly for adult emergence. These vials also contained a layer of moist cotton, and they were plugged with dry cotton.

MORPHOLOGICAL CHARACTERIZATION

Eggs, larvae, puparia, and adults are readily recognized. Eggs are elongate-ovoid, shiny white-translucent, and speckled with many minute, white, raised areas. Larvae are yellow to white, with transverse rows of six plumose tubercles situated laterally, dorsolaterally, and dorsally on thoracic segments 2–3 and abdominal segments 1–7, and a pair of minute ventrolateral tubercles on the abdominal segments. Thoracic segment 1 is heavily sclerotized dorsally, and segment 2 has two to six sclerotized patches dorsolaterally in second and third instars. The sternal spatula is serrate anteriorly in all instars. Abdominal segment 12 is margined by six long, plumose tubercles, which are often darkly pigmented, and it bears a pair of dark brown, conical spiracles, which are fused mesially in second and third instars. Puparia resemble third instars in most respects but are yellowish to reddish brown and bear a pair of distinctive, long, pinnate respiratory horns dorsolaterally on abdominal segment 2. Adults of the genus are readily recognized by the forked Rs, single longitudinal setal row on the hind tibia, sensory organ of stout setae on the posterior basal surface of the male's hind femur, and setation on the anepisternum. Of the four known species of *Dohrniphora* in the Nearctic Region, *D. cornuta* is recognizable by the lack of bristles on the hind tibia, the yellow coxae, the lack of a fifth tergite in females, and the distinctive arrangement of about five sensorial setae on the hind femur of males, as illustrated by Borgmeier (1963, Fig. 71) and Peterson (1987, Fig. 62).

GENERAL OBSERVATIONS

An opportunity to rear *Dohrniphora cornuta* arose in late September, 1988, when a massive infestation of this fly was discovered in a 1.8 × 1.2 × 1.2 m wooden box containing a colony of dermestids used to clean flesh from skeletons. The box was located in the New York State Museum's field research facility in Cambridge, Washington County, New York. Extensive Malaise trapping a few meters from the building throughout the summers of 1985, 1986, and 1988 yielded several thousand specimens of over 50 species of Phoridae, but no *D. cornuta.* Metal racks inside the box held partially cleaned skeletons of many types of vertebrates, and thermostatically controlled light bulbs held the temperature at 21–24°C. The vertebrates had been obtained from various areas of the United States—suggesting the possibility that the phorid was introduced from some other area. The dermestid colony, which was in a state of decline, had been initiated about two years earlier with the larder beetle, *Dermestes lardarius* L. (Coleoptera: Dermestidae), but that species apparently died out and was replaced by *D. vulpinus* Fabricius. The box was also infested with redlegged ham beetles, *Necrobia rufipes* (De Geer) (Coleoptera: Cleridae), and blow flies, *Phaenicia sericata* (Meigen) (Diptera: Calliphoridae).

In nearly two hours of searching for *D. cornuta* larvae and puparia, none were found on the vertebrate skeletons or flesh, although hundreds of adults were flying about. However, a moist, greasy, dark brown mass of decomposing flesh and living and dead insects lined the bottom of the box. This material contained many *D. cornuta* larvae and puparia. Several of the blow fly larvae collected at the same time were dead and covered with living *D. cornuta* larvae, which were consuming them. All other blow fly larvae, including those still alive, showed signs of injury—small brown spots dotting their integument—that might have been caused by the phorid larvae. Phorid puparia were taken to the laboratory, where they were observed for emergence of adults.

MATING BEHAVIOR

Adults mated frequently in captivity, often beginning on the day they emerged from puparia. Prior to mating, the male pursued the female, and while they ran about in the distinctive phorid stop-go pattern, the former fanned his wings at frequent intervals. This behavior continued until the male mounted the female. She stood with her wings, which did not reach the tip of her abdomen, in resting position, folded over her abdomen. The bases of the male's hind femora—the areas bearing the so-called sensory organs—came firmly into contact with the pleural plates of the female's seventh abdominal segment, which became laterally compressed. The bases of the male's hind tarsi or apices of his hind tibiae were crossed, and his hind legs were extended posteriorly, usually not touching the female or the substrate. His mid tarsi sometimes clutched the sides of the female's abdomen, and his fore femora were held erect and pressed against his thoracic pleurae and mid femora. The fore tibiae descended at an angle and were loosely crossed, usually suspended above the female's wings. Thus, the relatively small male was mounted at an angle to the female's body, which paralleled the substrate, and he pivoted on the bases of his hind femora with his head rising well above the female. The male stretched his hind legs backward and waved them up and down at a rate of about twice per second, causing his entire body to rock. The apex of the female's abdomen sometimes waved up and down slightly, and the male's hind tibiae were sometimes set into a quivering motion for short periods. The pair remained *in copula* 2–8 minutes, alternating periods of intense rocking with periods of relative calm. The male dismounted when his mate began to run about again, and he was sometimes encouraged with a push from her hind tarsi. It was not uncommon to find a second female apparently attempting to dislodge a copulating male, usually without success, as Miller (1984) observed in *Puliciphora borinquenensis* Wheeler. Males of both *P. borinquenensis* and *M. halterata* (Wood) attempt to interfere with pairs in stationary matings (Binns, 1980; Miller, 1984).

LIFE HISTORY PARAMETERS

Females began to oviposit 1–3 days (2.0 ± 0.5; N = 9) after emergence. Eggs were scattered randomly just beneath the surface in relatively dry areas of cotton in the breeding containers. They were not cemented to the fibers and became dislodged easily if the containers were disturbed, thus confirming Jones' (1918) description of the eggs as non-adherent. Kloter et al. (1977) found that *D. cornuta* eggs were deposited in protected crevices free from moisture and sewage film. In the present study, the eggs hatched in about 24 hours. Females laid 77–535 eggs each (368 ± 143; N = 9), for an average of 9.4–12.0 eggs per female per day.

Newly hatched larvae quickly found their way to the beef liver, whether it was fresh or tainted. They congregated in areas that were superficially moist and avoided drying areas. They did not burrow into the substrate. Second and third instars frequently burrowed into the surface, leaving only the posterodorsal surface and tubercles of abdominal segment 8, or in some cases only the posterior spiracles, exposed to the atmosphere. In the mass rearing boxes, soft tissues of dead adults were quickly consumed, as was the honey, yeast, and milk mixture. In one trial, a pair of adults was confined with a dead pond snail, *Stagnicola elodes* (Say) (Gastropoda: Lymnaeidae). The female oviposited, and the larvae developed normally and produced viable adults.

The mass rearings of larvae were initiated with over 350 eggs of known age. Little larval mortality occurred. By the second day after oviposition, larvae began molting to the second instar, and by the third day, all larvae were in the second stadium. They began to molt for the second time about the fourth day after oviposition, and all were in the third stadium by the fifth day. On the fifth day they began to leave the food source and wander, and by the eighth day nearly all had formed puparia. Therefore, considering the one-day egg incubation period, it can be inferred that, at 23 ± 1°C, the first and second stadia last approximately 1–2 days each, and the third stadium lasts about 3–4 days.

When mature larvae left the food source and began to wander, they became lighter in color. They found a spot in the cotton substrate and came to rest with a thin layer of fibers covering them. After about a day, puparia were formed. Nearly all of them were situated at an angle, with the anterior end higher than the posterior end. Most were on only a slight angle, but in some cases, they were nearly vertical. The fresh, yellowish brown puparia gradually turned to a darker, reddish brown. During the first day, darker, unfocussed, longitudinal lines became visible anterodorsally between thoracic segment 1 and about the level of the dorsocentral tubercles of abdominal segment 2, running along the mesial edge of light colored, raised, circular windows at the anterior end of the latter segment. One to two days after puparium formation, these lines became darker and more sharply focussed. After an hour or two they migrated posteriorly, to about the level of the dorsocentral tubercles of abdominal segment 4. After 4–5 minutes, the membrane covering the windows swelled slightly and ruptured. The respiratory horns were suddenly thrust out and reached full extension within five seconds after the rupture.

Adults emerged 13–15 days (females: 14.0 ± 0.7, N = 10; males: 14.8 ± 0.4, N = 12) after formation of the puparia, or 21–28 days (23.4 ± 4.0, N = 260) after oviposition. After emerging, the adults ran about the rearing containers and groomed themselves, but they frequently stopped and rhythmically contracted and expanded their abdomens. Wings were fully inflated about 20–30 minutes after emergence. In newly emerged adults the thorax was yellow except for the proepisternum, postpronotal lobe, upper portion of the anepisternum, and some minute areas at the bases of the wings, which were dark brown. They acquired normal coloration within a few hours.

Jones (1918) found that at 21.1°C, eggs hatched after three days, and the larval and pupal periods were about 16 days each. Bohart and Gressitt (1951) found that at 29.4°C the larval period was over six days, and the pupal period was nine days. The figures reported here for rearings held at 23°C are, as expected, intermediate.

Males lived 4–14 days (7.2 ± 2.2, N = 29), and females lived 7–46 days (35.0 ± 12.9, N = 9).

ADULT FEEDING BEHAVIOR

Adult males, which possess the lapping and sucking type of proboscis, fed most frequently on the honey-yeast-milk mixture, and only rarely were they seen feeding on the liver. Their labella have five pairs of pseudotracheae and lack prestomal teeth (Schmitz, 1938). Females, however, have the piercing and sucking type of proboscis. They fed frequently on the liver and only rarely on the honey-yeast-milk mixture. When the surface of the liver was moist, the females merely applied their labella to it to feed. However, when it was tacky or dried out, they rocked the front ends of their bodies up and down while their probosci were extended. Soon they penetrated the surface and sunk their probosci to a depth of about 0.5 mm, or to about the level of the clypeolabral suture. Females possess four pairs of rudimentary pseudotracheae. The prestomal teeth are large and tricuspid (Schmitz, 1938).

Three females confined in a breeding vial with a live calliphorid larva were found the following day feeding upon the latter, which was now dead. They inserted their probosci into the larva's oral pocket or folds in its integument. They were successful in piercing the integument of the larva's cephalic segment. It is not entirely clear whether or not the flies caused the larva's death, and unfortunately it was not possible to repeat the trial. Females were also successful in piercing the integument of dead adults of their own species, which they consumed. On several occasions, females were found feeding on larvae of their own species, and on at least one occasion a female was found with a living first instar suspended from the tip of her proboscis, suggesting that she was trying to feed on the larva. Schmitz (1938, 1951) mentioned a case in which an English physician in Brazil claimed a female of *D. cornuta* attempted to bite him, and he felt a prick. However, in seven man-hours that three people worked with the abovementioned, heavily infested box, no bites were reported, and swarming around the face was not noticed.

DISCUSSION

The catholic feeding habits and synanthropic tendencies of *Dohrniphora cornuta,* like those of *Megaselia scalaris, Spiniphora bergenstammi* (Mik), and probably some other phorid species, have undoubtedly contributed to its wide distribution and pest status. These three species are mentioned here because it has been found an easy matter to rear large populations of all of them in the laboratory on beef liver (unpubl.). Apparently, however, *D. cornuta* is never the nuisance that *M. scalaris* is capable of being. The latter species has been reported several times as causing cutaneous, ophthalmic, intestinal, and urogenital myiasis in man, and it is frequently found in animal carcasses and human and animal excrement (James, 1947; Biery et al., 1979; Singh and Rana, 1989). On 9 December, 1988, Dr. Stuart L. Dawson of the Office of the Medical Examiner, Suffolk County, New York, found *M. scalaris* breeding on a black and tarry, partially skeletonized corpse that had been buried in Aguas Buenas, Puerto Rico, for about one year (S. L. Dawson, pers. comm.). *D. cornuta* has somewhat less revolting habits; apparently, it has never been reported as the cause of human myiasis, and it has not been found in human corpses. *S. bergenstammi* is even less of a pest, although it is frequently reported by public health authorities in Great Britain from improperly washed milk bottles (Disney, 1983).

Studies of mating behavior in the Phoridae are exceedingly rare. In *M. scalaris,* copulation is usually preceded by a prolonged period of courtship during which the male makes complex wing and leg movements. Tandem flights of mating pairs have been observed. Such phoretic copulation is common in *Puliciphora borinquenensis,* a species that breeds in small patches of decomposing organic matter, such as dead insects. In this species, the females are small and apterous and there is little observable courtship. A male simply pounces upon a female, grasps her abdomen with his middle tarsi while his hind tarsi remain on the substrate, and attempts to mate. During copulation, the male rapidly vibrates his forelegs on either side of the female's head and thorax. The male frequently airlifts the female and seeks a new oviposition site (Miller, 1978). Miller (1984) described additional reproductive routines in which the male performs a rapid sequence of stationary copulations with "parading" (or "calling," suggesting the diffusion of a pheromone) females at the emergence site, the male mates on a new oviposition site with a recently arrived female, and the male airlifts a female from the emergence site and randomly deposits her when a new site cannot be found. Males can learn the locations of new oviposition sites, transport large numbers of females, guard recently deposited females against mating with other males, and switch routines. Observations on *Megaselia halterata,* a pest in mushroom houses, suggest that mating always takes place on a surface, males display around a single, stationary, calling female by running in arcs and circles while alternately vibrating and trailing their wings, that male display soon terminates when a single male wins in competition with several others for the right to copulate, and that pairs frequently fly *in copula* (Binns, 1980).

In the present observations of *Dohrniphora cornuta,* mating appears to be a much simpler process, with a brief display and chase by a male, followed by coupling. The fact that all observations were made in severely confined, and sometimes crowded, rearing containers suggests the possibility that a full range of routines was not displayed. Flight was minimal in the confined quarters, and food was always abundant.

It is therefore reasonable that prolonged courtships and copulatory flights would not be observed. Perhaps under sparser and more stressful conditions a fuller range of behaviors would be observed. On the other hand, *D. cornuta* might not have a fuller repertoire. Perhaps it specializes in using more stable resources than *P. borinquenensis* and *M. halterata* do, rendering competition for mates and specialized mating behaviors less necessary.

There are over 100 known species of *Dohrniphora,* most of them from the Neotropical Region, and they are most readily distinguished by the arrangement of spines or setae and the diverse lobes and ridges at the base of the posterior face of the male hind femur (Borgmeier, 1968; Borgmeier and Prado, 1975). Borgmeier (1960, 1961, 1963) referred to these areas as "Sinnesorganen" or "sensorial organs." The heretofore unreported observations that these areas contact the pleurites of the female's seventh abdominal segment and act as a pivot while male *D. cornuta* perform an elaborate copulatory rocking behavior suggest that they have a stimulatory, or courtship, function, rather than a sensorial function. According to Eberhard's (1985) hypothesis of sexual selection by female choice, a similar function is assumed for the elaborately evolved male genitalia found in many, perhaps most, groups of animals. The function of these structures, in other words, is not just insemination, but to induce the females to receive and use the sperm. Perhaps a better term for the complex, femoral areas is "stimulatory patches."

The tremendous diversity of form suggests rapid and divergent evolution of stimulatory patches and male genitalia relative to other structures. According to the hypothesis, males with mechanically superior sexual structures or better stimulating devices are favored, and females that preferentially allow such males to fertilize their eggs are also favored. The consequence is that runaway sexual selection by female choice on male sexual structures results in both rapid and divergent evolution. On the other hand, females evolve new and more effective neural properties and remain relatively uniform structurally. At the present time we lack evidence relating to rapid and divergent evolution of male genitalia in *Dohrniphora,* although it seems likely based upon our knowledge of other phorine genera. We also lack documented evidence that female sexual structures are relatively uniform, although nothing in the literature suggests otherwise. Further examination of these structures and studies of the mating behavior of other species in the genus could help shed some light on Eberhard's hypothesis.

Among the unfortunately few in-depth phorid life history studies that exist, some fairly common patterns emerge. As in *Dohrniphora cornuta,* females of many species, including *Puliciphora borinquenensis,* have better developed mouthparts than males. Males of both species live only about one fifth or one quarter as long as females. Males of the latter species were never observed feeding, even after eight years of being cultured at the University of Oxford (Miller, 1984). Life history parameters are similar among several species that have been studied, including *Megaselia aequalis* (Wood) (Robinson and Foote, 1968), *M. scalaris* (Loew) (Robinson, 1975), and *Gymnophora luteiventris* Schmitz (Brown, 1985). As in *D. cornuta,* eggs of these three species hatch about 24 hours after oviposition, larvae require about 9–10 days to mature at room temperature, and adults emerge 10–15 days after puparium formation. Also as in *D. cornuta,* the pupal respiratory horns of *M. aequalis* appear about 24 hours after pupariation (Robinson and Foote, 1968).

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NEW DISTRIBUTIONAL RECORDS OF *SCAPTOMYZA* (*BUNOSTOMA*) *AUSTRALIS* FROM SOUTH PACIFIC ISLANDS AND BIOGEOGRAPHIC IMPLICATIONS

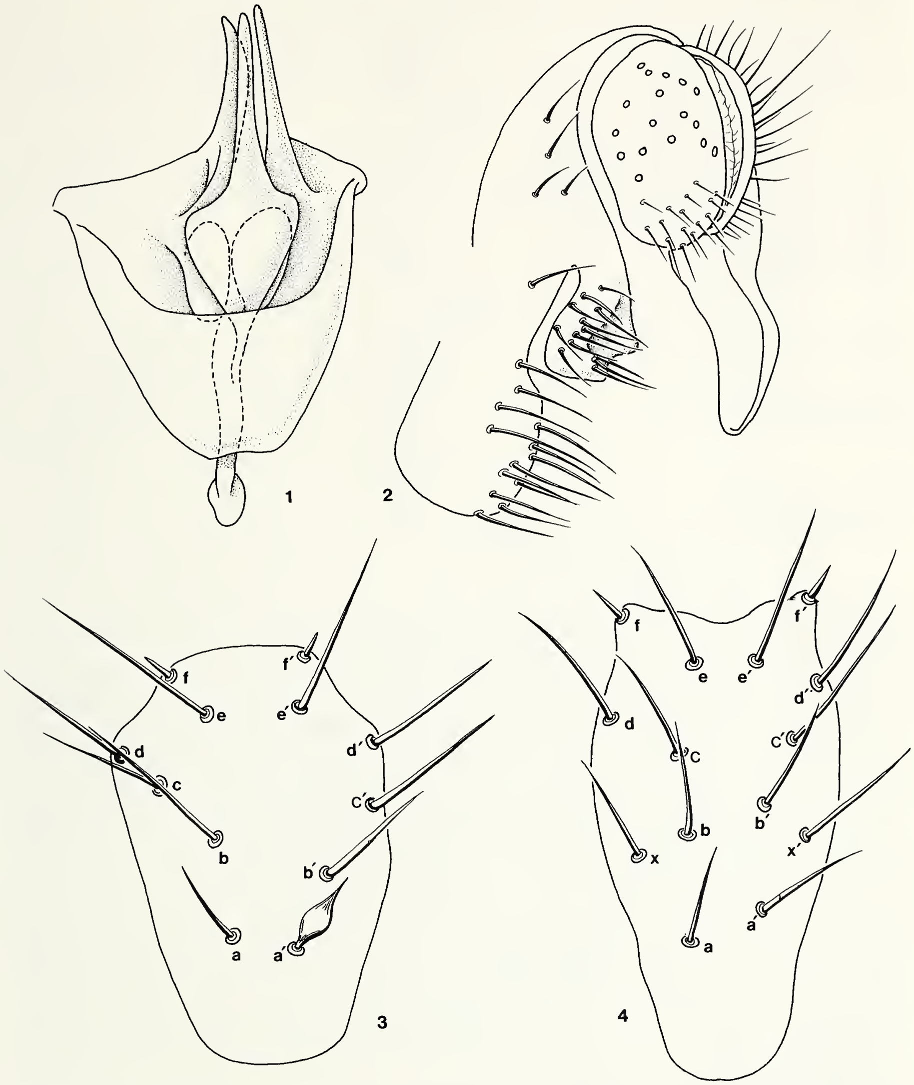
David Grimaldi

Department of Entomology, The American Museum of Natural History,
Central Park West at 79th St., New York, New York 10024-5192

Abstract.—Scaptomyza australis Malloch is a common species widespread throughout Australia, and most recently reported as well from Norfolk Island, ca. 900 miles off the east coast of Australia. It is reported for the first time from Pitcairn Island and Tanna, Vanuatu, which extend the range considerably east and north, respectively. Male genitalia of the Pitcairn specimens is described, and slight variation in sternite 8 of the female is documented. The distribution and monophyly of the subgenus *Bunostoma* is briefly discussed, with particular regard to the endemic Hawaiian fauna.

In his large monograph treating the Australian drosophilid fauna, Bock (1977) documented numerous records of *Scaptomyza australis,* ranging from Western Australia to Queensland. He also mentioned that the species is an ecological generalist, and is found in most habitats with the exception of rain forest, but prefers open, sclerophyllic habitats. Later, he reported a large series from Norfolk Island, a possession of Australia about 500 miles south of New Caledonia and about 1,000 miles northeast of Sydney (Bock, 1986). During curation of unsorted drosophilids in the AMNH collection I came upon a specimen collected in Vanuatu (New Hebrides), from Tanna Island, about 700 miles north of Norfolk Island. As a result of recent collecting by Wayne Mathis, of the Smithsonian Institution, 2 additional specimens were discovered on Pitcairn Island. Pitcairn is extremely isolated from other, larger islands and lies approximately 5,000 miles east of Sydney.

Specimen data of the important new records are as follows: PITCAIRN ISLAND: 25°04′S, 130°06′W, Adamstown, 22–26 May, 1987, W. N. Mathis, 1 male, 1 female (genitalia of both dissected by DAG) (in NMNH, Smithsonian Institution); NEW HEBRIDES (VANUATU): Tanna, Lenakel, 0–200 m, March, 1980, N. L. H. Krauss, 1 female (genitalia dissected by DAG) (in AMNH). I examined dissected preparations of specimens from New South Wales, Australia for comparative purposes, but did not examine material from Norfolk Island. Only very slight variation was found in the genitalic and other morphology among specimens from these three localities, and the small series from the islands precluded estimating whether or not such variation is consistent. Figures 1 and 2 show the genitalia of the male specimen from Pitcairn, which is indistinguishable from the genitalia of Australian specimens. The only difference found was that the fine setulae on the ventral margin of the cercus were more numerous in this specimen (15) versus that in the Australian specimens (9–11).



Figs. 1–4. Genitalia of *Scaptomyza australis* from newly discovered distributions. 1. Male: hypandrium, aedeagus, and associated structures, dorsal view (Pitcairn Is.). 2. Male: epandrium, cercus, oblique terminal view (same specimen as in Fig. 1). 3. Female: sternite 8 (Pitcairn Is.). 4. Female: sternite 8 (Vanuatu).

Some obvious variation was found in female sternite 8, which, in most drosophilines is divided into 2 lateral plates and connected anteriorly by a narrow bridge (all of it being the oviscapt). Most species in the subgenus *Bunostoma,* including *S. australis,* have a simple, undivided, setose sternite 8 (Figs. 3, 4). This is undoubtedly a reduction in the groundplan of the drosophiline oviscapt (Grimaldi, 1990), and appears to be correlated in various unrelated drosophilids with the loss of prensisetae

Table 1. *Scaptomyza australis* measurements and counts.

	Australia (NSW)	New Hebrides	Pitcairn
	Males		
Ventral lobe of epandrium: no. setae	18–19	–	17/18
	(N = 3)	–	(N = 1)
Ventro-mesal lobe of epandrium: no. setae	14–15	–	13/14
Ventral margin of cercus: no. setulae	9–11	–	15
Thorax length (mean)	0.80 mm	–	0.71
Wing length (mean)	1.96	–	1.60
	Females		
Sternite 8: no. setae	11–12	12	10
	(N = 3)	(N = 1)	(N = 1)
Thorax length (mean)	0.97	0.76	0.85
Wing length (mean)	2.26	1.71	1.83
	Both sexes: wing indices		
Costal index (mean)	4.70	3.55	3.70
4-V index (mean)	1.61	1.69	1.68

pegs in the male (surstylus), which is also another feature of *Bunostoma.* Pegs on the female and male terminalia are no doubt functionally related. In the Pitcairn female, sternite 8 had 10 setae, and the specimens from Australia and Vanuatu had 11–12 (Fig. 4). Some Australian specimens had asymmetrically arranged pairs of setae, as indicated in the drawing by Bock (1977). The Pitcairn female apparently lacked the supernumerary pair of setae (marked "*x*" in Fig. 3), and possessed an aberrant, scale-like seta in pair *a.* Wing indices and other meristic data are shown in Table 1.

The broad ecological tolerance of *S. australis* obviously accounts for the origin and/or maintenance of the widespread distribution of this species. It is interesting to note that the species is very common on the continent, but apparently rather rare on the South Pacific Islands. This is based not only on the number of museum specimens, but also the manner in which they were collected. For example, Krauss typically collects by sweep netting vegetation in open areas, which yielded very many chloropids in the sample in which the specimen from Vanuatu was found. This is a fauna always associated with *Scaptomyza* elsewhere in the world. Thus, it is conceivable that regimes of insular versus continental population-level processes have influenced the relative abundances.

As indicated by the two male and female genitalic apomorphies (reductions) mentioned above, the subgenus *Bunostoma* is unarguably monophyletic. Other male genitalic features support this fact: the ventral lobe of the epandrium is long (broad in lateral view) and with long setae; long thin lobes flank the distiphallus, which I consider to be the gonopods; paraphyses (parameres) are small and globose, at the base of the aedeagus and gonopods; the aedeagus is thin, cylindrical, straight (with a small apical hook in *S. boninensis* Okada), simple (without vestiture), and usually extended to the level of the gonopod apices. The diagnostic features for *Bunostoma* given by Hackman (1959) are very general but still do not apply to *S. australis* and some other *Bunostoma.* The diagnosis I have given has interesting biogeographic

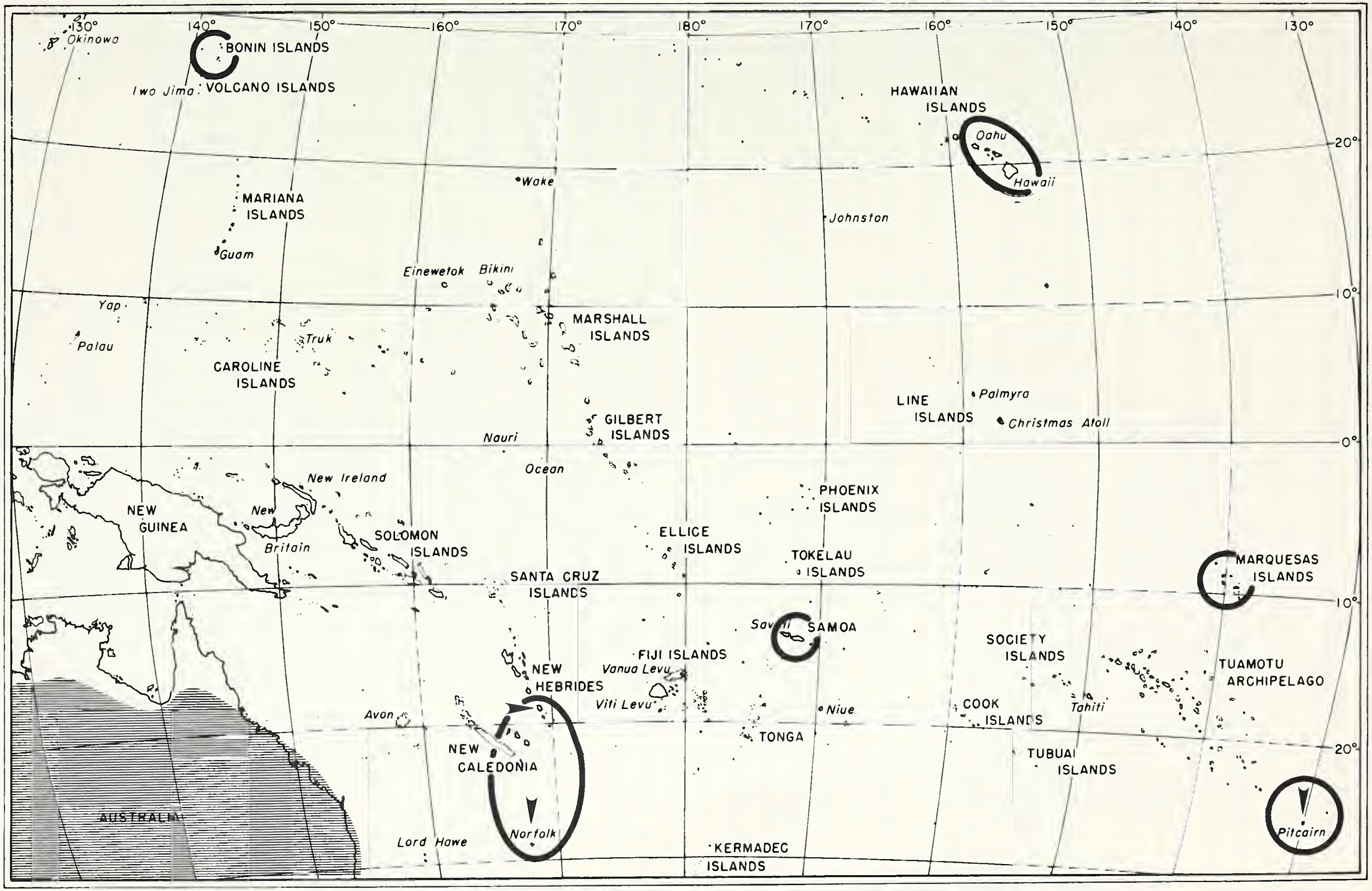


Fig. 5. Map showing a portion of the distribution of *Scaptomyza australis* in Australia (stippling) and the presently known distribution in South Pacific islands (arrows). The bold outlines circumscribe the known distribution of subgenus *Bunostoma*.

implications, since it includes 8 species endemic to Hawaii, and the geographic and phylogenetic relationships of the explosively radiated Hawaiian fauna have remained rather obscure.

Bunostoma presently includes the following species or groups of species: *bicolor* Malloch (Samoa), *boninensis* Okada (Bonin Is.), *philipensis* Bock (Norfolk and nearby Philip Island), *flavifacies* (Malloch) (Marquesas Is.), 8 species from Hawaii (Hardy, 1965), and perhaps *flavella* Harrison and *fuscitarsis* Harrison (both from New Zealand). I, like Hackman, have not examined the two New Zealand species, and Harrison's descriptions are based only on the external male genitalia, not the internal ones. Wheeler (1981) placed these two species in *Scaptomyza* subgenus incertae *sedis,* but Hackman (1982) indicated (on dubious morphological grounds, I feel) that they may be *Bunostoma.* Still, the undisputed sister species of *S. australis* is *S. philipensis,* based on male genitalic features. The male genitalia of these species are remarkably similar to that of *S. anomala* from Hawaii.

I have not examined enough *Bunostoma* species to determine if the Hawaiian species are monophyletic. Unlike Hackman (1962) I don't maintain that *Bunostoma* is the most plesiomorphic group of *Scaptomyza* (Grimaldi, 1990), and, unlike Okada (1973), I don't maintain that the Hawaiian *Scaptomyza* are monophyletic. Prior to the discovery of these three wide-ranging *S. australis* specimens, the notion of biogeographic affinities of Hawaiian species with Australian taxa might have seemed improbable because of distances alone. It is now more plausible that some of the Hawaiian *Scaptomyza* fauna have a southern affinity.

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DESCRIPTION OF A NEW ECUADOREAN *GNAMPTOGENYS* SPECIES (HYMENOPTERA: FORMICIDAE), WITH A DISCUSSION ON THE STATUS OF THE *ALFARIA* GROUP

Carlos Roberto F. Brandão and John E. Lattke
Museu de Zoologia da Universidade de São Paulo, c.p.7172,
Brazil, 01051, and
Fundación Terramar, apartado 80659, Caracas, Venezuela, 1080

Abstract.—A new Ecuadorean species of *Gnamptogenys* Roger of the *Alfaria* group is described based upon a worker holotype and a dealated queen paratype. *Gnamptogenys vriesi,* n. sp. belongs to a subgroup of the *Alfaria* group, which includes also *G. simulans, G. bufonis,* and *G. falcifera.* The other subgroup includes *G. minuta, G. pneodonax, G. striolata,* and possibly, *G. caelata.* We present a characterization of the *Alfaria* group and its subgroups, and a discussion on the status of the group.

Brown (1958) in a revision of the ponerine ant tribe Ectatommini synonymized several genera and subgenera with *Gnamptogenys* Roger, stating that this genus and its synonyms constitute the "upper ectatommines." According to him the species of *Gnamptogenys* fall into four groups: *Gnamptogenys s. str., Holcoponera* and *Alfaria* (the three from the New World), and *Stictoponera* (Old World). Within each group it is safe to consider the genera synonyms, albeit the assignment of all these generic and subgeneric names to the synonymy of *Gnamptogenys* was "set down with the greatest reluctance, and with the hope that some future study based on better material may establish a clear division of the species" (Brown, 1958).

New material of *Gnamptogenys* has accumulated in collections at a relatively slow pace, as these terrestrial ants are often difficult to see against the substrate. Nevertheless the "Museu de Zoologia da Universidade de São Paulo" (MZUSP) recently received two important collections of Ecuadorean soil ants, including a new *Gnamptogenys* species of the *Alfaria* group, which is described below.

Alfaria was described by Emery (1896) from workers, queens and a male of *A. simulans,* collected by A. Alfaro at Suerre, near Jimenez, Costa Rica. While the paper was in press Emery added another species, *A. minuta,* described from two alate queens collected in the Bolivian Chaco (received from "Casa Staudinger e Bang-Haas").

Mann (1926) described *A. bufonis* from a single "worker" taken from a stomach of a *Bufo valliceps* specimen, collected by Nelson and Goldman in July, 1894 at Choapan, Oaxaca, Mexico.

Borgmeier (1957) described *A. striolata* based on two workers collected by Fritz Plaumman in October, 1956 at Nova Teutônia, state of Santa Catarina, southeastern Brazil.

Alfaria mus Santschi, 1931 (Panamá: French Field); *A. emeryi* Forel, 1910 (Colombia: vic. Dibulla); *A. panamensis* Weber, 1940 (Panama: Barro Colorado Island); *Opisthoscyphus scabrosus* Mann, 1922 (Honduras: Lombardia) and *A. carinata* Weber, 1940 (British Guiana: Forest Settlement, Mazaruni River) were all correctly synonymized with *Gnamptogenys minuta* by Brown (1958).

After Brown's (1958) revision, three more *Gnamptogenys* species which fit into the *Alfaria* group concept were described by Kempf: *G. caelata* described in 1967(a) from an unique worker collected at Iguaçu, state of Paraná, southeastern Brazil by F. Plaumman; *G. falcifera,* described in 1967(b) from a female collected at Tingo Maria, Peru by William L. Brown, Jr., and *G. pneodonax,* described in 1968 from a worker taken in Benjamin Constant, Brazilian Amazon by Karol Lenko. Two additional species, both from Venezuela, remain to be published (Lattke, in press).

All these species share with the one we are describing the inflated second gastric segment (not so extremely vaulted in *G. striolata*), and a greater development of the frontal lobes than in other *Gnamptogenys* species. In the *Alfaria* group the frontal lobes are higher and more expanded laterally and anteriorly; as a consequence the base of the scape and the articular condyle are not so easily observable. Also particular to the *Alfaria* group is the presence of a carina that briefly borders the anterolateral regions of the antennal fossa, distinct from the neighboring sculpture. Despite these differences we see no cause for resurrecting *Alfaria* as a genus. The discovery and description of *G. striolata* was fundamental in relating this group with the rest of *Gnamptogenys* (Brown, 1958:222). Also Kempf (1967a) while describing *G. caelata* comments that it is "somewhat intermediate between *striolata* and the more orthodox species of *Gnamptogenys.*"

NOTES OF MEASUREMENTS

All measurements were obtained under 40× magnification. Head width was obtained across eyes (HWE) and just in front of the eyes (HW). The mandibular length (MLC) is represented by the chord between the externo-lateral clypeo-mandibular limit to the apex of the apical tooth. The scape length is taken from the visible part of the scape, as the frontal lobes completely cover the scape insertion and condylus, to the apex; (ED) represents the compound eye diameter. The petiolar (PL) and postpetiolar (PpL) were taken in dorsal view.

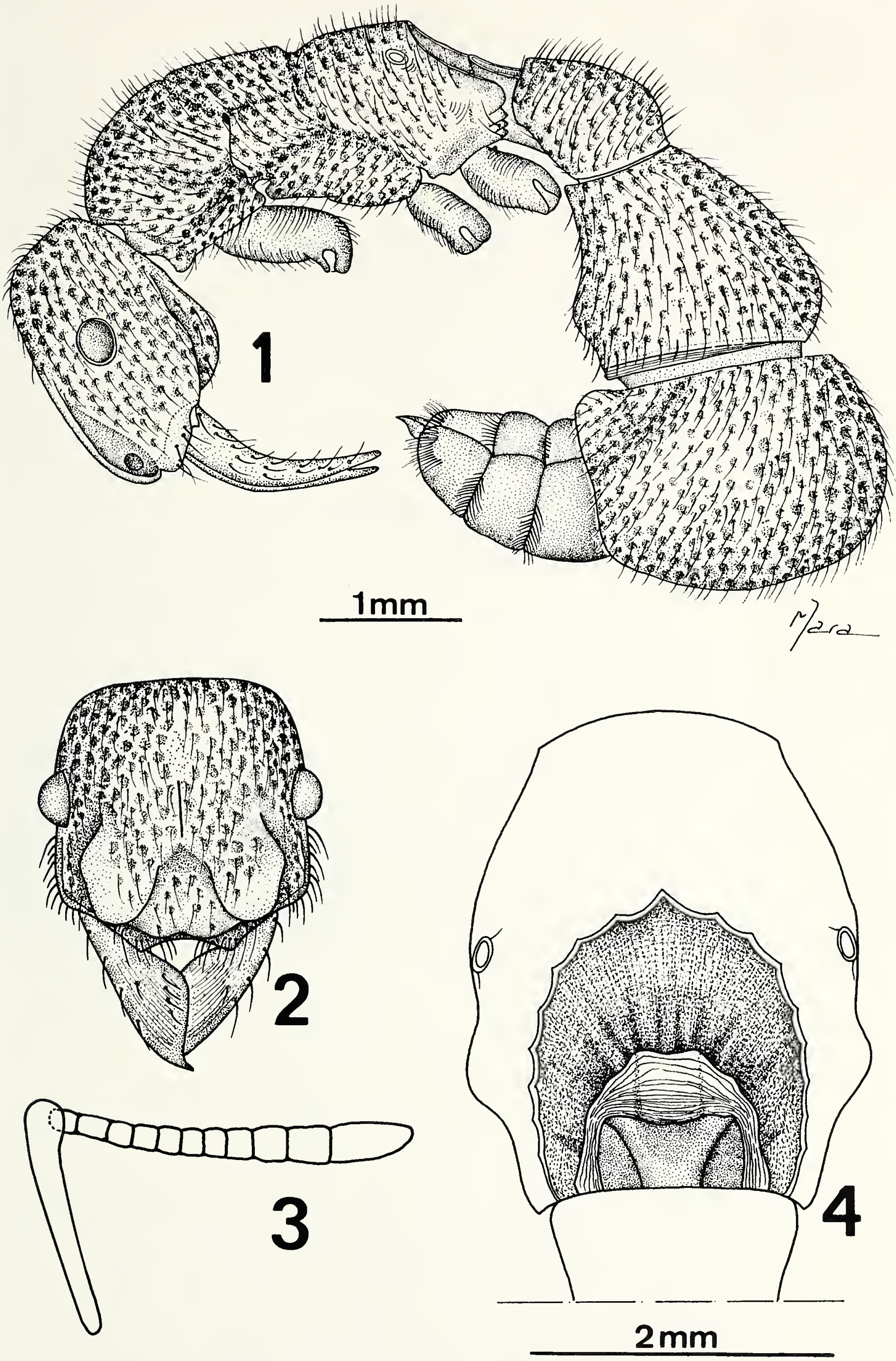
Gnamptogenys vriesi, new species

Figs. 1–7

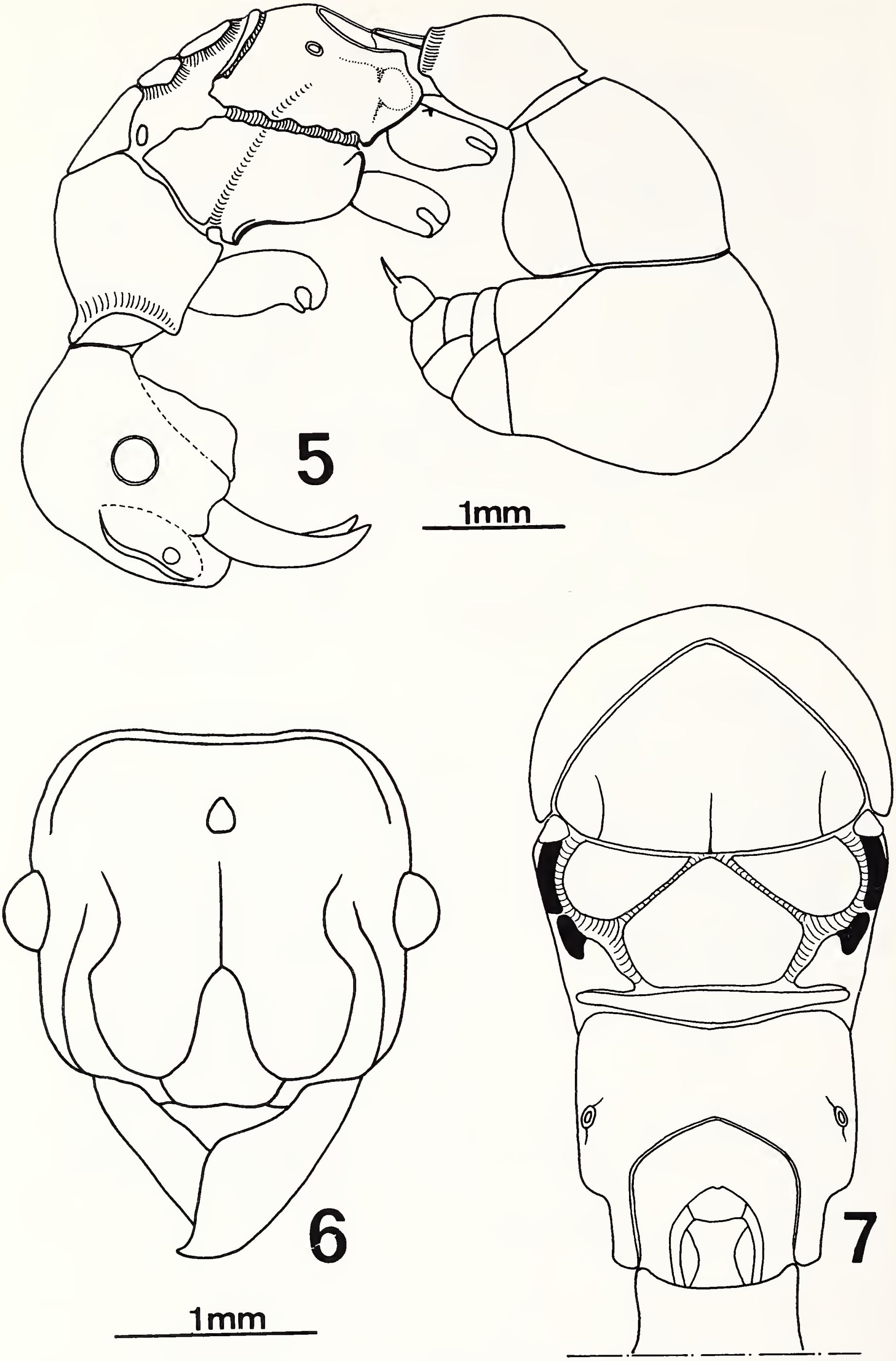
Diagnosis. Similar to *G. simulans, G. bufonis,* and *G. falcifera,* from which it differs in measurements (WL > 3.00 mm) and the following characters: anterior border of clypeus conspicuously concave: compound eyes bulging and with more than 20 facets in eye diameter, interrupting the head profile in full face view; metanotal groove deeper; propodeal spiracles circled by a conspicuous lighter band and bulging; propodeum declivity more deeply impressed; foramen circled by a raised margin (Fig. 4); and anterodorsal margin of petiole raised.

The paratype queen is very similar to the worker holotype, though slightly smaller (see measurements) and with the normal caste differences, i.e., three ocelli (the posterior ones may be confused with the surrounding foveolae, but bear visible lenses), complete alitrunk with parapsidal sutures and the arm of the notaulus. The extra tooth of each tarsal claw is less developed in the queen than in the worker.

Etymology. The specific name is a patronym in honor of the collector of the types.



Figs. 1–4. *Gnamptogenys vriesi,* n. sp. Holotype worker. 1. Side view, reticulation omitted. 2. Head in frontal view, reticulation and antennae omitted. 3. Left antenna, condylus omitted. 4. Detail of propodeum declivity depression in dorsal aspect.



Figs. 5–7. *Gnamptogenys vriesi,* n. sp. Paratype queen dealated, sculpture and pilosity omitted in all figures. 5. Side view. 6. Head in frontal view (antennae omitted). 7. Alitrunk in dorsal view.

Types. Worker (holotype) and dealated queen (paratype) collected at Ecuador: prov. Morona-Santiago: Los Tayos (03°08'S, 78°14'W) 3 July 1976 by Tjitte de Vries. Collection numbers VIII-4 (holotype) and I-16 (paratype). Holotype and paratype deposited at "Museu de Zoologia da Universidade de São Paulo."

Measurements (in mm). Holotype: HL 1.85, HWE 2.20, HW 2.00, MLC, 1.58, SL 1.83, WL 3.15, ED 0.33, PL 1.30, PpL 1.60, HfL 2.30, CI (HW/HL × 100) 108, SI (SL/HW × 100) 91.7, Paratype: HL 1.85, HWE 2.15, HW 1.88, MLC 1.53, SL 1.83, WL 3.10, ED 0.38, PL 1.25, PpL 1.56, HfL 2.15, CI 101.6, SI 97.3.

Remarks. The body surfaces of *G. simulans, G. bufonis, G. falcifera* and *G. vriesi* share a characteristic sculpturing: except for the legs, mandibles, anterolateral portions of frontal lobes and anterior portion of clypeus; very finely striolate and mostly covered by piligerous foveolae. In *G. vriesi* the foveolae are nearly contiguous and the striolation can be seen only at high magnifications at the confluence of the depressions. From each foveola departs an eccentric hair, which is turned in different directions, depending on the area of the body. *G. simulans, G. bufonis* and *G. falcifera* may have extensive areas smooth and shining, but in *G. vriesi,* as can be seen in Figure 1, the foveolae cover all body surfaces, except the cited ones. The holotype worker had these foveolae filled with earth, in a manner similar to that found by Hölldobler and Wilson (1986) in *Basiceros* and *Stegomyrmex* (Myrmicinae).

The propodeal declivity in the four species bears a crested depression, completely sculptured with radiate punctations, clearly centered at the foramen in the new Ecuadorean species (Fig. 4), but faintly visible in the previously described ones.

These combined features distinguish these species from other taxa described as *Gnamptogenys* and also from other species of the *Alfaria* group. They may be considered thus as forming a distinct subgroup of the *Alfaria* group.

In the case of *G. bufonis* we thought at first that it would prove to be a junior synonym of *G. simulans.* The *bufonis* type, deposited in the U.S. National Museum and examined by one of us (CRFB), presents some discrepant measurements, when compared to those obtained from Costa Rican samples of *G. simulans,* but as already stated by Brown (1958) these discrepancies, and also the differently shaped alitrunk, could be explained if the *G. bufonis* type is not a true worker, but a queen-worker "intermediate." The type series of *G. simulans* (not examined by us) included a dealated queen, with a "normal" alitrunk for the caste, but Brown (1958:225, 227) says that some cases among *Gnamptogenys* are known, especially in small species, where "intermediate" and "normal" females occur in the same species.

The "Museu de Zoologia da USP" Formicidae collection houses the following Costa Rican samples of *G. simulans*: 3 workers collected by the Peck couple on Osa Peninsula, Puntarenas in August, 1966; a worker from Tres Rios and two from San Isidro de Coronados, all collected by Bierig in September, 1940. One of us (JEL) examined more material of *G. bufonis* and *G. simulans* in the following collections: Museum of Comparative Zoology–Harvard University, U.S. National Museum, Los Angeles County Museum, and Jack Longino personal collection. He studied two more workers from the Osa Peninsula, Costa Rica, two samples from Mexico (a worker from Oaxaca and another from Chiapas) and a worker from Nicaragua, Santa Maria de Ostuma, collected in October, 1959 by N. L. Krauss. WL in all samples ranges from 1.90 to 2.00 mm. When we compare HL and HW above eyes the Costa Rican and Nicaragua-Mexican samples fall in two distinct groups. Those of Costa Rica have HL ranging from 1.23 to 1.33 mm and HW from 1.18 to 1.25 mm, while in the northern ones HL ranges from 1.35 to 1.47 mm and HW from 1.33 to 1.35 (including here the type *G. bufonis*). For the time being it seems best to consider them as two different taxa.

G. minuta, G. striolata and *G. pneodonax* constitute another tight subgroup within the *Alfaria* group of *Gnamptogenys.* It could be characterized by a coarse reticulo-rugose surface sculpturing, the meshes generally enclosing deeply impressed foveolae. The integument is densely covered with standing hairs, which are as long as the greatest thickness of scape, and fine, abundant and extremely fine suberect to subdecumbent pubescence among the long hairs. The propodeum faces in this subgroup may meet in more or less sharp angles or denticles; the declivity never bears the depression observable in the other subgroup. *G. caelata* is also very close to *G. minuta* and its allies, but its petiole and tergum I of gaster are costulate and not coarsely punctate.

From this latter subgroup the "Museu de Zoologia da USP" recently received: a worker of *G. minuta* from a cocoa field reserve at km 22 of Itabuna-Ilhéus Road (BR 415), state of Bahia, eastern Brazil, collected by Jacques Delabie, another *G. minuta* worker collected at Mirassol, São Paulo state, southeastern Brazil, by Jorge L. Diniz at April, 1989, carrying an unidentified calcareous millipede between the mandibles under log; two workers of *G. pneodonax* collected in primary forest soil and in an old cocoa field at "Centro Cientifico Rio Palenque," Pichincha province, Ecuador. *G. pneodonax* was known till now by the single type worker from cis-Andean Amazon!

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We wish to thank Tjitte de Vries and Sonia Sandoval for sending us their Ecuadorean ant samples. Also the curators of several institutions who loaned material under their care or received our visit to study the ant collections. CNPq and FAPESP supported CRFB research. E. Ross/Smithsonian Institute, and California Academy of Sciences supported JEL. We thank Dr. W. L. Brown, Jr. for useful comments on the manuscript.

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EFFECT OF QUEEN MANDIBULAR PHEROMONES ON *APIS MELLIFERA* WORKER STINGING BEHAVIOR (HYMENOPTERA: APIDAE)

STEVEN A. KOLMES AND NJOKI NJEHU
Department of Biology, Hobart and William Smith Colleges,
Geneva, New York 14456

Abstract.—Honey bee queen mandibular complex (HQMC), a five component pheromone blend, moderates the stinging behavior of worker honey bees when the workers are exposed to an atmosphere that also contains a queen. If either HQMC or an atmosphere in contact with a queen were absent, laboratory bioassays demonstrated that worker honey bees rapidly became more prone to sting.

The stinging of worker honey bees (*Apis mellifera* L.) is an often-suicidal form of colony defense. Pheromonal enhancement of defensive behavior by numerous alarm pheromone components released by disturbed worker bees has been well documented (see review in Free, 1987). This research deals with a different pheromonal input into the willingness of worker bees to sting: the moderating influence of recently identified queen mandibular gland pheromone components.

Honey bee queen mandibular complex (HQMC) is a five component blend identified by Slessor et al. (1988). HQMC is involved in the formation of worker retinues about the queen, in the inhibition of queen rearing, and in the attraction of worker bees during swarm cluster formation (Slessor et al., 1988; Winston et al., 1989, 1990). The five component blend is more pheromonally active than any of its components or blends of less than five components. Live queens show greater pheromonal activity than either synthetic HQMC or mandibular gland extracts, indicating that HQMC normally acts in concert with non-mandibular gland queen pheromones or queen behavior patterns (Slessor et al., 1988, 1989; Kaminski et al., 1989; Winston et al., 1989, 1990).

MATERIALS AND METHODS

The first experiment examined the influence of HQMC on stinging behavior in the presence of possible volatile queen pheromones. Groups of worker bees were shaken from frames into three holding boxes. Each holding box measured 23 cm high, 17.5 cm wide, and 30.5 cm deep, and had vertical walls of wire mesh for ventilation, and a revolving plexiglass door that allowed one bee at a time to be removed. Three holding boxes were filled. One box contained a colony's queen and a group of workers. The second box contained workers and a cotton wick impregnated with HQMC that was accessible to them. The third box contained workers and a cotton wick containing solvent alone that was accessible to them. This experiment was conducted in a double-blind fashion; researchers conducting the behavioral assays were not informed of which type of wick was which. The HQMC wick contained 10 queen equivalents of HQMC. Ten queen equivalents of HQMC consists of: 2.5 mg of 9-keto-2(E)-decenoic acid; 1.5 mg of 9-hydroxy-2(E)-decenoic acid (75% R(-)); 0.2 mg of methyl *p*-hydroxy-benzoate; 0.02 mg of 4-hydroxy-3-methoxyphenylethanol. All holding boxes were equipped with a jar of 1:3 (sugar : water) feeding solution that the bees could drink from freely. Approximately 1,500 bees were placed in each box. Bees taken from three colonies were tested sequentially in the manner described, with bees from only one colony being used at any one time.

The three holding boxes were removed from the apiary to a laboratory and housed together in a Conviron CMP 3023 growth chamber. The boxes were separated from physical contact but shared the same atmosphere. The environment of the holding boxes was maintained at 25°C, 99% relative humidity, and a 12L:12D photoperiod regime.

In the second experiment the influence of HQMC on the stinging behavior of workers in the absence of possible volatile queen pheromones was assessed. The procedure for collecting and housing bees was exactly as in the first experiment, except that only two holding boxes of bees were collected from a colony. One box contained workers and a HQMC wick, the other holding box contained workers and a blank wick. Bees taken from three colonies were tested sequentially in the manner described.

Workers were assessed for their willingness to sting 1½ hours, 1 day, and 2 days after removal from their colony. Fifteen bees from each holding box were tested each day. A threshold voltage bioassay described in detail elsewhere (Kolmes and Fergusson-Kolmes, 1989a, b; Echazarreta et al., 1989) was used to measure the threshold of excitation required to elicit stinging in individual bees. A total of 225 bees were tested using this procedure. Data were analyzed using Wilcoxon-Mann-Whitney tests corrected for ties as appropriate.

RESULTS AND CONCLUSIONS

In the presence of volatile queen pheromones (experiment 1) HQMC had an influence upon the stinging threshold voltage of worker bees. After having been removed from the hive for 1½ hours, the workers in the box containing their queen had a significantly higher threshold voltage than the workers in the box containing a blank control wick ($W = 2325.5$, $p = 0.025$). The workers in the box containing the HQMC wick had an intermediate threshold voltage that differed neither from the workers in the box containing the queen ($W = 2193.5$, $p = 0.240$) nor from the bees in the presence of a blank control wick ($W = 2202$, $p = 0.214$) (Fig. 1).

After the bees had been housed in the laboratory for one day, the moderating influence of HQMC on stinging behavior was greater. The workers in the presence of their queen were once again statistically indistinguishable from those in the presence of the HQMC wick ($W = 1979.5$, $p = 0.586$) while workers in the presence of a blank control wick had significantly lower threshold voltages than either workers in the presence of the HQMC wick ($W = 2382.0$, $p = 0.007$) or workers in the presence of their queen ($W = 2307.5$, $p = 0.036$) (Fig. 1).

After the bees had been housed in the laboratory for two days, the influences of the HQMC wick and the queen upon stinging behavior had both faded. The intermediate HQMC group differed from neither the queen group ($W = 2162.5$, $p = 0.356$) nor the blank control wick group ($W = 2154$, $p = 0.390$). The blank control wick group were most easily excited to sting, and they differed in a nearly statistically

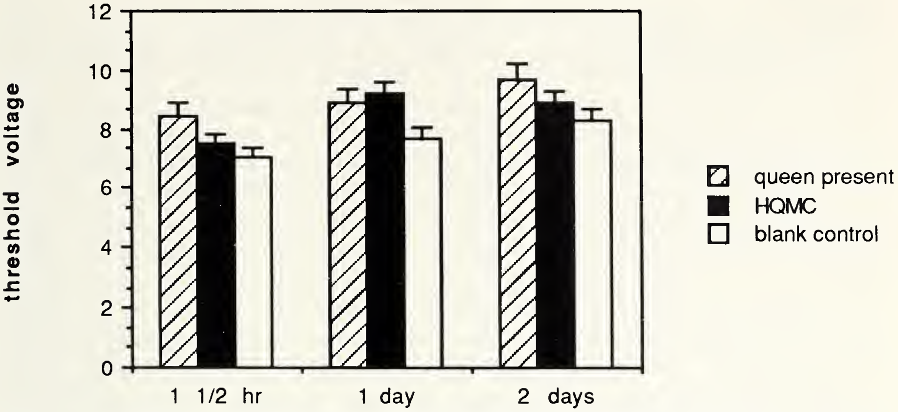

Fig. 1. Threshold voltages for worker bees in holding boxes with their queen, a wick containing HQMC, or a blank control wick. Values are expressed as means, with standard errors of the mean indicated.

significant fashion from the highest threshold voltage group (those bees in the presence of the queen) (W = 2278.5, $p = 0.063$) (Fig. 1). It is likely that some components (the aromatics) in the HQMC wick were being depleted.

In the absence of possible volatile queen pheromones (experiment 2) HQMC had no influence at any time upon the stinging threshold voltage of worker bees. This was true when the HQMC wick group was compared to the blank control wick group after 1½ hr in the laboratory (W = 1999.0, $p = 0.698$). There was no significant difference between the HQMC wick group and the blank control wick group after one day in the laboratory (W = 2078.0, $p = 0.809$). There was also no significant difference between the HQMC wick group and the blank control wick group after two days in the laboratory (W = 2017.0, $p = 0.809$) (Fig. 2).

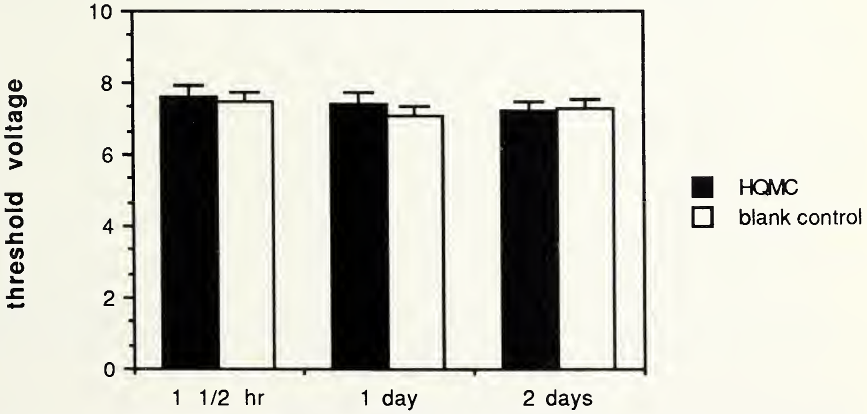

Fig. 2. Threshold voltages for worker bees in holding boxes with a wick containing HQMC or a blank control wick. Values are expressed as means, with standard errors of the mean indicated.

Worker bees responded very rapidly to queen pheromone deprivation with a lowered threshold for eliciting stinging. The effect of HQMC is probably dependent upon the presence of volatile queen pheromones; in the second experiment with the absence of a queen in the growth chamber the effect of a wick containing HQMC was indistinguishable from that of a blank control wick (Fig. 2). It is unlikely that the presence of a queen (first experiment) influenced worker behavior through any increase in the concentrations of the more volatile HQMC components. The workers in the HQMC wick box were already exposed to unusually high HQMC levels, and the workers in the blank control wick box did not behave as though they were being exposed to HQMC.

The significantly higher threshold voltage exhibited after one day by the HQMC wick bees compared with the blank control wick workers is intriguing (Fig. 1). It may be that supernormal levels of HQMC could be used to moderate the tendency of queenless packages of worker bees to sting, as long as one queen or some other source of volatile queen pheromones was present.

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A NEW SPECIES OF *LEGENDRENA* (ARANEAE: GALLIENIELLIDAE) FROM MADAGASCAR

Norman I. Platnick

Department of Entomology, American Museum of Natural History,
Central Park West at 79th Street, New York, New York 10024

Abstract.—A new species of the spider genus *Legendrena, L. steineri,* is described from Madagascar; males have an incrassate first tibia and an elongate embolus.

During a recent visit to the National Museum of Natural History, Smithsonian Institution (USNM), I was able to examine a collection of spiders taken in southeastern Madagascar, by Warren E. Steiner and colleagues, as part of an inventory of the proposed Ranomafana National Park. Among this material were several specimens of the family Gallieniellidae, a group previously considered endemic to Madagascar and the Comoro Islands (Millot, 1947; Legendre, 1967; Platnick, 1984), although newer evidence indicates that the family actually has a much wider, austral distribution (Platnick, in press).

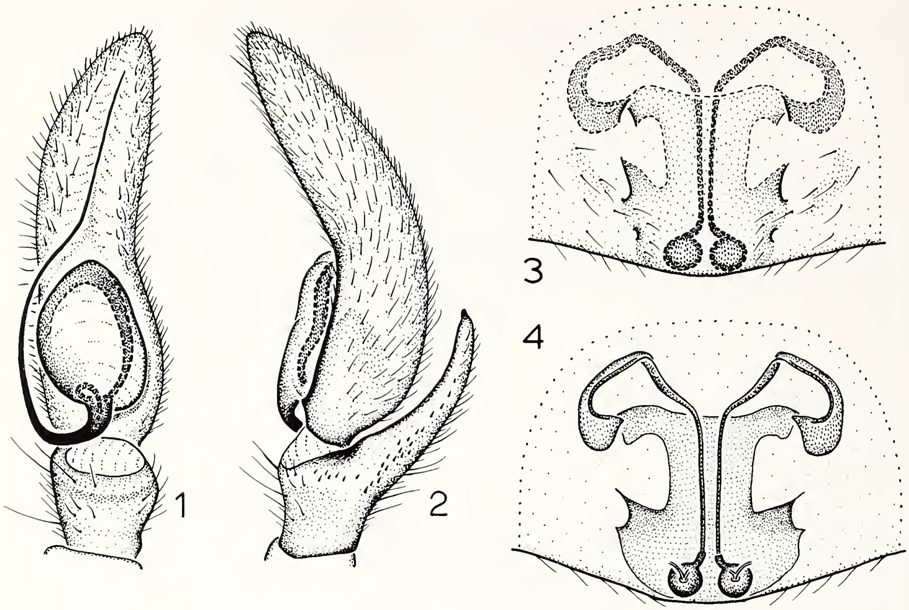
Two gallieniellid genera have been reported from Madagascar, and both are present in the Ranomafana material. The type species, *Gallieniella mygaloides* Millot, is represented by a male and female taken 7 km W of Ranomafana, at an elevation of 1,100 m (Nov. 1–7, 1988; W. E. Steiner). The second genus is represented by the second known specimen of *Legendrena rolandi* Platnick, a male taken earlier (Oct. 8–21, 1988) at the same locality, as well as by both sexes of a new species, the fifth to be described in the genus. I am indebted to Drs. Jonathan Coddington and Charles Griswold (USNM) for access to this interesting collection, and to Dr. M. U. Shadab of the American Museum of Natural History for providing illustrations. The format of the description follows that of my earlier revision (Platnick, 1984).

Legendrena steineri, new species
Figs. 1–4

Type. Male holotype taken in a flight intercept-yellow pan trap inside a Malaise trap in a small clearing at an elevation of 1,100 m in a montane rainforest located 7 km W of Ranomafana, Fianarantsoa, Madagascar (Nov. 1–7, 1988; W. E. Steiner), deposited in USNM.

Etymology. The specific name is a patronym in honor of the collector of the holotype.

Diagnosis. Males can easily be distinguished from those of the four previously described species of *Legendrena* by their greatly elongated embolus (Figs. 1, 2), which approaches in length that of male *Gallieniella,* as well as by having the first tibia basally incrassate as well as bicolored. The female described below is penultimate, but must have been very close to maturity when collected, as the adult epigynum seems to be fully formed; its ducts are much longer than those of the other two species of *Legendrena* known from females (Figs. 3, 4).



Figs. 1–4. *Legendrena steineri,* n sp. 1. Left male palp, ventral view. 2. Same, retrolateral view. 3. Epigynum, ventral view. 4. Same, dorsal view.

Male. As in *L. angavokely,* except for the following. Total length, not including chelicerae, 4.99. Carapace 2.06 long, 1.46 wide, dark chestnut brown. Eye sizes and interdistances: AME 0.05, ALE 0.08, PME 0.07, PLE 0.08; AME-AME 0.10, AME-ALE 0.02, PME-PME 0.14, PME-PLE 0.05, ALE-PLE 0.04; MOQ length 0.20, front width 0.21, back width 0.29. Chelicerae extending forward distance almost half of carapace length. Leg spination (only surfaces bearing spines listed): femora: I d1-0-0, p0-0-1; II-IV d1-0-0; patella I v1p-0-0; tibia I v5-4-0; metatarsus I v1p-1r-0. Legs light yellow, leg I coxae with prolateral, trochanters with pro- and retrolateral dark brown longitudinal stripes, femora and patellae enlarged, dark chestnut brown except along retrolateral surface of femora, tibiae incrassate, dark chestnut brown, setose on proximal half only; remaining legs with pro- and retrolateral dark stripes on femora, patellae, and tibiae. Abdominal scutum indistinct. Palpal tibia with elongate dorsal apophysis bearing retrolateral row of cusps; embolus originating basally, extending almost to tip of elongated cymbium (Figs. 1, 2).

Female (penultimate). As in male, except for the following. Total length, not including chelicerae, 4.65. Carapace 1.84 long, 1.31 wide. Eye sizes and interdistances: AME 0.06, ALE 0.08, PME 0.06, PLE 0.07; AME-AME 0.07, AME-ALE 0.02, PME-PME 0.14, PME-PLE 0.05, ALE-PLE 0.04; MOQ length 0.18, front width 0.19, back width 0.26. Leg spination: patella I v1p-1p-0; metatarsus I v3-0-0. Femur I with both prolateral and retrolateral undarkened longitudinal stripes; tibia I not incrassate, without basal fringe of setae. Epigynum with elongate ducts (Figs. 3, 4).

Other material examined. One male and one penultimate female taken at an elevation of 1,200 m at a site 7 km SW of Ranomafana (Oct. 22, 1988; W. Steiner, C. Kremen, R. Van Epps).

Distribution. Known only from southeastern Madagascar.

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BOOK REVIEWS

INVETERATE RELATIONSHIPS

J. New York Entomol. Soc. 98(4):502–504, 1990

Invertebrate Relationships.—P. Willmer. 1990. Cambridge University Press, Cambridge, 400 pp. $22.95 (paper).

> "There is no doubt that cladistic analyses of the whole of invertebrate phylogeny would be greatly welcomed in some quarters. It should therefore be made quite clear at the outset that this book is *not* attempting to fulfil that role." (italics original).

With this salutation, Willmer describes the central theme and methodological bent of her work, *Invertebrate Relationships,* and for the next 359 pages we are treated to convergence narratives, appeals to the functional integrity of ancestors, and denigrations of "rigorous" methods of phylogenetic research. She has achieved her goal handsomely.

Invertebrate Relationships is a bad book and not even the illustrations, which are the crudest line drawings, salvage a purpose for this work. Specific systematic methodology is almost entirely absent and the default reason for the similarity of traits is not history but convergence. In fact, almost every attribute which might be used to support the common history of organisms is said to have had multiple origins. This may well be true, but in absence of evidence to the contrary this can hardly be assumed.

Willmer rejects cladistic analysis for several reasons. She states that "cladistic treatises are generally rather unreadable for the non-specialists." They are also undesirable because "more informal language and arguments are needed." The desire to remove scientific gobbledygook is certainly understandable, but there are cases when specific concepts require specific terminology. At any rate, this seems a poor reason to reject a methodology. The criticism of cladistic unreadability is irrelevant; just because the material is difficult does not justify its rejection.

These two criticisms aside, Willmer states that there are two cladistic credos which are " 'inappropriate' to invertebrate systematics." These are the avoidance of adaptationist arguments as "story telling" and the assumption that minimization arguments are correct—in that convergence cannot be said to have occurred unless it has been conclusively proven. Willmer seems to think that one can "know" in an absolute sense whether a character has single or multiple origins. Simply because a character "could" arise multiply, does not mean that it has. Basing phylogenetic hypotheses on the plausibility of convergence stories is a dangerous thing. Strangely though, this skepticism does not lead her to question the monophyly of the phyla themselves when she states that the phylum "is probably the most satisfactory taxon after the species."

Willmer's second criticism of cladistics—that it assumes that minimization arguments are true—betrays a basic misunderstanding of cladistic thought and the concept of parsimony. Cladists do not believe that most parsimonious hypotheses of relationship are necessarily true, just that they are best supported. A hypothesis which explains the distribution of a character with a single origin is better supported than another which requires several, in that fewer evolutionary events are required to match the arrangement of taxa. This does not mean that the single origin hypothesis is true, it may well not be, but if you can explain a character distribution with a single change you have no right to propose several.

The fact that cladists do not assume that minimization equals truth is shown in almost every analysis. Unless the data are entirely consistent, some characters will have multiple origins on the most parsimonious cladogram. On other topologies, these same characters would have arisen only once. According to Willmer, this would present a dilemma, because several topologies would be assumed to be true. There is, of course, no dilemma because the arrangement which is most parsimonious overall is the best supported—truth has nothing to do with it.

One result of this world view is that Willmer is exceptionally reluctant to grant monophyletic origin to any grouping of taxa. She states herself that the book is biased towards polyphyly, and that it is. Throughout the entire work appeals are made to functional arguments in the spirit of Manton's work on arthropods. It seems that any number of characters which support a sister group relationship can be overthrown by appeals to the functional integrity of ancestors. The prime example of this is, of course, the case for arthropod monophyly.

Willmer cites sixteen synapomorphies which unite Arthropoda, yet only one (based on developmental fate maps of Anderson) to break up the group. This weight of evidence is overthrown in favor of a polyphyletic origin based on Manton's work in which she states that the method of biting in arthropods is entirely too dissimilar to allow any intermediate to function. On this basis Manton (and Willmer) dismiss the evidence for monophyly. The type of argument involved in stating that these transformations are impossible is really the same as that which asserts similarity as convergence *a priori.* In both cases, appeals are made to knowledge which can only come from phylogeny. More specifically, these statements are the conclusions of phylogenetic analyses, not their origins.

Willmer's overall phylogenetic conclusion is succinctly stated, "With convergence so very prevalent, any attempt to impose a hierarchy of such features and achieve a higher level cladistic type of classification for all these groups would be utterly artificial, if not impossible." However, she never attempts to do this to see if, in fact, it is impossible to discern hierarchy from this supposed jumble of character dissonance.

An analysis of the characters presented in the figures and text present a quite different picture. I was able to extract 55 characters for the 36 "phyla" discussed. Although there was a great deal of missing data, the most parsimonious arrangement of these taxa found by Farris's Hennig86 (see Fitzhugh, K., 1989, J. New York Entomol. Soc. 97:234–241 for review of this program) under the mh* bb* option did contain much structure (Fig. 1). There were over 1,700 equally parsimonious trees found (there were more but my computer overflowed at 1,723 trees) with a length of 113 steps, a consistency index of 52%, and a retention index of 72%. The figure shows the Nelson (strict) consensus of these topologies.

Clearly, there is a great lack of resolution, but approximately one third of the resolvable groups are supported. Additionally, the amount of noise in the data, as shown by the consistency index, is not overwhelming. Many useful analyses have

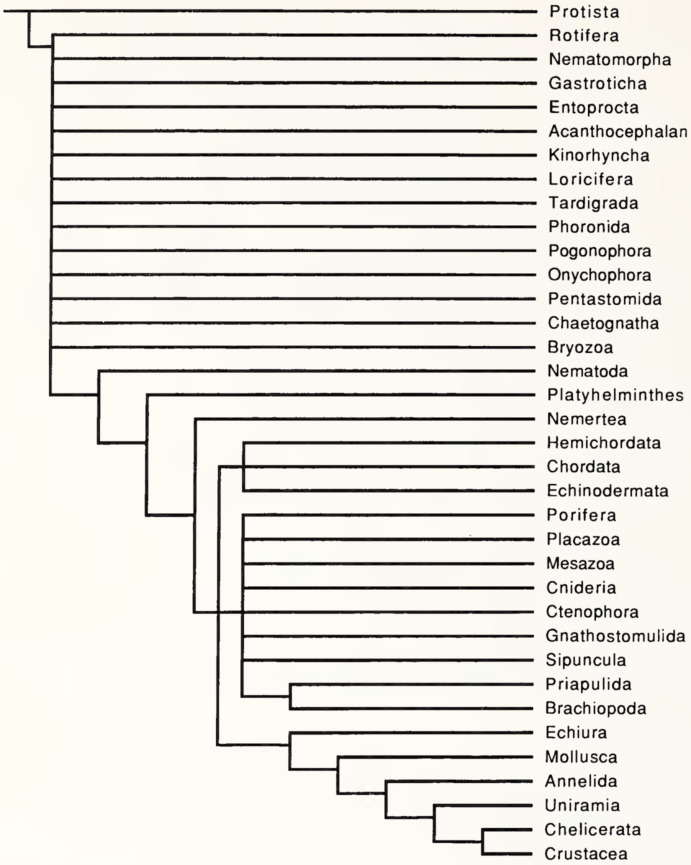

Fig. 1. Reanalysis of Willmer's data, based on 55 characters and using the Hennig86 program. This tree represents a strict consensus cladogram (see text).

much more homoplasy. Some of these groupings seem bizarre, but the point is not that these relationships are "true," but that they are supported by the data as they exist. This is certainly more informative than the analysis of *Invertebrate Relationships,* which is based on "supra-specific ancestors, paraphyletic groups, multiple non-dichotomous branchings, and adaptationist 'story-telling' arguments" (p. 14).—*Ward Wheeler, Department of Invertebrates, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024.*

J. New York Entomol. Soc. 98(4):505–506, 1990

Ecology and Natural History of Tropical Bees.—David W. Roubik. 1989. Cambridge University Press. x + 514 pp. $69.50 hardcover.

Anyone with even a glimmer of interest in natural history should find it easy to appreciate the beauty and fascination of bees. To begin with, they are aesthetically appealing. One need not be an entomologist to notice the close association of bees with flowers. Most of us probably learned in elementary school, or perhaps a little later when first exposed to that venerable old analogy for sexual reproduction, that the colors, shapes, and aromas that we find so pleasing in flowers owe their origins to complex interactions that these flowers have with bees (and other pollinators). Furthermore, bees are elegant and beautiful creatures in their own right, some sporting brilliant metallic hues as gaudy as anything in the animal kingdom, others more subtly clothed in elegant plumose vestiture. As with any area of natural history, an interest first sparked by simple aesthetic delight grows deeper and more captivating as one attempts to find explanations for the bewildering diversity of bees.

Consequently, it is rather puzzling that the English-speaking world has so few books dealing in a general way with the natural history of bees other than honey bees and bumblebees (not that there is anything wrong with these two genera, but they are just the tip of the iceberg). Anyone able to read German can enjoy the products of a long tradition of lovingly detailed, beautifully illustrated treatises on the biology of all the bees of central Europe. However, in America there is one publication from the Agricultural Experiment Station of Oregon State University (Stephen et al., 1969), which you will be lucky to find in your library, and Michener's (1974) widely-cited and influential text, which deals only with social bees. So far as I know, even the English, with their unequalled passion for natural history, have been woefully remiss in producing good general books on the natural history and ecology of bees.

Perhaps the editors of the Cambridge Tropical Biology Series sensed this crying need for a book on bees. Or perhaps they were seduced not by the intrinsic appeal of bees themselves, but by the rich and complex interactions between bees and angiosperms. (Complex interactions are an irresistable magnet for tropical biologists.) Whatever the motivation for commissioning a book about the ecology of tropical bees, an obvious choice for the author was David Roubik, who has more than a decade of research experience specifically with tropical bees.

The book that Dr. Roubik has produced is ambitious and comprehensive in scope. After a short introductory chapter that crudely sketches the classification, phylogeny, and geographic distribution of bees and outlines the basic life histories of solitary and social forms, he launches into detailed discussions of foraging behavior and pollination biology, nesting behavior and reproductive biology, and community ecology. No previous author has attempted to synthesize such a broad range of topics for bees. The chapter on foraging and pollination catalogs the types of resources gathered by bees and how they are collected, follows this with theoretical and empirical discussions of foraging ecology, and concludes with a section on pollination ecology that considers the interactions between bees and flowering plants. The next chapter deals with nesting and reproductive biology. It summarizes the wide variety of nest architectures employed by bees, along with the array of natural enemies and associates that are drawn to these nests. The final section in this chapter discusses mate selection, larval development and nutrition, modes of reproduction in solitary and social bees, and some general aspects of population genetics in bees. The book's final chapter covers several topics in community ecology, including bee seasonality, abundance, and flower preference, ecological (as opposed to historical) biogeography of bees, and the roles of bees in communities.

A major challenge for any author trying to write about a group of organisms as diverse as bees is that he or she cannot possibly avoid discussing many organisms that will be unfamiliar to most of his or her readers. Illustrations are the traditional method for dealing with this problem, and carefully selected illustrations can be extremely effective. In addition to the many graphs and tables that are such an essential (and rarely appreciated) feature of communication among scientists, Roubik's book is filled with numerous excellent drawings and photographs that should help any reader visualize bees as living organisms. The book also contains a unique appendix of black-and-white photographs of museum specimens of tropical bees, which provides a direct visual impression of bee diversity.

Ideally, a general book such as this, which summarizes and synthesizes such a wide range of information, would also be written in a lucid and engaging style that would capture the interest and excite the imagination of any ecologist or evolutionary biologist who picks it up. I found the book to be a disappointment in this respect. I was repeatedly frustrated when the author was discussing an intriguing topic in evolutionary biology, but I lost track of the logic of his argument in a dense thicket of misplaced modifiers within sentences, unrelated sentences within paragraphs, and paragraphs with no obvious relevance to the chapter heading under which they were placed. Perhaps a more patient or persistent reader will not find this as troublesome as I did, and perhaps he or she will discover important new ideas and insights about evolutionary biology where I did not. In any case, Roubik's book is a valuable and unique compendium of information about bees in general, and tropical bees in particular.—*Byron Alexander, Snow Entomological Museum, Snow Hall, University of Kansas, Lawrence, Kansas 66045.*

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