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(Continued on inside of back cover)

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Vol. 107, No. 1, January & February, 1996

FISSIMENTUM, A NEW GENUS OF DROUGHT-TOLERANT CHIRONOMINI (DIPTERA: CHIRONOMIDAE) FROM THE AMERICAS AND AUSTRALIA[1]

Peter S. Cranston[2], Ulrike Nolte[3]

ABSTRACT: The genus *Fissimentum* is described from all life history stages for a previously recognized but unreared larval taxon "Tendipedini genus A" of Roback, 1966. A Neotropical species *Fissimentum desiccatum,* here described for Roback's (1966) species 4, shows drought tolerance in Brazil. Unreared larvae from Brazil and Australia allocated to genus *Fissimentum* are discussed in relation to the type species.

Identification of chironomid larvae often is hampered by incomplete knowledge of the full life history (Epler and Ferrington, 1994). This arises from an historical legacy of species descriptions based on the adult male, which has deterred most taxonomists from naming taxa solely on the immature stages because of the risk of unintentional creation of synonymy with previously described but unreared adults. However, locating and rearing particular larvae to obtain the complete life history for description may be slow. For example, it took nearly half a century between the description of *Paratendipes basidens* Townes and the discovery of its distinctive larva (Epler and Ferrington, 1994) and some thirty years for the equally characteristic *Stelechomyia* to be fully associated (Reiss, 1982).

Among the distinctive larval forms which have remained unreared for a protracted period is a group of Chironomini that have curious medially cleft menta. First reported from the southern USA and the neotropics by Roback (1966) as "Tendipedini genus A," this taxon encompassed the larvae of four species and one variety. By the time of the compilation of the keys and diagnoses for the Holarctic Chironominae (Pinder and Reiss, 1983), the still-unreared taxon (there referred to as "Chironomini genus A Roback") was known to occur in marginal sediments of slowly-flowing, tropical, lowland rivers of South America, Florida and Texas.

In 1993, the junior author found a distinctive larva of this group to be common in potamal benthic habitats of the Rio Bento Gomes, a white water river in the Brazilian state of Mato Grosso. Using both individual and mass techniques, pupae and adults of both sexes were reared and found to belong to no formally described taxon. In this and contemporary studies elsewhere in Brazil a second of Roback's species was found. Meanwhile in Australia larvae apparently belonging also to "Chironomini genus A Roback" were discovered in a dystrophic subtropical perched lake and among an earlier survey collection from the marginal sediments of a temperate river.

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In this contribution we describe the genus as new, bestowing the name *Fissimentum* based on the distinctive cleft larval mentum. We describe and illustrate the pupa and both sexes of adult, redescribe and illustrate the larvae, examine the phylogenetic position and discuss the ecology, including the larval desiccation tolerance.

MATERIALS AND METHODS

Larvae were collected by conventional nets and reared in the laboratory (by Nolte) in petri dishes filled with mud and water from the river and maintained at ambient temperature (27-32°C). Associated material was preserved in 75% ethanol. Australian material either died in attempted rearing or was preserved directly on collecting. Microscope slide preparation (Cranston) involved clearing where necessary with 10% KOH, neutralization and initiation of dehydration with glacial acetic acid, then mounting from propan-2-ol (isopropanol) into Euparal.

Morphological terminology follows Sæther (1980) except where we adopt Langton's (1994) suggested use of taenia (adjective taeniate) for "filamentous" or "lamelliform" (LS) pupal setae.

All measurements in µm unless stated otherwise.

Fissimentum NEW GENUS

Fissimentum Cranston and Nolte, gen. nov.
"Tendipedini Genus A" Roback 1966: 325
"Chironomini Genus A Roback"; Pinder & Reiss, 1983: 349; Epler, 1992: 7.116

Type species: *Fissimentum desiccatum* Cranston and Nolte, sp. nov., by present designation.

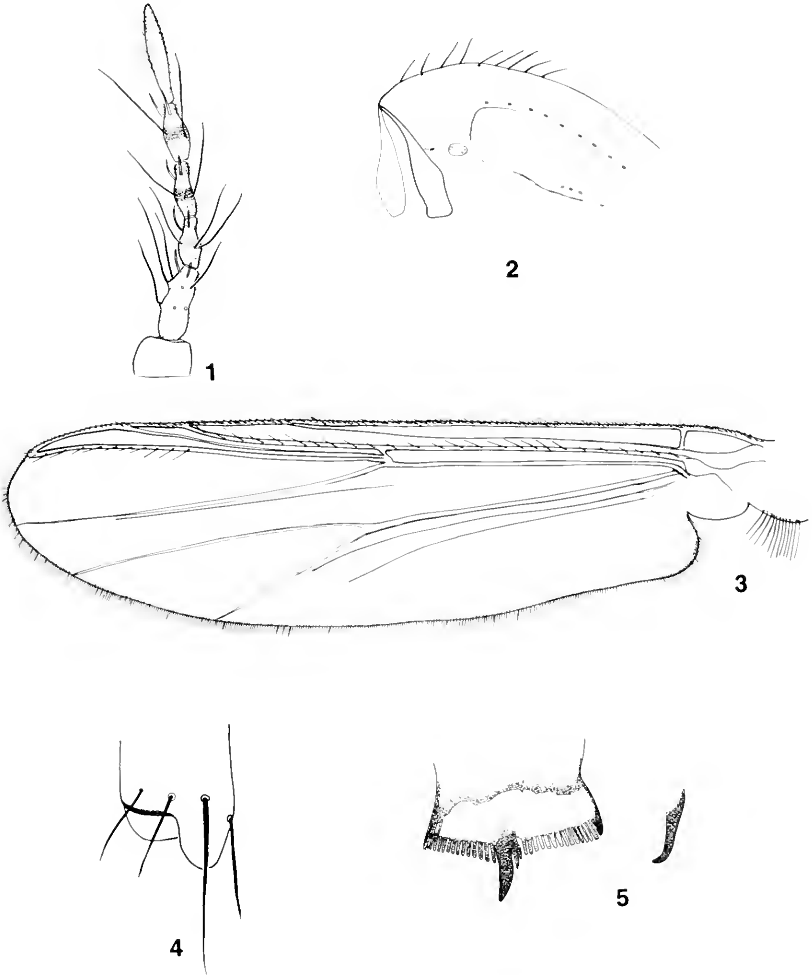
Etymology: from L. *fissus* cleft, past participle of *findere* - to split and NL. *mentum*, the median toothed plate. Neuter noun.

Generic diagnosis

Adult. Medium-sized species, with body length to 5mm, wing length to 2.5mm. Wing unpatterned; thorax brown with darker vittae and postnotum; legs dark brown with yellower basitarsomeres.

Antenna. Male with 13 flagellomeres, antennal ratio (AR) c. 1.7. Female with 5 flagellomeres (Fig. 1), AR c. 0.4.

Head. Eye bare, with bluntly wedge-shaped dorsomedial parallel-sided extension about 6 ommatidia long; in both sexes eyes separated medially by about width of 4-5 ommatidia. Temporal setae of uni-biserial postorbitals merging into verticals; clypeals present. Frontal tubercles absent. Palp 5 segmented, segment 2 globular, segment 4 shorter than 3 and 5; segment 3 with or without 1 sensilla.



Figures 1-5. *Fissimentum desiccatum* n. gen. n. sp. adult. 1. Female antenna. 2. Male thorax. 3. Male wing. 4. Apex of anterior tibia. 5. Apex of hind tibia and spur of hind tibial comb in lateral view.

Thorax (Fig. 2). Antepronotal lobes tapering dorsally, medially narrowly separated. Scutum not overreaching antepronotum; profile of scutum gently rounded, tubercle lacking. Acrostichals biserial running from anterior thorax to mid-scutum; dorsocentrals, prealars and scutellars uniserial.

Wing (Fig. 3). Membrane without setae, with moderate to strong microtrichiation ('punctation'). Anal lobe rounded. Costa ending abruptly at apex of R_{4+5}, somewhat proximal to wing apex; R_{2+3} running midway between but ending in proximal $^1/_4$ between R_1 and R_{4+5}. FCu slightly distal to RM. R, R_1 and R_{4+5} setose in both sexes. Squama setose.

Leg. Apex of fore tibia with rounded scale, without spur (Fig. 4). Mid and hind tibiae apically with two nearly fused combs (Fig. 5) occupying two-thirds circumference of tibial apex, inner comb without spur, outer (longer) comb with short, curved spur (Fig. 5). Fore leg ratio > 2.0. Pulvilli absent. Sensilla chaetica absent. Beard absent.

Abdomen. Tergites I - VII with irregularly scattered setae.

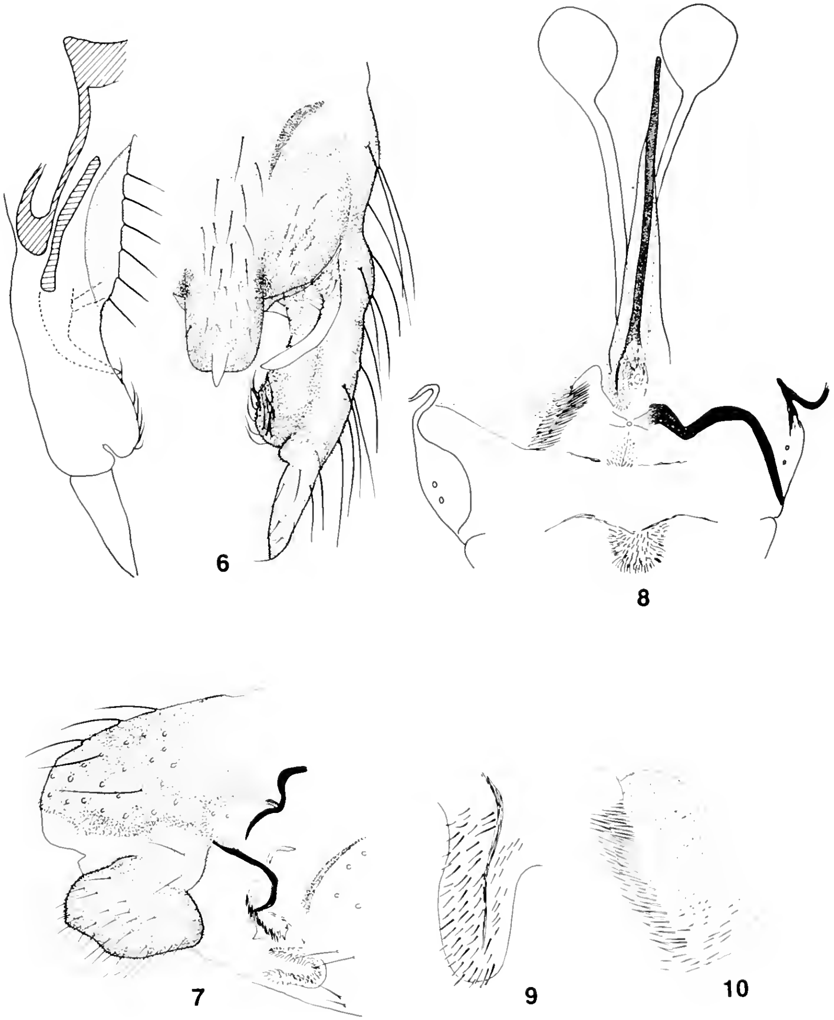
Hypopygium (Fig. 6). Anal tergite bands weak, delimiting median anal tergite setae that intergrade into shorter, finer apical setae. Anal point short, tapering to blunt apex, arising from elevated projecting tergal extension. Superior volsella slightly swollen basally and microtrichiose/setose, with curved digitiform extension, without microtrichia, with 2 medially directed setae on inner margin. Median volsella absent. Inferior volsella fused to full length of gonocoxite, extending to apex of gonocoxite; microtrichiose with medially and dorsomedially directed, simple setae, without differentiated posteriorly directed strong seta. Gonostylus bulbous at base, straight, ending bluntly. Sternapodeme bluntly pointed apicomedially, without oral projections. Phallapodeme elongate, narrow.

Female genitalia (Figs. 7-10). Notum long and thin, with long, broadened rami. Gonocoxapodeme almost straight, not fused medially. Coxosternapodeme IX weakly sclerotised and gently curved. Dorsomesal lobe of gonapophysis VIII (Fig. 9) elongate, continuous with inner contour of vagina, microtrichiose except hyaline apico-medially. Ventrolateral lobe distinct, darkened, rectangular, as large as dorsomesal lobe (Fig. 10), lying lateral to, and not covering, dorsomesal lobe, microtrichiose basally, with long pointed scales apico-medially. Apodeme lobe more or less rectangular, variably sclerotised, lying dorsal to dorsomesal lobe. Labia hyaline, with microtrichia (Fig. 8). Gonocoxite IX small, not laterally extended, with 1-2 setae. Tergite IX large, undivided. Postgenital plate large, microtrichiose. Seminal capsules oval, darkened near very short neck; seminal ducts straight and ending separately. Cerci relatively small, elongate-quadrate (Fig. 7).

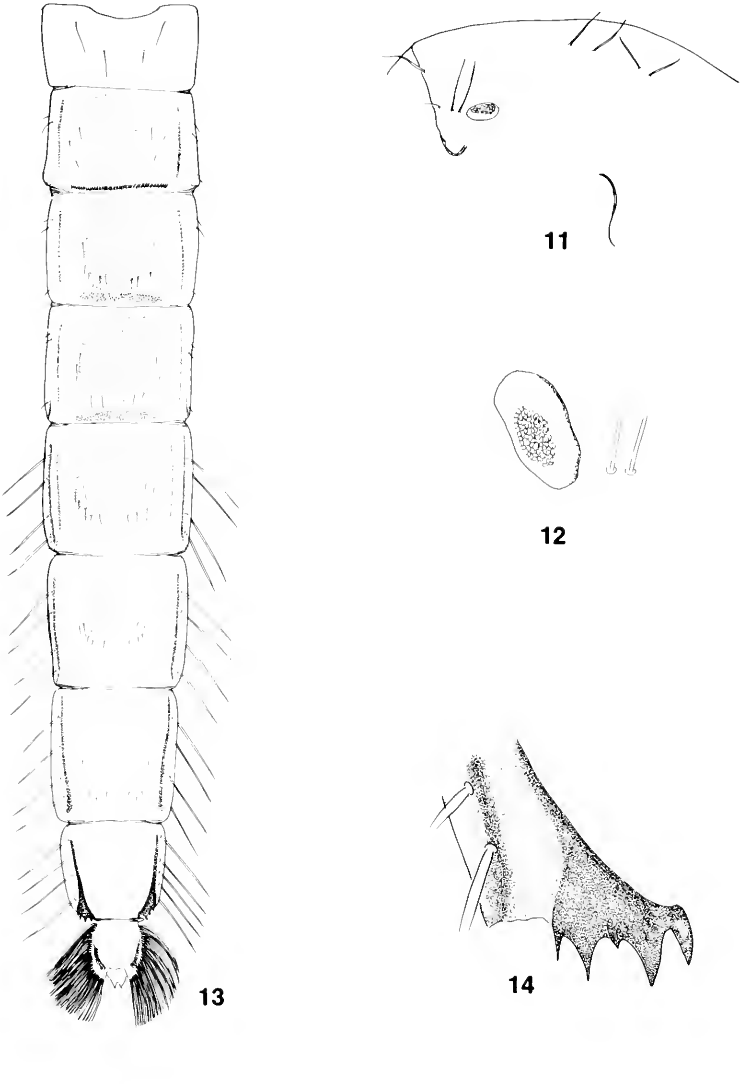
Pupa. Medium-sized, up to 6.5mm long, red colored. Cephalothorax pale to mid-brown, anterior abdominal segments very pale brown, posterior abdomen pale with darker brown apophyses, comb and anal lobe.

Cephalothorax. Cephalic area without tubercles, frontal warts or frontal setae. Thorax (Fig. 11) with 1 median, 1 lateral taeniate antepronotal seta; 2 stout taeniate precorneals; dorsocentral (dc) 2 midway between dc_1, and the more approximated dc_3 and dc_4, all subequal and rather stoutly taeniate. Thoracic horn very plumose; basal ring (Fig. 12) well developed, oval, with 1 elongate-oval tracheal bundle. Median suture smooth except few scales in mid-thorax. Prealar tubercle absent.

Abdomen (Fig. 13). Tergite I bare, II-VII with subquadrate area of spinules, VII with anterior transverse band, VIII with antero-lateral fine spinule area. Anal segment bare. Tergite II hook row continuous, 60% tergite width, comprising c. 50-60 hooks. Conjunctives III/IV and IV/V with fine anterior directed spines/spinules. All sternites with at least anterior transverse band of spinules, most strongly developed and extending posterolaterally on I and II. Pedes spurii A present on sternite IV, weak or absent on V and VI; pedes spurii B weak. Posterolateral corner of segment VIII dark, few stout golden-brown teeth (Fig. 14). Apophyses strong.



Figures 6-10. *Fissimentum desiccatum* n. gen. n. sp. genitalia. 6. Male, left side ventral, right side dorsal. 7. Female, lateral. 8. Female, ventral. 9. Dorsomesal lobe of gonapophysis VIII. 10. Ventrolateral lobe of gonapophysis VIII.



Figures 11-14. *Fissimentum desiccatum* n. gen. n. sp. pupa. 11. Thorax, lateral. 12. Base of thoracic horn. 13. Abdominal tergites. 14. Posterolateral corner of sternite VIII.

Setation. Segment I with 2D, IV and without L setae; II-VII with 5D, 2-3V; 3L on II-IV, V-VII with 4L taeniate setae, VIII with 0D, 2V, 5 taeniate L setae. 1 pair of 0 setae on tergites and sternites II - VII.

Anal lobe rather elongate, with fringe of 50+ uniserially inserted taeniate setae, setal bases darkened. Dorsal taeniate seta small. Genital sac of male reaching just beyond apex of anal lobes, female genital sac shorter than anal lobes.

4th instar Larva. Medium sized, up to 9mm long, with ventral head length up to 650 µm, red colored, with dark occipital margin and "collar" lying anterior to lateral occipital margin, giving impression of doubled margin (Figs. 15-16).

Dorsal surface of head (Fig. 17). Frontal apotome broad, without frontal pit; labral sclerite 1 and 4 disrupted, 2 and 3 complete.

Antenna (Figs. 18, 27, 28). Six segmented, either with short 4th segment or with each successive segment shorter than the preceding. Lauterborn organs small to moderately well developed and alternate on apices of 2nd and 3rd segments. Segment 3 with subapically inserted fine style or style absent. Ring organ in apical third of segment 1, seta absent. Blade extending beyond antenna apex.

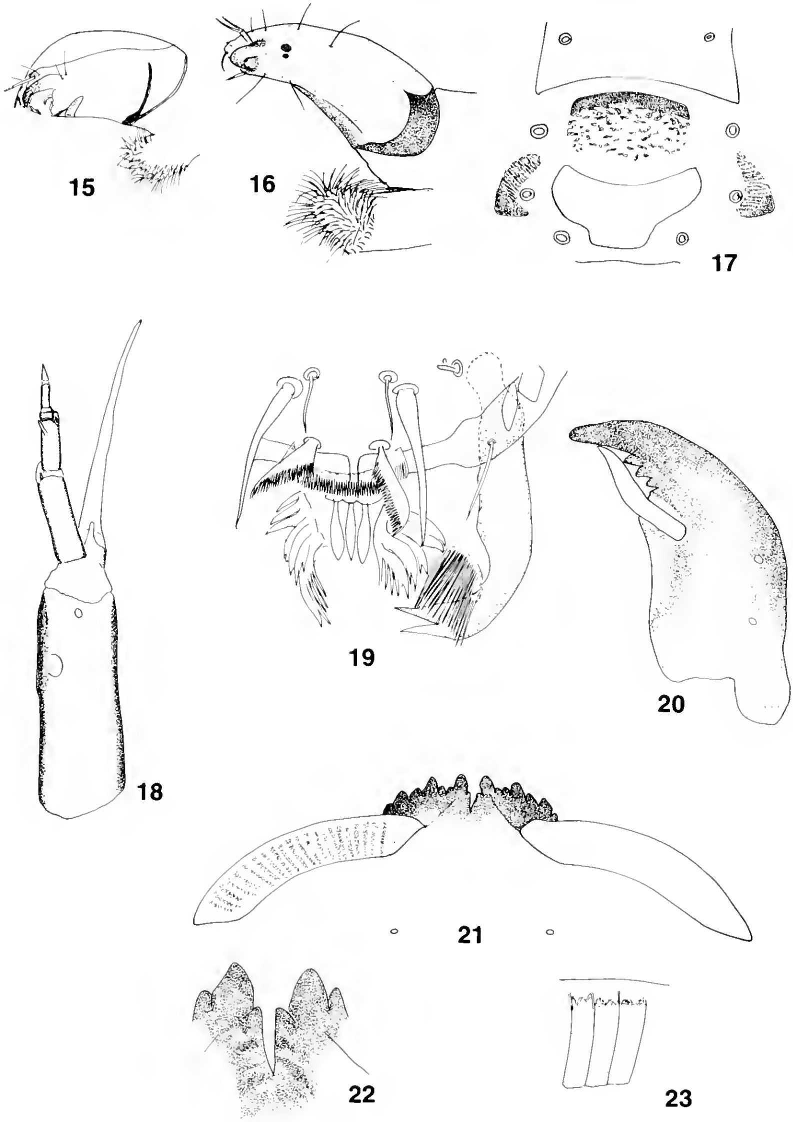
Labrum (Figs. 19, 32). SI plumose, with branching strongest on inner margin; SII long, curved simple; SIII simple, short; SIVa small, SIVb strongly developed. Chaetae developed as 2 broad scales. Seta praemandibularis strong and simple. Labral lamellae broad, with slight indication of median division. Pecten epipharyngis of three separate scales, either simple, narrow, elongate and pointed or 3-4 toothed in a single plane. Chaetulae short, triangular or with 4-5 inner teeth; chaetulae basales weak. Premandible with 2 pointed teeth and strong brush.

Mandible (Figs. 20, 29-31). Dorsal tooth absent (in one species perhaps represented by medio-dorsal hooked tooth [Fig. 31]); strong apical tooth and 3 small inner teeth. Pecten mandibularis absent. Seta subdentalis broad, sinuous, variably extended up to length of apical tooth. Mola and inner margin smooth. Seta interna absent.

Mentum (Figs. 21-26). With distinct cleft in mid-mentum, with cleft including either paired small teeth, fine serrations or smooth inner surface. Cleft and median teeth combined forming ventromentum faintly demarcated by antero-median extension of ventromental plate, dorsomentum of six teeth on each side, variously organized, sometimes directed antero-medially; all teeth brown. Ventromental plates separated medially by > 50% of mentum width, elongate with smooth margin, with striae either of regularly spaced broad lappets without anterior hooks or spines (Fig. 23) or variably reduced (Fig. 26). Setae submenti very long, simple.

Maxilla broad, with exceptionally long maxillary palp.

Abdomen. Lateral and ventral tubules absent. Anterior parapods with dense, fine claws, some of which may be finely serrate apically; posterior parapod claws simple, some broad-based, with or without basal fine spinules. Procercus weakly pigmented, small, as wide as high, bearing 6-7 subequal anal setae. Supraanal setae as long as anal setae, procercal seta elongate, half length of anal and supraanal setae. Four unconstricted anal tubules.



Figures 15-23. *Fissimentum* n. gen. n. sp. larva. Lateral head of 15. *F. desiccatum*. 16. *F.* sp. 2. *F. desiccatum*: 17. Dorsal head. 18. Antenna. 19. Labrum. 20. Mandible. 21. Mentum and ventromental plates. 22. Median mentum, 23. Detail of striae.

Fissimentum desiccatum NEW SPECIES

Genus A sp. 4 Roback 1966: 326.

Etymology: from L. *desiccare*, to dry up, referring to the desiccation tolerance of this species.

Male adult (n=3). Body length 4.7-5.4mm, wing length 1.7-2.0 mm. Brown, with apical $^2/_3$ of tarsomere 1 pale.

Head. With 13-18 uniserial temporal setae, 15-20 clypeals. Antenna with apical flagellomere 740-890 long, basal 12 flagellomeres 400-445 long, AR 1.73-2.00, palp segment 2-5 lengths: 38-45, 175-195, 145-160, 205-265.

Thorax. Setation: acrostichals 10-16, biserial, dorsocentrals 8-11, uniserial, 3 prealars, 7-8 scutellars.

Wing with VR 1.05-1-07. Vein setation: R with 16-21, R_1 8-13, R_{4+5} 12-13; squama with 12-13.

Leg lengths and proportions:

	Fe	Ti	Ta1	Ta2	Ta3	Ta4
PI	845-935	450-540	1190-1405	865-900	575-610	470-520
PII	785-900	685-790	515- 540	230-258	160-186	105-115
PIII	755-865	755-880	715- 845	355-420	265-320	150-185

	Ta5	LR	BV	SV	BR
PI	215-250	2.34-2.60	1.2-1.3	1.1-1.2	0.8-1.2
PII	90-100	0.67-0.68	3.4-3.6	3.1	1.4-2.0
PIII	105-130	0.94-0.96	2.4-2.5	2.1	1.8-2.2

Sensilla chaetica absent.

Hypopygium (Fig. 6). Dorsal tergite IX setae 12-17, bounded laterally by weak tergal bands, 11-14 finer setae on ventral surface of tergite IX. Gonocoxite 220-235 long, gonostylus 80-105 long.

Adult female (n = 4). Body length 4.3-5.4 mm, wing length 1.9-2.3 mm, color as male.

Head. With 13-15 biserial temporal setae, 23-27 clypeals. Antenna with apical flagellomere 126-151 long, basal 4 flagellomeres 330-355 long, AR 0.38-0.42. Palp segment 2-5 lengths: 45-50, 175-185, 170-185, 265-320.

Thorax. Setation: acrostichals 18-20, biserial, dorsocentrals 15-18, uniserial, 3 prealars, 8-9 scutellars. Wing with VR 1.08-1.12; setation: R with 20-23, R_1 16-23, R_{4+5} 26-28, squama with 11-23.

Leg lengths and proportions as follows:

	Fe	Ti	Ta1	Ta2	Ta3	Ta4
PI	880-980	545-620	1260-1350	900-910	590-610	505-520
PII	870-970	790-880	535- 580	230-250	160-170	105-125
PIII	820-900	855-955	755- 790	355-395	285-325	180-190

	Ta5	LR	BV	SV	BR
PI	215-240	2.3 -2.4	1.2-1.3	1.1-1.2	0.7-1.1
PII	80-105	0.65-0.69	3.7-3.9	3.1-3.2	1.3-1.5
PIII	125-145	0.83-0.91	2.4-2.7	2.2-2.3	1.9-2.3

Sensilla chaetica absent.
Genitalia. As in Figs. 7-10.

Pupa (n = 4) (Figs. 11-14). Body length 5.9-7.2mm. Pale with darker apophyses on more posterior abdominal segments. Distance from dc_1 - dc_2 88-94, dc_2-dc_3 115-122, dc_3-dc_4 28-38. Hook row on tergite II with 47-55 hooks, occupying 56-60% of the segment width. Anal lobe with 36-40 taeniate setae.

4th instar larva (n = 5) (Figs. 17-23). Body length 5.7-9.5mm, deep red pigmented; head capsule length 430-480, pale yellow with brown mentum, pale brown mandible, with characteristically doubled pale occipital margin.

Antennal segment lengths, 53-58, 18-22, 10-12, 1-2, 5-6, 3-4; AR 1.20-1.34; alternate Lauterborn organs 1-2 long; blade length 46-50; style length 10-12.

Mandible length 150-162. Mentum width 88-98, ventromental plate width 140-152. Premandible length 56-66.

Material examined. HOLOTYPE: male, Brazil, Mato Grosso, Rio Bento Gomes, 16°20'S 56°32'W, 110m a.s.l., 17.viii. 1994, U. Nolte; deposited in the Entomological Collection of the Federal University of Cuiabá, Mato Grosso, Brazil (UFMT). PARATYPES, 2 males, 4 females, 4 Pe, 11 larvae, same data as holotype, 1f, 1Pe, 1L in The Natural History Museum, London (BMNH), 1m, 1f, 1Pe, 1L, deposited in Zoologische Staatsammlung München, Germany (ZSM), remainder in Australian National Insect Collection, Canberra (ANIC).

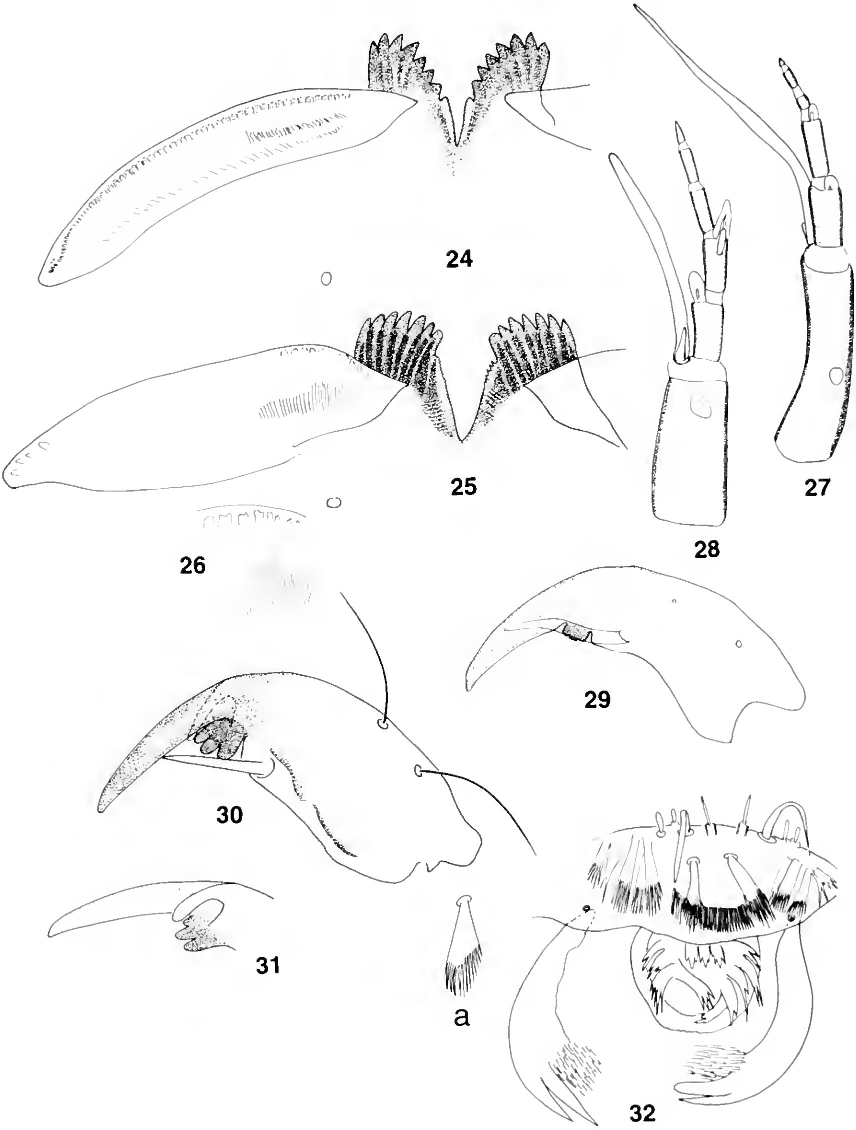
Larval taxa

The following two larval taxa share the cleft mentum with *F. desiccatum*, but differ from the genotype in the pecten epipharyngis scales, which in both taxa are toothed rather than elongate and simple, and the reduction of the ventromental plate striae. However, features of the labrum, the very extended maxillary palp and the mandible shape are all shared, apparently derived features that suggest homology of the cleft mentum, rather than convergence.

Fissimentum sp.2

Tendipedini Genus A species 2 Roback 1966: 326.

4th instar larva (n = 5). Body length 8-9 mm. Head capsule length 620-660, golden to pale-brown with brown mentum, golden to pale brown mandible, with broad brown "collar" (wide



Figures 24-32. *Fissimentum* n. gen., undescribed larvae. Menta of: 24. *F.* "sp. 2". 25. *F.* sp. "Australia". 26. Detail of striae of *F.* sp. "Australia". Antenna of: 27. *F.* sp. "2". 28. *F.* sp. "Australia". Mandible of: 29. *F.* sp. "2". 30. *F.* sp. "Australia". 31 detail of mandible of *F.* sp. "Australia". 32. Labrum of *F.* sp. "Australia", a. detail of SI seta.

occipital margin). Antenna (Fig. 27) segment lengths, 55-62, 18-20, 18-20, 4-5, 6- 7, 2-3, AR 1.06-1.18; alternate Lauterborn organs 4-5 long; blade length 80-88; style not visible. Mandible (Fig. 29) length 215-225. Mentum (Fig. 24) width 90-110, ventromental plate width 190-230. Labrum with premandible length 84-88.

Material examined. 5L, BRAZIL, Sao Paulo, Sao Carlos, Faz. Cauchim. 22°02S 47°53W, 1993, S. Strixino (1 to UFMT, 3 to ANIC). 5L, BRAZIL, Sao Paulo, Itarapina, Respresa do Lobo, 1979, S. Strixino (1 to Zoologische Staatsammlung München, 4 to ANIC).

Fissimentum sp. "Australia"

4th instar larva (n=1). Body length unknown (only head capsule retained). Head capsule length 350, pale yellow with brown mentum, pale brown mandible, with doubled occipital margin somewhat darker.

Antenna (Fig. 28) segment lengths, 32, 15, 10, 10, 7, 5; AR 0.68; alternate Lauterborn organs 3-4 long; blade length 56; style 8.

Mandible (Fig. 30) length 106, with strongly developed hooked tooth on dorsal surface (Fig. 31). Mentum (Fig. 25) width 63, ventromental plate width 135. Labrum (Fig. 32) with premandible length 43.

3rd instar larva (n = 2). Body length unknown. Head capsule 260. Antennal segment lengths 18, 11, 9, 7, 6, 4, AR c. 0.5, blade 45. Mandible 68. Mentum width 43, ventromental plate width 77. Premandible 27.

Material examined. 2L (1 4th instar, 1 3rd instar), AUSTRALIA, Victoria, Lower Woori Yallock, nr Healesville, Yarra River, "YRS 103," 37°46'S 145°31'E, 6.xii.1985, V. Pettigrove (1 to ANIC, 1 to Water Ecoscience, Mt. Waverley, Melbourne, Victoria.), 1L (3rd instar), AUSTRALIA, Queensland, Fraser Island, Lake Boomanjin, 24°03'S 153°05'E, P. S. Cranston (ANIC).

DISTRIBUTION AND ECOLOGY

The most northerly records of *Fissimentum* are from coastal plain drainages in southern USA: Lake Murray, S. Carolina (34°N) (Hudson *et al.*, 1990), the Guadalupe River, Texas (29°N) (Roback 1966) and the Suwannee River, Florida (29°-30°N) (Epler, 1992). The genus occurs in Central America (Costa Rica, Epler, 1992), Puerto Rico (L. Ferrington pers. comm.), Peruvian rivers in the foothills of the Andes (6°S, 11°S, Roback, 1966) and as far south as 30°S in the coastal plains of Rio Grande do Sul, Brazil (Wiedenbrüg, 1993). In Australia, the two records of the genus span a range from 24° to 37°S.

In the Rio Bento Gomes, a Brazilian intermittent tropical lowland river, the larvae of *Fissimentum desiccatum* live in the potamal zone. In the studied 6th order stretch, the bed width is 50-60m, and maximum depth 3.5m (except in flood when the river leaves its bed). The discharge is highly dynamic, with 80% of the annual rainfall falling between November and April. With no rainfall from June to August, sometimes May to September, flow ceases even in the potamal and some drying down takes place. Areas of low current velocity support extensive floating macrophyte beds. During the study period, the temperature mean was 28°C (range 21°-31°C), pH mean 6.8 (5.6-7.3), conductivity 80 $\mu S.cm^{-1}$ (30-130 $\mu S.cm^{-1}$).

The larvae of *Fissimentum desiccatum* live in soft, muddy sediments including those which include some fine sand but they are not found in pure clay and silt. These sediments may be visibly organically enriched with decomposing macrophytes or litter from the riparian forest, or may contain little visible organics. Observations through several seasons showed that microhabitat preference is for the texture of mud, fine sand and detritus, which is prevalent in the dry season when water levels decrease and lentic conditions prevail. Depths range from the littoral (Roback, 1966) to mid-river at 3m. With a maximum density of 4,570 larvae per m^2, *F. desiccatum* may be either the dominant benthic chironomid or share dominance with *Polypedilum* spp.

The two Australian sites are superficially rather dissimilar: on Fraser Island, Lake Boomanjin is one of the largest perched (elevated above the water table) lakes in the world, with highly dystrophic, claret-colored water of low conductivity (95 $\mu S.cm^{-1}$) and low pH (3.5-3.6). The second site, from which a series of larvae was collected, is lightly colored, gently flowing, about 12-15m wide and several metres deep, in a Yarra River pool disturbed by swimmers in the summer. However, in both locations the Australian larvae occurred at depths of approximately 1 metre in a fine organic film overlying coarser substrates (Pettigrove, 1988).

DESICCATION

Larvae of *Fissimentum desiccatum* typically burrow into the sediments, where flimsy silk galleries are formed. When these sediments are dried in the laboratory until cracks form, larval *F. desiccatum* tolerate desiccation and revive when rehydrated. This ability seems to be related to the distinctive, cellophane-like, unwettable larval cuticle. In further testing of this phenomenon (by Nolte), larvae were placed in water-filled petri dishes containing 5-7mm of sediment which were allowed to dry. The duration of exposure to desiccation was calculated from the time of loss of visible free water to the time of refilling of the petri dish with water. In the first trial, following three days of dry conditions, pupation and subsequent successful female emergence took place within 36h of rehydration. In a second trial involving several successive desiccations and rehydrations, an initial drying of three larvae for 11h was followed by completely successful overnight rehydration. These revived larvae were then subjected to different treatments: one was completely dried for 2d - upon rehydration, pupation and the female adult emergence took place within 16h; the two remaining larvae were dried for 36h, rehydrated for 10h, desiccated again for 3d - upon rehydration, pupation and male adult emergence took place within 19h.

Studies of *Polypedilum vanderplancki* Hinton have allowed good understanding of desiccation in larval Chironomidae (Hinton, 1951, 1960a, b). However, this spectacular example of cryptobiosis (loss of all body water and cessation of metabolism) probably is unique and is not repeated in other desiccation-tolerant chironomids. In most other species studied, larval cocoon formation is the prevailing mode of survival of drying (Jones, 1975; Grodhaus, 1980; Pinder, 1994). On the evidence available, *Fissimentum desiccatum* does not form a cocoon but may limit water loss through a less permeable cuticle.

SYSTEMATICS

In the Holarctic keys to adult males (Cranston *et al.*, 1989) *Fissimentum* keys with some difficulty into genera close to *Tribelos*, differing particularly in the absence of pulvilli. When Holarctic genera with adults lacking pulvilli are considered, then *Apedilum* and *Paralauterborniella* enter into consideration, but both these genera lack squamal setae and have the fore tibial spur truncate. Never the less, these genera share some larval features with *Fissimentum*, notably the six segmented antennae bearing alternate Lauterborn organs. Looking more widely for resemblance among Chironomini, *Fissimentum* keys in Sæther (1977) to the Australian endemic monotypic genus *Paraborniella*, which lacks pulvilli, has a single spur on comb, and a larva that belongs in the 6 segmented grouping, but the fore tibial spur of this taxon is very flat, and the female genitalia differ strongly. Ignoring the absence of pulvilli, *Polypedilum* is a candidate, but this is refuted by the immature stages, both pupa and larva.

Features of the pupa are predominantly uninformative of relationships, with those few Holarctic Chironomini taxa that lack frontal setae (such as *Robackia*) eliminated on other grounds.

In view of this uncertainty, data matrices comprising character states scored from all life history stages of 50 genera of Chironomini have been combined and analyzed using the criterion of parsimony, following the rationale of Cranston (1994), with *Pseudochironomus* and *Riethia* (Pseudochironomini) chosen as outgroups. The results show *Fissimentum* postulated to be the sister group to *Imparipecten* Freeman, a taxon whose full description is in press (Cranston and Hardwick, 1996). These two are closely related to *Conochironomus* Freeman (Cranston and Hare, 1995) and *Skusella* Freeman and more distantly to the genera centered on *Stictochironomus* and *Paratendipes*. This monophyletic generic grouping is supported almost entirely by the six-segmented larval antenna, with all supportive characters from the pupa and adults being highly homoplasious. Provisionally this placement is accepted, pending incorporation of further taxa from the six-segmented larval antenna group, thereby allowing phylogenetic analysis with species treated as terminals (rather than a *priori* determined genera, as at present).

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LIFE HISTORY OF THE WEEVIL *EUHRYCHIOPSIS LECONTEI*, A POTENTIAL BIOLOGICAL CONTROL AGENT OF EURASIAN WATERMILFOIL[1]

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ABSTRACT: We followed weevil life history in the lab and phenology in the field. In lab cultures, weevils progressed from eggs to adults in approximately 30 days. Females laid an average of 1.9 eggs per day; hatching success was 87%. In a Vermont lake, weevil adults and eggs were first found in late May. Thereafter there was a cyclic series of peaks in weevil stage abundance; there appeared to be three generations of weevils each summer in Vermont. This weevil is being evaluated as a possible agent of biological control.

Euhrychiopsis lecontei (Dietz) (Colonnelli 1986), a North American aquatic weevil, has potential as an agent of biological control for Eurasian watermilfoil [*Myriophyllum spicatum* (L.)]. Eurasian watermilfoil is a nuisance weed found throughout North America (Couch and Nelson 1986). In laboratory and field trials the weevil had a significant negative effect on Eurasian watermilfoil (Creed and Sheldon 1993), but not on native plants (Sheldon and Creed 1995). In the field in two lakes without weevils, when enclosed with weevils Eurasian watermilfoil did not increase in biomass over the growing season and by the end collapsed, contrary to control plants in enclosures without weevils (Sheldon and Creed 1995). In another lake, weevils were associated with an extensive decline of Eurasian watermilfoil (Creed and Sheldon 1995).

This native weevil is feeding on an exotic plant. Prior to the introduction of Eurasian watermilfoil the weevil most likely fed on native *Myriophyllum*s. In Alberta, Canada where Eurasian watermilfoil has not been found, *E. lecontei* was found on northern watermilfoil, *Myriophyllum sibiricum* Komarov (= *exalbescens* Fernald) (Creed and Sheldon 1994).

The life history and phenology of this potentially important weevil has not previously been documented.

METHODS

To follow the life history *E. lecontei* we set up growth chambers in a controlled lab setting. We collected < 30 cm long Eurasian watermilfoil stems

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from local Vermont lakes and planted them into cups of autoclaved lake sediment then enclosed each in a clear, cylindrical polycarbonate chamber (30 cm long, 6 cm inside diameter). Each chamber was capped with a lid of 202 µm Nitex mesh. The chambers were set in aquaria filled with aerated tap water. Each chamber was also individually aerated. Chambers were housed in a light room, illuminated by artificial light under a 16 h light : 8 h dark regime. Water temperatures ranged from 21.5 - 24.0 °C.

Adult *E. lecontei* were collected from *M. spicatum* and placed in the chambers. Within 24 hours after an egg was laid on an Eurasian watermilfoil plant, we transferred the plant and egg into a new chamber, and examined the egg daily until hatching. Each newly hatched larva was transferred to the meristem of an undamaged Eurasian watermilfoil plant in a chamber. Plants were added to the chambers, usually every second or third day, when the plants in the chambers had extensive apical damage. Late instar larvae formed pupal chambers inside plant stems. Plants were handled often, and many stems containing pupae broke.

Because the repeated handling could have affected pupal duration in the lab, we also looked at pupal duration in the field. We put late instar larvae on *M. spicatum* stems rooted in sediment in a local lake. The larvae and a portion of the plant stem were enclosed in a polycarbonate cylinder (30 cm by 4 cm diameter). The ends of the chambers were capped with foam to prevent weevil escape and allow air exchange. The dates of initiation of pupal phase and adult emergence were recorded.

In the lab, each newly emerged adult was removed from its chamber. Weevil sex could be determined by the shape of the pygidium: flat (female) or knobbed (male) (C. O'Brien, Florida A. and M. University, Tallahassee Florida, personal communication). For quantification of the lifetime egg production by a female, we placed each newly emerged female in a chamber with two males and from three to six *M. spicatum* stems with intact meristems. Plants were replaced when there was extensive feeding damage or there were many (>5) eggs per meristem. Dead males were replaced. The number of eggs each female laid was recorded every 3-4 days until she died.

To see whether weevils could survive on a different genetic stock of Eurasian watermilfoil we set up a batch culture in the lab. Weevils were placed in an aquarium containing *M. spicatum* collected from Lake Minnetonka, Minnesota, USA. The Eurasian watermilfoil in Lake Minnetonka is gentically different from Vermont Eurasian watermilfoil (G. R. Furnier, University of Minnesota, St. Paul MN, personal communication).

To determine if weevils could live on native watermilfoil, weevils were collected from *M. spicatum*, and placed in an aquarium with the native northern watermilfoil, *Myriophyllum sibiricum*. We followed both of these cultures qualitatively, noting adult survival, deposition of eggs on plants, and evidence of tunneling damage by weevil larvae.

E. lecontei phenology was followed in Lake Bomoseen, VT during the summers of 1991-1994. At three sites, transect lines were set up running perpendicular to the shore. On each transect, the upper 40 cm of 10 plants were collected. Plants were taken at regular intervals over the transect line, and three lines were run at each site; n = 90 stems per date. Plants were examined under a dissecting microscope; all weevils were removed and counted. In 1991 collection started in early July. In 1992, and subsequent years, samples were started in April, with weevils first being collected in mid-May. *M. spicatum* apical shoots were collected weekly from in 1991 and 1992, and every third week in 1993 and 1994.

RESULTS AND DISCUSSION

In the laboratory, eggs were laid on apical meristems. Eggs were elliptical, approximately 0.52 (± 0.06, mean ± SE) mm long and 0.39 (± 0.05) mm wide (n = 36). First instar larvae fed on meristematic tissue for 3-5 days. Later instar larvae spent most of their time inside the stem, resulting in a hollowed-out stem. Sometimes, particularly when larvae reached the end of an internode, larvae burrowed out, spiraled across the outside of a stem to a new internode, then burrowed back into the stem. Larvae were usually found in the top third of the plant. Late instar larvae were up to 4.5 mm long. Puparia were formed inside the stem and tended to be found further down in thicker (> 4 mm) portions of the stem. Adults were small, typically between 2 and 3 mm (2.85 ± 0.88 mm, n = 35) from the anterior edge of the eye to posterior end of the pygidium, and were usually found on the top third of the plants, where they fed on both leaves and stem tissue. In the lab, all of the life history stages took place entirely under water.

Under these laboratory conditions with temperature ranging from 21.5 to 24°C), the duration of the egg phase was 3.9 (± 0.2, n = 48) days. Larval duration averaged 13.0 (± 1.8, n = 9) days. Pupal duration in the lab averaged 13.0 (± 1.5, n = 5) days. The sum of these values suggests that the average time between egg deposition and emergence as an adult is approximately 30 days. Mean pupal duration on rooted plants in the field was 9.6 (± 1.2, n = 24) days, reducing the estimate from egg to egg as 26 days.

Because it was difficult to get weevils through the pupal phase, we had only 7 unmated females for which we knew the date of emergence. Total egg production for these females ranged from 3 to 562 eggs per female with a mean of 1.9 (± 0.4) eggs laid per female per day. Eggs were preferentially laid on the apical meristem. If eggs were already present on the apical meristem, eggs were often laid on the uppermost lateral meristems or on leaves near the plant apex. Hatching rate of eggs was 87.3%. Normally a few eggs were laid on each meristem in a chamber, however in a concurrent experiment under similar conditions, when weevils were enclosed with few plants, we found as many as 29 eggs on a single plant. In the lab, female length of life as an adult ranged from 11 to 162 days.

For the batch culture of weevils with *M. spicatum* from Minnesota, larvae and adult weevils from Vermont fed on the Minnesota plants, and eggs were laid and hatched. In the batch cultures of the native watermilfoil *M. sibiricum*, adults fed on the plants and eggs were laid. Qualitatively, there were fewer adults generated from the native watermilfoil batch cultures than from Eurasian watermilfoil from Minnesota.

The life history data collected in the laboratory are consistent with our observations of *E. lecontei* phenology in the field (1991-1994); time from egg to egg was about 26 days, which could yield three generations of weevils each summer. In Lake Bomoseen there appear to be three generations of weevils each summer. The abundance of each life stage was cyclic (Figure 1). In the spring the first weevils collected were adults, then eggs. Peaks in egg abundance were followed by increased larval densities, followed by peaks in the abundance of pupae and adults. Thus, although the sample sizes were low in some cases for quantifying length of life history stage, the prediction for duration from egg to egg from lab data was 26 days, similar to what we found in Lake Bomoseen.

In September, densities of weevil eggs declined, followed by a decline of larvae, then pupae, then adults. Thereafter no weevils were found in the lake. Adults appear to overwinter terrestrially in leaf litter along lake margins (C. O'Brien, Florida A. and M. University, Tallahassee Florida, personal communication). Adults have been collected in sweeps of shoreline vegetation in the fall (David Ragsdale, University of Minnesota, St. Paul MN, personal communication). We found one adult weevil in terrestrial soil samples collected in October, five meters inland from the edge of Lake Bomoseen.

The patterns of egg laying and adult and larvae location in the field, were also consistent with the lab studies. Weevil eggs were found primarily on the apical or other meristems nearest to the water surface. If there were few meristems available, eggs were found on any meristem, or apical leaves. Larvae were usually found in the top meter of the plant. Pupae were typically found further down the stem (>0.5 m) where the stem is thicker (> 4 mm). Adults were usually found on the top one meter of plant.

The current range of the weevil in North America is not well known. *E. lecontei* previously had been found in Iowa, Michigan, Wisconsin, Alberta, British Columbia, and Saskatchewan (O'Brien and Wibmer 1982). We have found weevils in Connecticut, Massachusetts, New York, and Vermont. *E. lecontei* have also been found in Minnesota (Newman and Maher 1995) and they have recently been collected in Illinois (M. Pfister, Lake County Health Department, Chicago, IL, personal communication). Creed found weevils on northern watermilfoil, *M. sibiricum*, in western Washington (Creed and Sheldon 1994).

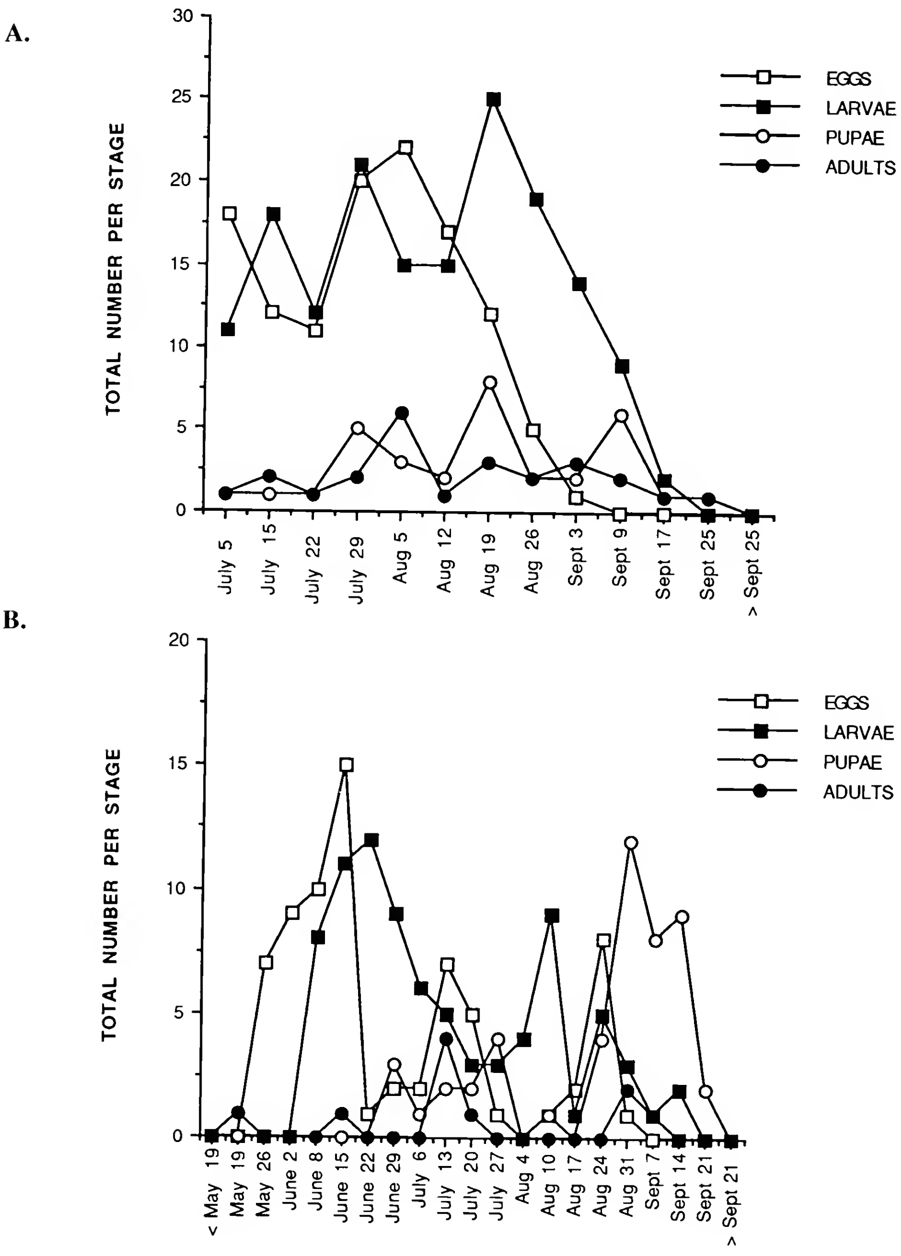

Figure 1. Phenology of weevil life history stages in a Vermont lake. Data are from A. 1991 and B. 1992. Patterns of frequency of life history stages were similar in 1993 and 1994.

E. lecontei may be a suitable agent for the biological control of Eurasian watermilfoil. Weevils have a significant negative effect on *M. spicatum*. At the same time, weevils did not have a significant impact on native plant species (Sheldon and Creed 1995). Other insects found in North America have been evaluated as potential biological controls for Eurasian watermilfoil including a moth [*Acentria ephemerella* (Dennis & Schiffermüller; Painter and McCabe 1988)], another weevil (*Phytobius leucogaster* Marsham; Buckingham and Bennett 1981), and a midge (*Cricotopus myriophylli* (Oliver; Kangasniemi and Oliver 1983, MacRae *et al.* 1990, Kangasniemi *et al.* 1993). *E. lecontei* may be a more effective biological control agent because they have a relatively long lived feeding adult phase, unlike *A. ephemerella* (Buckingham and Ross 1981) and *C. myriophylli* Kangasniemi *et al.* 1993) facilitating culturing; they are specific to *Myriophyllums* unlike *A. ephemerella* (Buckingham and Ross 1981), their phenology is well timed, unlike *C. myriophylli* (Kangasniemi *et al.* 1993); and *E. lecontei* causes significant damage to the apical submersed portion of the plants, unlike *P. leucogaster* which feed primarily on flowers (Buckingham and Bennett 1981).

If *E. lecontei* is used as a biological control agent, it should be noted that all life history stages remain in the apical portion of the plants. Aquatic weed harvesting, a common control technique for Eurasian watermilfoil, removes the top 1-2 m of the plants.

While use of a native insect for biological control of an exotic plant is unusual, it may prove efficient and pose fewer potential drawbacks than introducing an exotic biological control agent. *M. spicatum* has a similar life history and phenology as native watermilfoils. Presumably this native weevil is coevolved with the native watermilfoils, which decreases the probability of damage to non-target plant species. The weevil coexists with *M. sibiricum* in both the United States and Canada.

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CENTRAL AMERICAN *TORTOPUS* (EPHEMEROPTERA: POLYMITARCYIDAE): A UNIQUE NEW SPECIES AND NEW COUNTRY RECORDS[1,2]

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ABSTRACT: *Tortopus bellus*, new species, from Costa Rica is described on the basis of the male adult. The species is distinguished by its basally fused penes, undeveloped parastyli, and general abdominal coloration. *Tortopus unguiculatus*, previously known in Central America from Costa Rica and Nicaragua, is newly reported from Guatemala and Honduras.

The Pan-American mayfly genus *Tortopus* Needham and Murphy (Polymitarcyidae) is known from 11 described species. Seven are from South America (Hubbard and Peters 1981, Domínguez 1985, Hubbard *et al.* 1992), three from North America (McCafferty 1975, 1994; Edmunds *et al.* 1976), and one from South and Central America (Maés 1988, McCafferty and Lugo-Ortiz 1992). Only the North American *T. incertus* (Traver) is known from larvae and male and female adults (McCafferty 1975, 1994; Edmunds *et al.* 1976). Of the other described species, three are known from male adults, four from female adults, and two from male and female adults (Traver 1950, Edmunds *et al.* 1976, Hubbard *et al.* 1992). Ulmer (1932, 1942) and Traver (1950) provided taxonomic treatments of the adults of the genus. Scott *et al.* (1959) described the larval stage and its habitat. McCafferty (1975) provided a provisional species key to the larvae in North America based on geographic distribution. Until more associations of sexes and of larvae and adults are performed the taxonomy of the genus will remain problematic.

Tortopus is a sister lineage of the Pan-American genus *Campsurus* Eaton (McCafferty 1991), and they are very similar in both the larval and adult stages. Larvae of *Tortopus* can be distinguished by the presence of a single subapical tubercle on the medial margin of the mandibular tusks, and the adults by the presence of genital parastyli (males) and parastyli receptors (females) and shriveled and stringlike mid- and hindlegs [see Edmunds *et al.* (1976): Figs. 33, 206, 207, and 349; McCafferty and Bloodgood (1979): Figs. 1-9]. Larvae of *Campsurus* possess prominent basal and subbasal tubercles on the medial margin of the mandibular tusks, and adults lack genital parastyli

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and parastyli receptors and have highly atrophied, short, flattened mid- and hindlegs [see Edmunds *et al.* (1976): Figs. 350 and 351].

McCafferty *et al.* (1992) hypothesized that *Tortopus* has a Neotropical center of origin based on its close relationship with *Campsurus.* They indicated that the restriction of *Tortopus* to the east in North America was atypical of other Pan-American genera in North America. *Tortopus* evidently penetrated the Nearctic via the maritime corridor of the Gulf of Mexico rather than via the mountainous corridors used by western genera. The genus appears to be warm-water sublimited, but it is also humid restricted (McCafferty 1975, McCafferty *et al.* 1992).

Only *T. unguiculatus* (Ulmer) has been reported from Central America (Maés 1988). We herein describe a new species from Costa Rica and provide new distributional records for *T. unguiculatus.* The materials studied are housed in the Purdue Entomological Research Collection, West Lafayette, Indiana.

Tortopus bellus Lugo-Ortiz and McCafferty, NEW SPECIES

Figs. 1-2

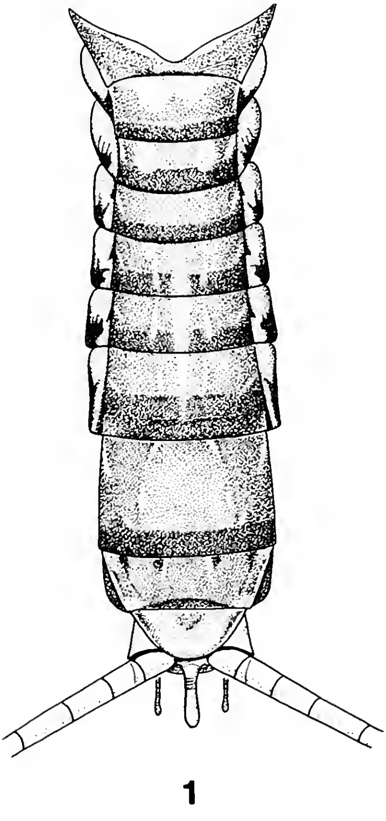
Male adult. Body length: 8.3 mm; wing: 10.5 mm; caudal filaments: 28.0 mm. Head: Dorsal surface heavily suffused with purplish gray dots anteriorly, light brown to pale posteriorly, light brown ventrally. Ocellar bases black. Scapes stippled with purplish gray dots, inner sides pale; pedicels entirely suffused with purplish gray dots; flagella pale. Thorax: Pronotum purplish gray anteriorly and posteriorly; heavily suffused with purplish gray dots medially, becoming pale brown laterally; thin pale dorsal median line present. Prosternum pale brown and suffused with purplish gray dots. Mesonotum light brown, posteriorly suffused with purplish gray dots. Mesosternum heavily suffused with purplish gray dots submedially. Metanotum pale brown, heavily suffused with purplish gray dots medially. Region between costal and subcostal veins in forewings lightly suffused with purplish gray from base to middle of wing. Legs suffused with purplish gray dots; foretibiae almost black. Abdomen (Fig. 1): Tergum 1 purplish gray and very narrow; terga 2-7 anteriorly pale, becoming heavily suffused with purplish gray dots posteriorly and laterally, and with oblique pale sublateral dashes; terga 8-9 purplish gray, tergum 8 almost twice length of any tergum between terga 2-7; tergum 10 lightly suffused with purplish gray dots. Prominent pleural folds on segments 2-7, suffused with purplish gray dots and marginally pale. Sternal coloration as in terga, except lighter and marginally pale on sterna 2-7. Genitalia (Fig. 2) with bladelike penes, narrowly sclerotized along lateral margin, and basally fused; styli purplish gray, clublike, with very small spines along interior margin, spination becoming more dense distally and forming terminal pad [see McCafferty and Bloodgood (1989): Figs. 3-4]; parastyli undeveloped. Caudal filaments pale; terminal filament appearing 4-segmented, clublike, suffused with purplish gray dots; cerci very long, with tuft of fine setae distally.

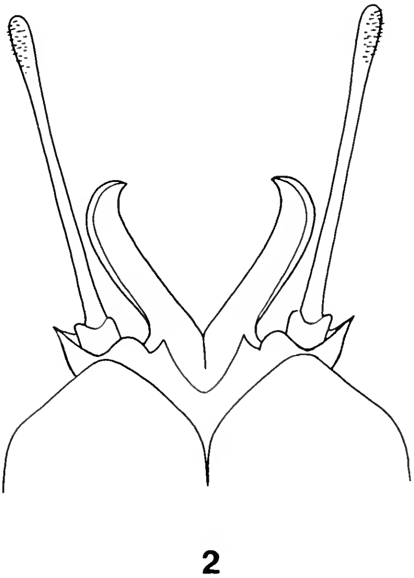
Female adult. Unknown.

Larva. Unknown

Material examined. Holotype: Male adult, COSTA RICA, Heredia Prov., light trap, rain forest, VIII-24-1987, D. Brigham.

Etymology. The specific epithet is a Latin word meaning beautiful.





Figs. 1-2. *Tortopus bellus*, NEW SPECIES, male adult: 1. Abdomen (dorsal). 2. Genitalia (ventral).

DISCUSSION

Tortopus bellus can be distinguished from other members of the genus by its unique abdominal coloration (Fig. 1), basally fused penes, and undeveloped parastyli (Fig. 2).

McCafferty and Bloodgood (1989) indicated that the parastyli probably function as holding structures during copulation. However, the undeveloped nature of these appendages in *T. bellus* suggests that they could not function in holding the female during copulation, and it is possible that they are vestigial in this species. If this is indeed the case, we expect the female of *T. bellus* to have a reduced or no parastyli receptors on abdominal segment 8 [see McCafferty and Bloodgood (1989): Figs. 6-9], a condition which has not been documented in any of the species known from females only.

The undeveloped nature of the parastyli of *T. bellus* may alternatively indicate a primordial condition of a primitive species of *Tortopus*. All other species of *Tortopus* known from males possess elongate parastyli [see Edmunds *et al.* (1976): Figs. 206 and 207], but the undeveloped nature of the parastyli in *T. bellus* is more reminiscent of the condition found in *Campsurus*.

Tortopus unguiculatus (Ulmer)

Material examined. GUATEMALA, Río Polochic, III-22-1906, male adults; Panzos, IV-1905, male and female adults. HONDURAS, Gracias a Dios Prov., Río Sigre, III-24-29-1952, R Greenfield, male adult.

DISCUSSION

Tortopus unguiculatus was previously reported from Costa Rica (Ulmer 1942) and Nicaragua (Maés 1988). The new records provided herein extend its known range northward. The species probably also occurs in Panama, since it has been reported from Colombia (Ulmer 1920).

Ulmer (1920) originally described this species from male adults. Later, Ulmer (1942) described the female adults. Its larvae, however, remain unknown. Ulmer (1942) indicated that until the male adults of *T. igaranus* Needham and Murphy are known, the species status of *T. unguiculatus* should be regarded as tentative.

ACKNOWLEDGEMENTS

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A NEW SPECIES OF *NADLERIA* (PSOCOPTERA: LACHESILLIDAE) FROM THE TAMBOPATA RESERVED ZONE, MADRE DE DIOS, PERU[1]

Alfonso Neri García Aldrete[2]

ABSTRACT: A new species of *Nadleria* from the western edge of the Amazon Basin, in southeastern Peru, is here described. It is close to *N. mockfordi* and it is the second species of the genus known from both sexes; the male of the new species can be separated from the male of *N. gamma* on details of terminalia, particularly of the epiproct, clunium and phallosome. The types are deposited in the Smithsonian Institution, Washington, D.C.

RESUMEN: Se describe aquí una nueva especie de *Nadleria* de la Zona Reservada de Tambopata, en la Amazonia Peruana. La nueva especie es cercana a *N. mockfordi* y es la segunda especie del género de la que se conocen los dos sexos; el macho de la nueva especie puede separarse del macho de *N. gamma* en detalles genitales, particularmente del epiprocto, clunio y falosoma. Los tipos de la nueva especie están depositados en el Smithsonian Institution, de Washington, D.C., U.S.A.

The three known species of the psocid genus *Nadleria* (*N. alpha* Badonnel and García Aldrete, *N. mockfordi* Badonnel and García Aldrete, and *N. gamma* Mockford), are virtually restricted to the Amazon Basin; only the former occurs outside of this area, in Trinidad (Badonnel and García Aldrete, 1979, 1980; Mockford, 1985). The purpose of this paper is to describe an additional species of *Nadleria* from the southwestern edge of the Amazon Basin, in the Tambopata Reserved Zone, Perú. The specimens studied were collected by the team that conducted the Smithsonian Institution Canopy Fogging Project headed by Dr. Terry L. Erwin. For details of the collecting technique and about the area see Erwin, 1983, 1984, and 1989. The specimens for microscopic study were dissected in 80% alcohol and the head, right wings and legs, and terminalia were permanently mounted, either in Euparal or in Balsam of Canada. The measurements are in microns and were taken with a filar micrometer whose measuring unit was 1.36 microns for wings and 0.53 microns for other parts. The following abbreviations are used for parts measured: FW: fore wing length; HW: hind wing length; F, T, t1, t2: length of femur, tibia and tarsomeres of right hind leg; ctt1: number of ctenidia on t1; P4: length of fourth maxillary palpomere; f1...fn: length of antennal flagellomeres; IO:

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minimum distance between compound eyes; D: antero-posterior diameter of compound eye; d: transverse diameter of compound eye: PO= d/D (IO, D and d, measured in frontal view of head mounted on slide.). Other abbreviations: M= male, F= female. The types of the species here described will be deposited in the Smithsonian Institution Collection, Washington, D.C.

Nadleria mariateresae García Aldrete, NEW SPECIES

Figs. 1 - 9

FEMALE. Color (in 80% alcohol). Body reddish brown. Compound eyes black, ocelli clear, with well developed, ochre centripetal crescents. Antennae and legs pale brown, areas next to dorsal articulations of coxae reddish brown, much more pigmented than rest of the leg. Fore wings with large, cloudy brown area covering proximal half of the wing; hind wings hyaline, with slight brown wash along anterior wing margin, from wing base to end of vein R1, fading posteriorly. Abdomen pale brown, with small, transverse sclerites on segments 2-7.

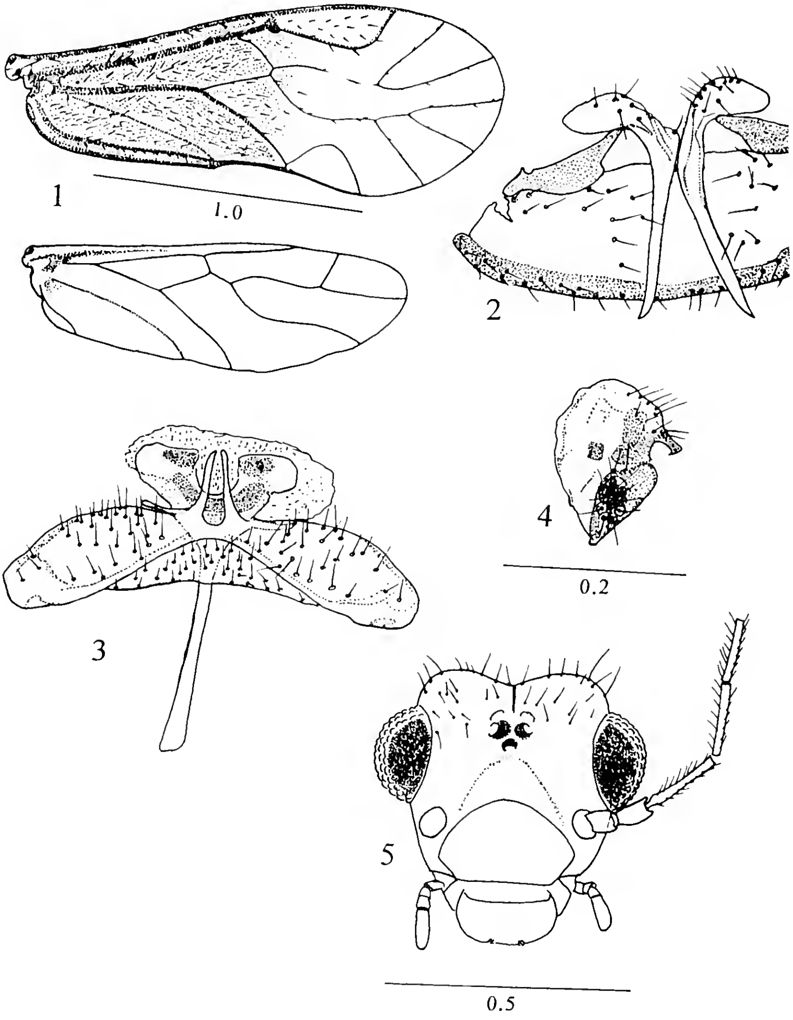
Morphology. Vertex of head extended above compound eyes, impressed in the middle; ocelli close together. Fore wing with extensive ciliation in the membrane of the pigmented proximal half; veins ciliated, except along Cu2. Hind wing lacking ciliation. Hind tibiae with row of ctenidobothria along median margin reaching distal end; these ctenidobothria not perpendicular to longitudinal axis of tibia. Subgenital plate (Fig. 9), wide, setose, with median lobe slightly projected posteriorly; pigmented area deeply cleft anteriorly, without macrosetae, and with a small, slender, hyaline area in apex of median lobe. Gonapophyses (Fig. 6) slender at base, each with a large pre-apical bulge, ending in a small conical apophysis. Ninth sternum (Fig. 6) with a large, distinct, pigmented transverse area as illustrated. Paraprocts (Fig. 7) elongate, semi-elliptical; sensoria with 11 - 12 trichobothria, one, on outer edge, without basal rosette; setae and pigmented area as illustrated. Epiproct (Fig. 8) straight anteriorly, rounded posteriorly, with setal field towards posterior margin, 4 setae much longer than the others, disposed as illustrated.

Measurements. FW: 1743; HW: 1343; F: 355; T: 629; t1: 199; t2: 106; ctt1: 14; P4: 87; f1: 155; f2: 128; f3: 112; f4: 92; f5: 58; f6: 60; IO: 337; D: 192; d: 93; IO/D: 1.75; PO: 0.48

MALE. Color (in 80% alcohol). Same as the female.

Morphology. Vertex of head more deeply impressed than that of the female. Hypandrium (Fig. 3) small, triangular, with claspers fused to its sides, each clasper terminating in a straight, finger like projection. Phallosome apodemes fused to form a straight baculum that divides distally, each arm terminating in a pigmented membranous area, these connected by a pigmented U-shaped arch. Clunium (Fig. 2) limited anteriorly by a pigmented area on each side of epiproct, to which each paraproct is articulated. Paraprocts (Fig. 4) with sclerotized, aquiline prong on median margin; areas next to prong and surrounding sensorium strongly sclerotized, a mesal pigmented spot next pigmented areas of prong and sensorium, this with 12 trichobothria, one, on outer edge, without basal rosette. Epiproct (Fig. 2) with two stout, long, acuminate processes, (one shorter than the other in one specimen).

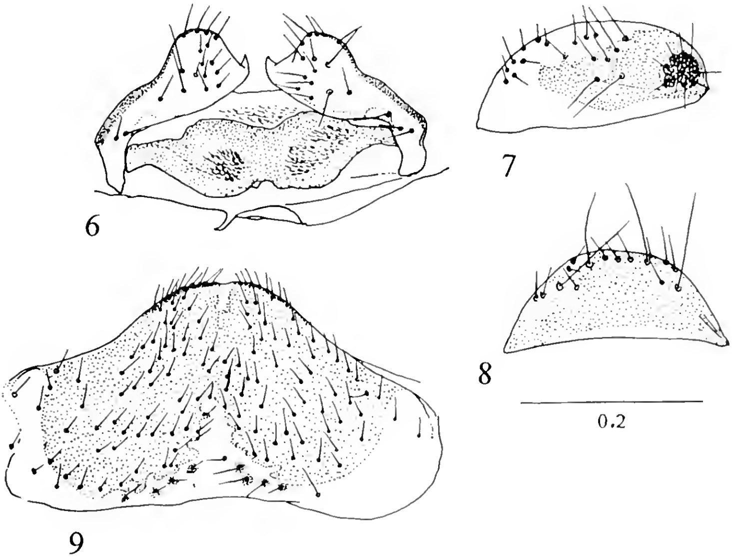
Measurements. FW: 1839; HW: 1388; F: 362; T: 642; t1: 204; t2: 96; ctt1: 15; P4: 91; f1: 181; f2: 143; f3: 123; f4: 94; IO: 332; D: 208; d: 92; IO/D: 1.59; PO: 0.44



Figures 1-5. *Nadleria mariateresae* n. sp. Male. Fig. 1. Fore and hind wings. Fig. 2. Clunium and epiproct. Fig. 3. Hypandrium and phallic apodemes. Fig. 4. Right paraproct. Fig. 5. Frontal view of head. Scales in mm. Figs. 2 and 3 to scale of Fig. 4

TYPE MATERIAL. PERU. Madre de Dios. Río Tambopata Reserved Zone. 30km (air) SW Puerto Maldonado, 290m, 12°50' S: 69° 20' W. 6.1X.1984, holotype M. allotype F, 1 paratype M. 12.XI.1983, 1 paratype M. 25.II. 1984, 1 paratype F. 7.V.1984, 3 paratypes F. T.L. Erwin *et al.* collectors; Smithsonian Institution Canopy Fogging Project. Types deposited in the Smithsonian Institution Collection, Washington, D.C.

The species here described is dedicated to my wife María Teresa, who, in many ways, has contributed to my work.



Figures 6-9. *Nadleria mariateresae* n. sp. Female. Fig. 6. Gonapophyses and ninth sternum. Fig. 7. Right paraproct. Fig. 8. Epiproct. Fig. 9. Subgenital plate. Scale in mm. All figures to the same scale.

With the above description, Mockford's key to the species of *Nadleria* (Mockford, 1985) is modified as follows:

Key to the species of *Nadleria* (Females)

1. Posterior margin of subgenital plate decidedly protruding posteriorly as a rounded lobe; third valvula with apex projecting as a short process beyond a broad lateral bulge 2

1'. Posterior margin of subgenital plate at least slightly depressed between slightly developed lateral lobes, third valvula with a broad, rounded or somewhat tapering apex, lacking a lateral bulge 3

2\. Rounded lobe of subgenital plate narrow, strongly projected posteriorly; several macrosetae on field of pigmented area of subgenital plate; pigmented area on ninth sternum, between third valvulae, with two sclerotized bands on anterior edge, one to each side of longitudinal midline . . . . *N. mockfordi* Badonnel and García Aldrete

2'. Rounded lobe of subgenital plate broad, slightly projected posteriorly; macrosetae on field of pigmented area of subgenital plate not apparent; pigmented area on ninth sternum, between third valvulae, biconcave in the middle, without anterior, sclerotized bands . . . . *N. mariateresae* n. sp.

3\. Subgenital plate only slightly depressed on posterior margin between lateral lobes; third valvula evenly rounded on median margin . . . . *N. alpha* Badonnel and García Aldrete

3'. Subgenital plate decidedly depressed on posterior margin between lateral lobes; third valvula decidedly bulging on median margin near apex . . . . *N. gamma* Mockford

DISCUSSION

On female characters, *N. mariateresae* n. sp. is closer to *N. mockfordi* Badonnel and García Aldrete than to the other two species in the genus; they have in common projected subgenital plates, paraprocts similarly pigmented, and gonapophyses bulging, with apices projecting into short, conical processes. I would predict the structural characters of the male of the latter species to be similar to the male of *N. mariateresae*. This and the male of *N. gamma* can be clearly separated on details of terminalia: in the latter, the phallic apodemes widely diverge posteriorly and the epiproct has a single, short, truncate process. The male terminalia of *N. mariateresae* is strikingly similar to the male terminalia of *Lachesilla* species in the *pedicularia* group, occurring in South America, as discussed by Mockford (1985).

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EFFECTIVENESS OF COMBINING FLOTATION AND STAINING TECHNIQUES WHEN SORTING BENTHIC INVERTEBRATES[1]

Dianne L. Hall[2], Diane L. Wood[3], Daryl L. Moorhead[2], Robert W. Sites[3]

ABSTRACT: Several methods for quickly and precisely separating benthic organisms from collected substrate have been suggested. We tested the effectiveness of using a flotation technique versus a combination of flotation and staining techniques. The flotation method required less time than combining flotation and staining techniques, but failed to adequately recover annelids. Consequently, when knowledge of the contribution to diversity of annelids or other dense invertebrates is required, use of a combination of flotation and staining techniques is advisable.

An important requirement for studying benthic invertebrates is an accurate and efficient method for sorting organisms. Many techniques have been advanced to decrease sorting time while ensuring the retention of captured taxa. Early methods focused on using saturated sucrose solutions as a flotation medium in which benthic invertebrates were separated from substrate by differences in specific gravity (Anderson 1959, Flannagan 1973, Merickel 1978). Residual sediments were then sorted by hand for invertebrates with high specific gravities. More recent studies have suggested using a combination of techniques, mostly flotation (either sucrose or NaCl) and staining (Thorp and Covich 1991, Wetzel and Likens 1991). In our analysis of the benthic fauna of playa lakes, we found a NaCl solution in conjunction with staining to be a superior technique, especially in the recovery of annelids.

MATERIALS AND METHODS

The benthic fauna of ten playa lakes was surveyed with a 2" ID, single-core sampler. Two hundred fifty substrate samples were taken from each lake and immediately preserved with 10% formalin. In the laboratory, each benthic sample was placed in a wash bucket and immersed in a supersaturated NaCl solution. Floating material was collected with a hand strainer and preserved in 80% ethyl alcohol. The remaining (non-floating) benthic material subsequently was removed from the NaCl solution and transferred from the wash

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bucket into a white enamel sorting pan. Tap water was added to the pan until the sediment was covered by a thin layer of water. Approximately one gm of rose bengal stain was added to the sediment and mixed thoroughly. The mixture was allowed to stand for 30 min then returned to the wash bucket where it was thoroughly rinsed with tap water. The washed sediment was then transferred into a clean white enamel pan for sorting by hand.

RESULTS AND DISCUSSION

Retention and removal of collected organisms using the combination of flotation and staining techniques was superior to flotation alone (Table 1). Using the flotation technique alone, one entire family of annelids (Lumbriculidae) was not detected. Moreover, six times as many leeches (Erpobdellidae) were recovered using the flotation/stain combination technique rather than flotation alone. A G-test of independence (Sokal and Rohlf 1981) revealed significant differences (P = 0.009) in families retrieved using the flotation technique versus the flotation/stain technique. However, when the

Table 1. Number of individuals of each family recovered using the flotation method alone versus a combination flotation/staining technique based on 2500 samples divided equally among 10 playas. Alphabetic superscripts denote those families combined for the G-test. Asterisks denote those families whose presence was probably accidental and not used in the G-test.

	Technique	
Benthic Invertebrate Families	**Float alone**	**Float/Stain**
Lumbriculidae^{A}	0	5
Erpobdellidae^{A}	7	41
Planorbidae^{B}	6	22
Carabidae^{C}	1	1
Curculionidae^{D}	7	7
Scarabidae^{C}	3	3
Hydrophilidae^{C}	1	2
Chironomidae^{E}	8	9
Coenagrionidae^{F}	4	4
Aculeata*	1	1
Leptoceridae*	1	1
Caenestheriidae^{G}	2	3
Cyprididae^{G}	1	1

annelids (Lumbriculidae and Erpobdellidae) were removed from the analysis, no significant differences were found between the two techniques (P = 0.333). Therefore, when surveying benthic invertebrates, both flotation and and staining techniques should be used to ensure the detection of all collected organisms. However, if annelids are not a concern, the flotation method is more efficient than the combination technique because substrate staining requires approximately an additional 45 min per sample.

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RECORDS OF *PROPYLEA QUATUORDECIMPUNCTATA* (COLEOPTERA: COCCINELLIDAE) FROM LONG ISLAND, NEW YORK: EVIDENCE FOR A NATURALIZED POPULATION BEFORE 1991[1]

Douglas Yanega[2]

ABSTRACT: Recently published discussions on the distribution and dispersal of the exotic lady beetle *Propylea quatuordecimpunctata* have suggested that it was not established in either New Jersey or southernmost New York (including Long Island) prior to 1991. Earlier introduction attempts in New Jersey were reportedly unsuccessful, and it has been inferred that the beetle eventually arrived on Long Island by migrating in from the north in 1991. I here present collection data and personal observations that suggest that a naturalized population of this species had become established in western Long Island (Queens County) as early as 1989, and propose alternative models of its establishment.

There is a growing literature on the establishment and spread of the exotic aphidophagous coccinellid *Propylea quatuordecimpunctata* (L.) in northeastern North America, with two recent overviews by Wheeler (1990) and Day *et al.* (1994), which discuss much of the history and prior literature. Introductions were attempted, and presumed to have failed, several times in Delaware, New Jersey, and Oklahoma between 1970 and 1989 (Wheeler 1990, 1993, Day *et al.* 1994). Accidental introduction in Quebec by waterway has been repeatedly suggested as the origin of the present North American population, and Dysart (1988) suggested further introductions to facilitate its spread. The first U.S. records were in Vermont in 1984 and 1985 (Dysart 1988).

Along with my thesis research in North Floral Park, Queens County, New York, from 1982-1987, I collected vouchers of any insects I had not previously encountered in the area, and I continue to do so, in an attempt to develop a faunistic list of insects in the area (unpublished data). I made no collections in 1988, but in 1989 I collected a specimen of *P. quatuordecimpunctata* in nearby Nassau Co., and shortly thereafter saw (but did not collect) another specimen in Floral Park (this species is very distinctive in appearance; Gordon 1985). I collected one more specimen the following year in a nearby park, and saw several more individuals in the area. I have seen this species in Queens on an infrequent but regular basis since then. It was not until 1992 that I first recognized its identity, and not until Day *et al.* (1994) appeared in print that I realized the observations were of possible interest. In a brief visit to the area in 1994, *P. quatuordecimpunctata* was in fact the only coccinellid I en-

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[1] Received May 25, 1995. Accepted August 12, 1995

[2] Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, IL 61820

countered, and in 1995, the only other species seen were *Coccinella septempunctata* L. and *Harmonia axyridis* (Pallas), themselves both imported species. The specimens collected are deposited in the Snow Museum, University of Kansas (KU), and the Illinois Natural History Survey (INHS), as follows:

Propylea quatuordecimpunctata: Additional U.S. collection records: NEW YORK: Nassau Co., Roslyn area, 30-VI-1989, D. Yanega (1 specimen, KU); Queens Co., Alley Park [nr. Queens Village], 7-VIII-1990, D. Yanega (1 specimen, KU); Queens Co., Alley Park nr. Queens Village, 28-VI-1995, D. Yanega (1 specimen, INHS); Suffolk Co., East Hampton, Montauk Point St. Pk., 30-VI-1993, D. Yanega (1 specimen, INHS); Suffolk Co., Southard's Pond nr. Babylon Village, 2-VII-1995, D. Yanega (1 specimen, INHS).

DISCUSSION

My collections and observations suggest that a naturalized population of *P. 14-punctata* was present on Long Island as early as 1989. There are a few possible explanations for this, none of which corresponds to the present view of this species' establishment in the eastern U.S. In what I would suggest are decreasing degrees of likelihood, these are: (1) an unintentional introduction event directly via the ports of greater New York, independent of the introductions into Quebec and New Jersey, which remained essentially restricted to Long Island until the Quebec-derived population spread into southern New York (2) part of the natural southward spread from Quebec, placing the leading edge of its advancement two years ahead and 200-300 miles farther south than any other confirmed records have indicated (3) a side-effect of an intentional introduction event into New Jersey, perhaps the program that began in 1989 (Day *et al.* 1994), which failed at the site of introduction but sent successful propagules to nearby Long Island. Any of these alternatives would at least partially invalidate the model proposed by Day *et al.* (1994; their figure 1). Contacts at the American Museum of Natural History and Cornell University in New York report no additional identified specimens from this area over this time period.

ACKNOWLEDGMENTS

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TWO NEW SPECIES OF *DIPLOCENTRUS* (SCORPIONES: DIPLOCENTRIDAE) FROM MEXICO[1]

Debra A. Fritts, W. David Sissom[2]

ABSTRACT: Two new species of the genus *Diplocentrus* from Mexico are described, illustrated, and compared to related taxa and others in their respective geographical areas. *Diplocentrus ferrugineus* occurs in northeastern Mexico in the southern part of Nuevo León, and *D. coylei* is found in southern Mexico in the northwestern part of Guerrero. Two new records for *D. colwelli* in Nuevo León are also reported.

The genus *Diplocentrus* is proving to be one of the most diverse elements of the Mexican and Central American scorpiofauna. Of the thirty species currently recognized as valid, twenty-two have been reported to occur in Mexico. It is evident from ongoing research that many new species remain to be described. This is particularly true for western Mexico, where in certain states no records of the genus exist. Although the diplocentrid fauna of northeastern, central, and southern Mexico (including Yucatan) seems fairly well known, it is clear from closer examination that sampling even in these areas is still largely incomplete. Consequently, it is not possible at this time to provide an accurate estimate of the total number of species in this genus.

It is the purpose here to describe two new forms, one from northeastern Mexico and the other from southern Mexico, based on specimens originating from the American Museum of Natural History (New York), the Louisiana State University Museum of Zoology (Baton Rouge), and the Museum of Comparative Zoology (Harvard University, Cambridge, MA).

Diplocentrus ferrugineus, NEW SPECIES

(Figs. 1-7)

Type Data. - Adult holotype male from 2.7 mi N and 2.4 mi SE La Ascension on La Caballada Rd., Nuevo León, Mexico on 19 July 1975 by E. A. Liner; deposited in the Florida State Collection of Arthropods, Gainesville.

Etymology. - The specific epithet is based on the Latin word, *ferrugineus*, for "rust-colored", which refers to the base coloration of this species.

Distribution. - Known only from southern Nuevo León, Mexico.

Comparative Diagnosis. - Currently, three other species of *Diplocentrus* are known from northeastern Mexico: *D. colwelli* Sissom, *D. diablo* Stockwell & Nilsson, and *D. whitei* (Gervais).

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Diplocentrus colwelli was described from the mountains in the Monterrey area in central Nuevo León (Sissom 1986) and is closely related to the new species. *Diplocentrus ferrugineus* is larger, with adults exceeding 40 mm in length (the 40-mm female paratype is probably subadult); adults of *D. colwelli* are less than 40 mm long (the paratype female reported at 44 mm long is almost certainly referable to *D. ferrugineus*; see "Comments" below). The pedipalp chela palms of male *D. ferrugineus* are weakly reticulate with the reticulations primarily limited to the dorsal face; in *D. colwelli*, both the dorsal and external faces of the palms are strongly reticulate. Morphometric differences in chela proportions between the two species are also conspicuous: In *D. ferrugineus*, the male chela is more slender (chela length/depth ratio is 2.19-2.28, compared to 1.78-1.88) and the chela fingers in both sexes of *D. ferrugineus* are longer (male fixed finger length/carapace length 0.77-0.88 in *D. ferrugineus*, 0.62-0.68 in *D. colwelli*; female ratios 0.65 in *D. ferrugineus*, 0.56 in *D. colwelli*).

Diplocentrus diablo is known from the southeastern Rio Grande Valley in Texas and in neighboring Tamaulipas (Ciudad Camargo) in Mexico (Stockwell & Nilsson 1987). The two species are approximately the same size, but *D. ferrugineus* is light-colored (orange-brown) whereas *D. diablo* is dark brown. *Diplocentrus ferrugineus* further differs from it by having lower pectinal tooth counts (9-11 in males and 8-9 in females, rather than 12-14 and 9-11, respectively) and a higher modal tarsomere II spine formula (5/5: 6/6: 7/7: 7/7-8, rather than 4/4: 4/5: 5/6: 5/6). The male pedipalps are distinctly more slender in *D. ferrugineus*, with chela length/depth ratios of 2.19-2.28 (rather than 1.86-2.00); morphometrics of the female chelae in the two species are similar. Finally, the reticulations on the male chelae are very weak in *D. ferrugineus*, but are pronounced in *D. diablo*.

Of the three species listed above, *Diplocentrus whitei* is the least similar to *D. ferrugineus*. Perhaps the only possible confusion in making identifications could be with juveniles of *D. whitei*. *Diplocentrus whitei* is a large dark species with adult size to about 70 mm. It has higher pectinal tooth counts (16-20 in males and 14-18 in females) and higher tarsomere II spine counts (6/7: 6/8: 7/8: 7/8); neither character exhibits age-specific variation so they will be useful in separating all age groups of the two species.

Description. - Based on holotype male.

Coloration: Base color of dorsum orange brown with faint dusky pattern; metasomal segment V and telson dark orange brown. Pedipalp chela reddish orange proximally, dark orange brown distally with fingers infuscate. Proximal segments of legs yellow brown, tarsi yellow. Venter light yellow brown. Cheliceral manus yellow brown with faint dusky pattern distally; cheliceral teeth dark reddish brown.

Prosoma: Anterior margin of carapace moderately, coarsely granular (Fig. 1); remainder of carapace smooth to finely granular, lustrous. Sternum with single anteromedian seta and eight additional pairs of setae.

Mesosoma: Tergites finely granular, interspersed with sparse coarse granulation posterolaterally. Tergite VII weakly bilobed, moderately granulose posterolaterally. Genital operculum moderately setose throughout; pectinal tooth count 11-11. Sternites III-VI smooth, lustrous, moderately setose. Sternite VII with submedian carinae vestigial, weak, and smooth; lateral carinae weak, smooth.

Metasoma: Segments I-IV: Dorsolateral carinae on I-III moderate to strong, irregularly granulose; on IV moderate, irregularly granular. Lateral supramedian carinae on I-III strong to moderate, irregularly granular; on IV moderate, smooth. Lateral inframedian carinae on I weak, irregularly granular; II-III weak, granular; on IV vestigial, weak, smooth. Ventrolateral carinae on I-II strong, irregularly crenulate; on III moderate, irregularly granular; on IV moderate, slightly granular. Ventral submedian carinae on I-II strong, irregularly crenulate; on III weak, granular; on IV vestigial, weak, smooth. Segment V (Fig. 2): Dorsolateral carinae moderate, slightly granular. Lateromedian carinae vestigial, feeble, smooth. Ventrolateral, ventromedian, and ventral transverse carinae strong, with distinctly enlarged subconical granules. Ratio of segment II length/width = 1.09; III length/width = 1.31; segment V length/width = 2.57.

Telson (Fig. 2): moderately setose.

Chelicerae: Movable finger distinctly shorter than manus length; fixed finger distinctly shorter than manus width.

Pedipalps: Trichobothrial pattern Type C, orthobothriotaxic (Vachon 1974). Femur (Fig. 3): Dorsal and internal faces moderately granular. Dorsointernal carina strong, granulose; ventrointernal carina vestigial, strong, granulose on anterior half; dorsoexternal carina moderate, irregularly granular; ventroexternal carina vestigial, smooth on posterior half. Ratio of femur length/width = 2.52. Patella (Figs. 4-5): Dorsointernal carina strong, smooth; dorsal median carina faint, smooth; dorsoexternal carina weak, smooth; ventroexternal carina moderate, smooth; ventrointernal carina strong, smooth. Internal face with basal tubercle bearing three large granules. Dorsal face faintly, smoothly reticulate. Ratio of patella length/width = 2.62. Chela (Figs. 6-7): Dorsal marginal carina strong, irregularly granular; dorsal secondary carina weak, smooth; digital carina strong, smooth; external secondary carina moderate, smooth; ventral external carina vestigial, weak at movable finger condyle, smooth; ventromedian carina strong, smooth; dorsointernal carina weak, smooth basally with a few granules by fixed finger; ventrointernal and internal secondary carinae moderate, smooth. Dorsal face of manus feebly, smoothly reticulate. Ratio of chela length/depth = 2.24; of fixed finger length/carapace length = 0.88; movable finger length/chela depth = 1.60.

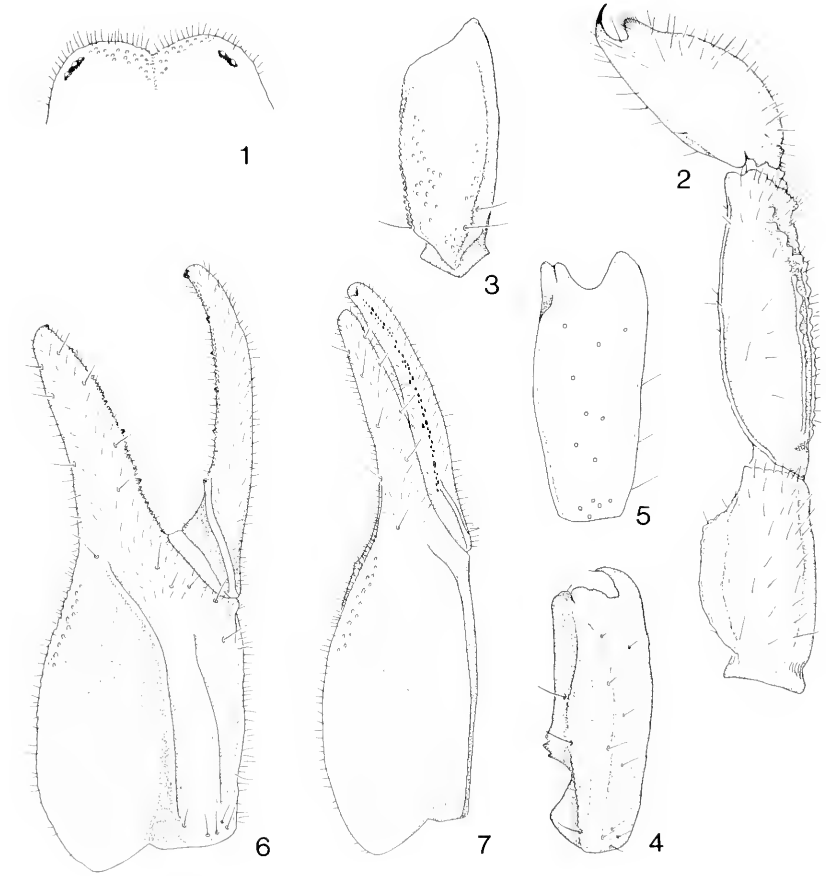
Legs: Tarsomere II spine formula 5/5 3/3: 6/7 5/6: 7/7 7/7: 7/7 7/7.

Variation. - The other males are about 10% smaller than the holotype in various body dimensions, but otherwise do not differ significantly. The female is similar to the male except in the following characters: (1) the metasomal and pedipalpal segments are proportionately shorter (Table 1); (2) metasomal inframedian carinae are stronger; (3) the carinae of the pedipalp chelae are weak to obsolete, and their dorsal faces bear only faint reticulations; and (4) the pectinal tooth counts are lower (see below). As is typical of *Diplocentrus* spp., the young specimens are uniformly pale yellowish in coloration and have rudimentary carination.

Variation in pectinal tooth counts is as follows: in males there were three pectines with 11 teeth, two with 10 teeth, and one with nine teeth; in females there were two pectines with nine teeth and two with eight. Morphometric variation is summarized in Table 1, and variation in tarsomere II spine formulas is presented in Table 2.

Measurements. - Holotype male (in mm): Total L, 46.4; carapace L, 5.8; mesosoma L, 14.4; metasoma L, 21.0; telson L, 5.2. Metasomal segments: I L/W, 3.2/3.4; II L/W, 3.6/3.3; III L/W, 3.8/2.9; IV L/W, 4.5/2.7; V L/W, 5.9/2.3. Telson: vesicle L/W/D, 4.2/2.3/2.0; aculeus L, 1.0. Pedipalps: femur L/W, 5.3/2.1; patella L/W, 5.5/2.1; chela L/W/D, 10.1/2.8/4.5; fixed finger L, 5.1; movable finger L, 7.2.

Paratype female (in mm): Total L, 40.0; carapace L, 5.5; mesosoma L, 13.5; metasoma L, 16.6; telson L, 4.4. Metasomal segments: I L/W, 2.5/3.2; II L/W, 2.8/2.8; III L/W, 3.0/2.8; IV L/W, 3.6/2.7; V L/W, 4.7/2.3. Telson: vesicle L/W/D, 3.5/2.5/1.9; aculeus L, 0.9. Pedipalps: femur L/W, 4.0/1.8; patella L/W, 4.1/1.9; chela L/W/D, 8.7/3.1/4.3; fixed finger L, 3.6; movable finger L, 5.2.



Figs. 1-7. Morphology of *Diplocentrus ferrugineus*, new species. All figures are of holotype male. 1, anterior portion of carapace, dorsal aspect; 2, lateral aspect of metasomal segments IV, V, and telson; 3, dorsal aspect of pedipalp femur; 4, dorsal aspect of pedipalp patella; 5, external aspect of pedipalp patella; 6, external aspect of pedipalp chela; 7, dorsal aspect of pedipalp chela..

Comments. - The paratype female of *D. colwelli* from Cerro Potosí in southern Nuevo León is almost certainly referable instead to *D. ferrugineus*. Unfortunately, the specimen could not be located in the California Academy of Sciences (D. Ubick, personal communication), where it was presumably deposited, so it could not be reexamined. In the description of *D. colwelli* (Sissom 1986), it was noted that the Cerro Potosí female, at 44 mm, was larger than the other adult female of *D. colwelli* and that the dorsal margin of its pedipalp chela was virtually smooth (not granulose). These characters are consistent with female characters in *D. ferrugineus*, based on information available from the single subadult specimen studied herein. Morphometrically, the Cerro Potosí female is closer to *D. ferrugineus* as well, particularly in the following ratios: Chela length/depth = 1.96 (reported as chela length/width in Sissom 1986) and fixed finger length/carapace length = 0.64. Although tarsomere II spine counts overlap in the two species, the specimen's count is very near the modal count for *D. ferrugineus*, but is at the upper end of the range for *D. colwelli*. Finally, Cerro Potosí is located in south central Nuevo León very near the localities from which *D. ferrugineus* was taken.

In the course of studying *Diplocentrus* material from Nuevo León, two new records of *D. colwelli* were found. Two females and a very young specimen from Cienega de Flores were taken on 14 June 1941 by H. Dybas; these specimens are deposited in the Field Museum of Natural History, Chicago. A male and two females were also taken 3 mi N Galeana on Rayones Road on 23 July 1975 by E. A. Liner, *et al.*; these specimens are in the Florida State Collection of Arthropods.

Specimens Examined. - MEXICO: Nuevo León, 2.7 mi N and 2.4 mi SE La Ascension on La Caballada Rd., 19 July 1975 (E. A. Liner), 1 holotype male, 1 paratype male, 1 adult? female, 2 juv. females (FSCA); 3 mi N General Ignacio Zaragoza, 19 July 1974 (E. A. Liner, *et al.*), 1 male (FSCA); 1-3.3 mi N General Ignacio Zaragoza, 20 July 1975 (E. A. Liner), 3 juvs. in three vials (FSCA); 0.6 mi S Poterio Prieto in Arroyo Mesquital, 16 July 1974 (E. A. Liner, *et al.*), 1 male (partial specimen) (FSCA); 12.6 mi W, 1.4 mi N Dr. Arroyo on El Pequeño Road, 21 July 1975 (E. A. Liner), 1 juv. (FSCA).

Diplocentrus coylei, NEW SPECIES

(Figs. 8-14)

Type Data. - Adult male holotype from outside Grutas de Cacahuamilpa, Guerrero, Mexico on 8 June 1982 by F. Coyle; deposited in the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

Etymology. - The specific epithet is a dedication to Dr. Frederick Coyle, who collected the holotype, for his contributions to arachnology.

Distribution. - Known only from northern Guerrero, Mexico.

Comparative Diagnosis. - Two species of the genus *Diplocentrus* have been reported from Guerrero: *D. tehuacanus* Hoffmann and *D. magnus* Beutelspacher & López-Forment. *Diplocentrus coylei* appears most similar to *D. tehuacanus*, but differs in a number of important characters. The anterior margin of the carapace is very finely granular in *D. coylei*, but is granulose in *D. tehuacanus*. In *D. coylei*, the metasomal carinae are stronger, with the dorsolaterals and lateral supramedians distinctly granular. Metasomal segment III bears ten carinae in *D. coylei* (the lateral inframedians are present), but only eight carinae in *D. tehuacanus*. The dorsolateral, lateral supramedian, and ventrolateral carinae of metasomal segment IV are all moderate to strong in *D. coylei*, but are obsolete or vestigial, weak, and smooth in *D. tehuacanus*. Males of *D. coylei* have the dorsal and external surfaces of the pedipalp chelae reticulate, but only the dorsal face bears reticulations in *D. tehuacanus*.

There are also distinctive morphometric differences in the pedipalps and metasoma between the two species, particularly in males. Some ratios demonstrating these differences are as follows (female ratios given in parentheses): pedipalp chela length/depth = 2.81-3.15 (2.10) in *D. coylei*, but is 2.54 (1.92) in *D. tehuacanus*; pedipalp patella length/width = 2.83-3.20 (2.48) in *D. coylei*, but is 2.77 (2.07) in *D. tehuacanus*.

Diplocentrus magnus is a much larger, dark-colored species with adults approximately 100 mm in length. In addition, the tarsomere II spine formula of the legs (4/6-7: 4-5/7: 5-6/7: 5-6/7-8) is quite different from that in *D. coylei*. Adult males of *D. magnus* are currently unknown, so morphometric comparisons with males of *D. coylei* cannot be made.

Description. - Based on holotype male.

Coloration: Base color uniformly orange to orange brown with a fairly strong underlying dusky pattern on carapace and anterior half of each tergite. Carinae of metasoma and pedipalps dark reddish brown. Distal part of pedipalp chela palm and fingers slightly darker orange brown. Proximal segments of legs yellow brown, distal segments yellowish. Venter light yellow brown. Cheliceral manus yellow brown with faint dusky pattern distally; cheliceral teeth dark reddish brown.

Prosoma: Anterior margin of carapace densely, finely granular (Fig. 8); remainder of carapace smooth to finely granular, lustrous. Sternum with single anteromedian seta and nine additional pairs of setae.

Mesosoma: Tergites finely granular, interspersed with sparse coarse granulation posterolaterally. Tergite VII weakly bilobed, granuloreticulate posterolaterally. Genital operculum with four pairs of larger setae along posterior margin and one median pair; microsetae present along posteromedial margins and on genital papillae. Pectinal tooth count 16-15. Sternites III-VI minutely punctate, lustrous, sparsely setose. Sternite VII with submedian and lateral carinae vestigial, weak, and finely granular.

Metasoma: Segments I-IV: Dorsolateral carinae on I-III moderate, irregularly granular; on IV moderate, smooth to granular. Lateral supramedian carinae on I-IV moderate to strong, irregularly granulose. Lateral inframedian carinae on I moderate, irregularly granulose; on II-III moderate, irregularly granular; on IV weak, almost smooth. Ventrolateral carinae on I-II strong, crenulate; on III moderate, crenulate; on IV moderate, irregularly crenulate. Ventral submedian carinae on I-II moderate, irregularly granulose; on III-IV vestigial, weak, granular. Dorsal and lateral intercarinal spaces of I-II granuloreticulate, of III-IV granular. Segment V (Fig. 9): Dorsolateral carinae moderate, smooth. Lateromedian carinae vestigial, weak, smooth. Ventrolateral, ventromedian, and ventral transverse carinae strong, with distinctly enlarged subconical granules. Ratio of segment II length/width = 1.17; III length/width = 1.30; segment V length/width = 2.79.

Telson (Fig. 9): moderately setose.

Chelicerae: Movable finger distinctly shorter than manus length; fixed finger distinctly shorter than manus width.

Pedipalps: Trichobothrial pattern Type C, orthobothriotaxic (Vachon 1974). Femur (Fig. 10): Dorsal and internal faces moderately, coarsely granular; dorsal face flattened throughout. Dorsointernal carina strong, granulose; ventrointernal carina strong, granulose; dorsoexternal carina moderate, irregularly granular; ventroexternal carina obsolete. Ratio of femur length/width = 2.78. Patella (Figs. 11-12): Dorsointernal carina strong, smooth; dorsal median carina vestigial, smooth; dorsoexternal carina weak, smooth; ventroexternal carina moderate, smooth; ventrointernal carina strong, moderately granulose. Internal face with basal tubercle bearing four large granules; distal portion densely, finely granular. Dorsal face weakly, smoothly reticulate. Ratio of patella length/width = 3.20. Chela (Figs. 13-14): Dorsal marginal carina strong, granulose; dorsal secondary carina weak, smooth; digital carina strong, smooth; external secondary carina weak, smooth; ventroexternal carina vestigial, weak at movable finger condyle, smooth; ventromedian carina very strong, smooth; dorsointernal carina vestigial, granular; ventrointernal and internal secondary carinae weak, smooth. Dorsal and external faces of manus moderately, smoothly reticulate throughout. Ratio of chela length/width = 4.83; chela length/depth = 3.15; of fixed finger length/carapace length = 0.85; of movable finger length (normal left side)/chela depth = 1.70.

Legs: Tarsomere II spine formula 4/4 4/5: 5/5 5/5: 5/6 5/6: 6/6 4/5 (count of left leg IV abnormal).

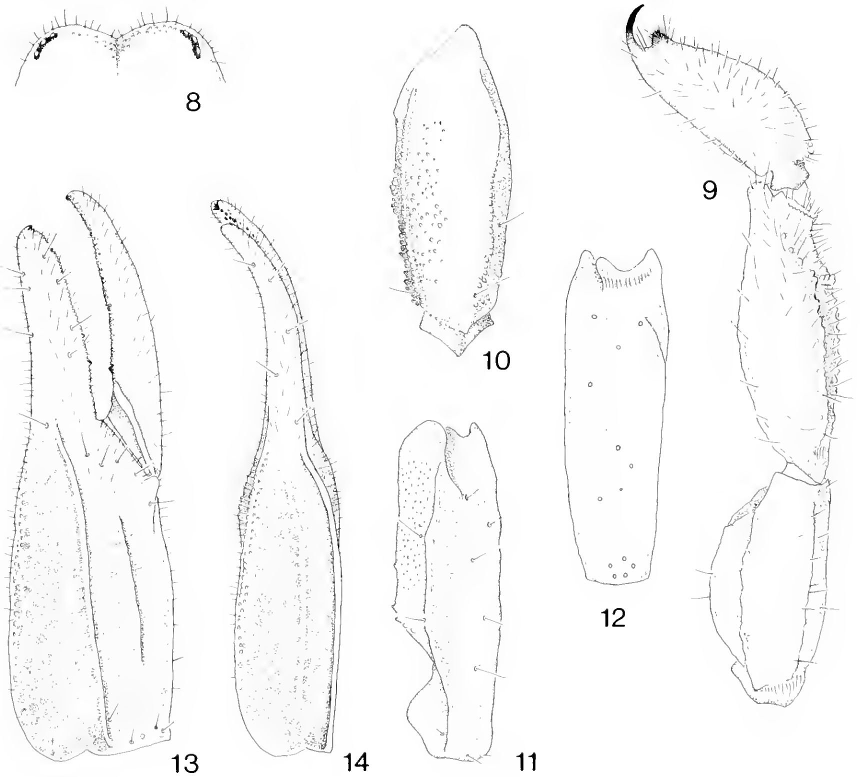
Variation. - The female is similar to the male except in the following characters: (1) the metasomal segments and pedipalpal femur and patella are proportionately shorter, and the chela more robust (Table 1); (2) the dorsal and lateral carinae of the metasomal segments are weaker; (3) the carinae of the pedipalp chelae are weaker, and the reticulations of the dorsal and external faces are faint; and (4) pectinal tooth counts are lower (see below). As is typical of *Diplocentrus* spp., the young specimens are pale yellow to yellow brown in coloration, but have a distinct dusky pattern on the carapace, tergites, pedipalps, and metasoma; they also have rudimentary carination.

Variation in pectinal tooth counts is as follows: in males there were two pectines with 16 teeth, two with 15 teeth, and two with 14 teeth; in females there were three pectines with 13 teeth, four with 12 teeth, and one with 11 teeth. Morphometric variation is summarized in Table 1, and variation in tarsomere II spine formulas is presented in Table 2.

Measurements. - Holotype male (in mm): Total L, 53.2; carapace L, 6.8; mesosoma L, 17.1; metasoma L, 23.9; telson L, 5.4. Metasomal segments: I L/W, 3.7/3.9; II L/W, 4.1/3/5; III L/W, 4.3/3.3; IV L/W, 5.1/2.9; V L/W, 6.7/2.4. Telson: vesicle L/W/D, 4.4/2.4/1.9; aculeus L, 1.0. Pedipalps: femur L/W, 7.5/2.7; patella L/W, 8.0/2.5; chela L/W/D, 14.5/3.0/4.6; fixed finger L, 5.8; movable finger L, 8.5. Note: The movable finger of the right side is disproportionately longer than on the left side; the measurement for the left movable finger length is 7.8 mm.

Paratype female, Las Granadas (in mm): Total L, 56.5; carapace L, 7.6; mesosoma L, 20.7; metasoma L, 22.5; telson L, 5.7. Metasomal segments: I L/W, 3.4/4.3; II L/W, 3.8/3.9; III L/W, 4.2/3.7; IV L/W, 4.9/3.5; V L/W, 6.2/2.9. Telson: vesicle L/W/D, 4.6/3.0/2.5; aculeus L, 1.1. Pedipalps: femur L/W, 6.1/2.7; patella L/W, 6.7/2.7; chela L/W/D, 13.0/4.6/6.2; fixed finger L, 5.4; movable finger L, 7.7.

Specimens Examined. - MEXICO: Guerrero, Gruta de Cacahuamilpa (W 99.30, N 18.40), 2 Sept 1966 (J. & W. Ivie), 1 juv. (AMNH); outside Gruta de Cacahuamilpa, 8 June 1982 (F. Coyle), 1 holotype male (MCZ); summit, 4 mi W Cacahuamilpa (W 99.34, N 18.41), 3 Sept 1966 (J. & W. Ivie), 1 male, 1 female, 1 juv. (AMNH); Las Granadas, 12 July 1980 (E. Martin & R. Garcia), 1 male, 1 female (AMNH-OFF).



Figs. 8-14. Morphology of *Diplocentrus coylei*, new species. All figures are of holotype male. 8, anterior portion of carapace, dorsal aspect; 9, lateral aspect of metasomal segments IV, V, and telson; 10, dorsal aspect of pedipalp femur; 11, dorsal aspect of pedipalp patella; 12, external aspect of pedipalp patella; 13, external aspect of pedipalp chela; 14, dorsal aspect of pedipalp chela.

Table 1. Ranges in morphometric characters (ratios) of *Diplocentrus ferrugineus*, new species and *D. coylei*, new species. Included herein are additional ratios (not mentioned in the text) that may prove to be of value in separating these species from others in the genus. Only a single female was available for *D. ferrugineus*. Abbreviations are as follows: L = length, W = width, D = depth.

Ratio	***D. ferrugineus*** 3 Males (1 Female)	***D. coylei*** 3 Males (2 Females)
Chela L/W	3.36-3.61 (2.81)	4.17-4.83 (2.83-3.10)
Chela L/D	2.19-2.28 (2.02)	2.81-3.15 (2.09-2.10)
Fixed Finger L/carapace L	0.77-0.88 (0.65)	0.79-0.86 (0.70-0.71)
Movable Finger L/metasoma V L	1.09-1.22 (1.11)	1.16-1.21 (1.24-1.26)
Metasoma III L/W	1.21-1.31 (1.07)	1.28-1.32 (1.14-1.18)
Metasoma V L/W	2.30-2.57 (2.04)	2.55-2.79 (2.14-2.23)
Pedipalp Femur L/W	2.35-2.52 (2.22)	2.61-2.78 (2.22-2.26)
Movable Finger L/Chela D	1.35-1.60 (1.21)	1.50-1.70 (1.24-1.26)

Table 2. Variation in tarsomere II spine formulas in *Diplocentrus ferrugineus* and *D. coylei*, new species. A few specimens were missing legs.

D. ferrugineus

Leg	Spine row	3	4	5	6	7	8
I	Prolateral	1	-	11	1	-	-
	Retrolateral	1	-	8	4	-	-
II	Prolateral	-	-	3	10	-	-
	Retrolateral	-	-	-	10	3	-
III	Prolateral	-	-	1	1	8	1
	Retrolateral	-	-	1	-	7	3
IV	Prolateral	-	-	-	1	10	3
	Retrolateral	-	-	-	-	7	7

D. coylei

Leg	Spine row	1	2	3	4	5	6
I	Prolateral	1	-	-	8	3	-
	Retrolateral	-	1	-	1	11	-
II	Prolateral	-	-	-	1	12	-
	Retrolateral	-	-	-	-	12	-
III	Prolateral	-	-	-	-	2	12
	Retrolateral	-	-	-	-	-	14
IV	Prolateral	-	-	-	1	-	12
	Retrolateral	-	-	-	-	1	12

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FIRST TEXAS RECORDS OF FIVE GENERA OF AQUATIC BEETLES (COLEOPTERA: NOTERIDAE, DYTISCIDAE, HYDROPHILIDAE) WITH HABITAT NOTES[1]

Sharon Knight Jasper[2], Roy C. Vogtsberger[3]

ABSTRACT: Five genera of aquatic beetles are reported from Texas for the first time. Species recorded include *Suphis inflatus* (Noteridae), *Hoperius planatus* (Dytiscidae), *Dibolocelus ovatus*, *Hydrobiomorpha casta*, and *Sperchopsis tessellata* (Hydrophilidae). Habitat notes are reported for four of these. In addition, some locality and habitat data are provided for *Helobata larvalis* (Hydrophilidae) which has only recently been recorded from Texas as *Helobata striata*. Label data are listed for 168 specimens representing the six genera in Texas.

This paper is a fortuitous result of surveys made from 1991 to 1995 on the Haliplidae of Texas by the senior author, and on potential predators of Culicidae larvae in the upper Gulf Coast region of Texas by the junior author. Five genera of aquatic Coleoptera previously unreported from Texas were encountered in our samples. Additional information was obtained from material in the Insect Collection of the Department of Entomology at Texas A&M University (TAMU). Recorded localities and ranges for each species and available habitat notes are presented. Each of these genera is either monotypic or is represented in the United States by a single species. Unless otherwise indicated, the collection data represent single specimens and the identifications were made or confirmed by the authors. Specimens collected by the authors are indicated by their initials in the locality data. The sexes of the beetles are given when known. Habitats from which more than one of these species were collected are described under the first species listed, and referred to briefly in subsequent species discussions. Many of the collections were made at the Runnell's Family Mad Island Preserve, southwest of Houston, and the Roy E. Larsen Sandyland Sanctuary, north of Beaumont (both of which are properties of The Nature Conservancy of Texas), the Anahuac National Wildlife Refuge, just east of Houston, and the J.D. Murphree Wildlife Management Area, south of Port Arthur. Representative specimens from this study are deposited in the Insect Collection of the Department of Entomology at Texas A&M University.

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NOTERIDAE

Genus *Suphis* Aubé 1836

Suphis inflatus (LeConte)

Colpius inflatus LeConte 1863: 22
Copius inflatus; Arnett 1973: 205
Coepius inflatus; Arnett 1983: 9-1
Suphis inflatus; Spangler and Folkerts 1973: 501

Suphis inflatus (LeConte) was originally described in the genus *Colpius*. Spangler and Folkerts (1973) transferred this species to *Suphis* and described its third instar larva. This is the only known representative of the genus in the United States. This beetle has been listed from Florida and Louisiana (Crotch and Cantab 1873, Young 1954 [in *Colpius*], Spangler and Folkerts 1973, Arnett 1973 [in *Copius*], 1983 [in *Coepius*]). Later it was recorded from Alabama, Georgia and South Carolina (Spangler and Folkerts 1973, Folkerts and Donovan 1974). Brigham *et al.* (1982) found this species in both North and South Carolina. A New York locality followed by a question mark was listed by Crotch and Cantab (1873), but this record is very doubtful as *Suphis inflatus* has not been reported from the Northeast by any other author. The records here extend the known range of this species westward from Louisiana to Brazos and Matagorda Counties of southeastern Texas (Map 1).

The habitat of *S. inflatus* is characterized as "sinkhole ponds, lakes and marshes" and it "...apparently prefers relatively permanent bodies of water, often of low pH" (Young 1954). The habitats at the following localities are consistent with those previously recorded. Alligator Lake, located in the Roy E. Larsen Sandyland Sanctuary of southeastern Texas, had a pH of 4.5 and is a large, shallow, catchment lake mostly covered with *Nymphaea* sp. Shoveler's Pond, located in the Anahuac National Wildlife Refuge just east of Houston, is a large, permanent pond with several types of submergent and emergent vegetation and *Lemna* sp. None of the specimens of *S. inflatus* collected in our study were taken at lights except those in underwater light traps. This suggests that this species rarely leaves the water or has diurnal flight activity. Fifty-two specimens were taken in seven counties.

TEXAS RECORDS. Brazos Co.: Postoak Lake, TAMU, 18 Jul 1972, J. Roberts. **Chambers Co.**: Large shallow pool just E of Trinity River @ IH 10, 9 Aug 1991, SKJ. Anahuac National Wildlife Refuge, Shoveler's Pond, 7 Jun 1993, RCV. **Hardin Co.**: Roy E. Larsen Sandyland Sanctuary, Alligator Lake, 18 Aug 1992, 2 adults; 17 May 1993, 6 adults; 3 Sep 1994, 4 adults; underwater light trap, 4 Sep 1994, 2 adults, SKJ. Roy E. Larsen Sandyland Sanctuary, temporary pool, 18 Aug 1992, 2 adults; 17 May 1993, SKJ. **Jefferson Co.**: Hwy 365W, 2.3 km W of 823N, marsh, 11 Aug 1991, SKJ. **Matagorda Co.**: Mad Island Slough N of lake, underwater light trap, 19 Jun 1993, SKJ. **San Jacinto Co.**: pond on Loop 424, 0.48 km N of Shepherd, 6 Sep 1992, SKJ. **Tyler Co.**: marsh of Steinhagen Lake, @ Hwy 90 just W of Martin Dies Cherokee Unit, 21 Jul 1991, 3 adults; 31 Aug 1991, SKJ. Temple-Inland Forest Lake Club @ swamp, 27 Mar 1993, 6 adults, SKJ; 10 Jun 1995, 19 adults, J.R. Gibson.

DYTISCIDAE

Genus *Hoperius* Fall 1927

Hoperius planatus Fall

Hoperius planatus Fall 1927: 177

The monotypic genus, *Hoperius*, was described from a single male specimen taken at lights in Hempstead County, Arkansas (Fall 1927). In addition to Lawrence County, Arkansas, Spangler (1973a) reported it from Talbot County, Maryland, Florence and Horry Counties, South Carolina [from Kirk 1970], and Nansemond County, Virginia. A single specimen taken at lights in Elmore County, Alabama, was reported by Folkerts and Donovan (1974), extending the range of this species southward in the United States. Michael and Matta (1977) summarized the known distribution of *Hoperius planatus* as "south from Maryland to South Carolina and west to Alabama and Arkansas." Anders Nilsson (pers. comm., 1994) confirms that the species has not previously been reported from Texas. Our collection data indicate a southwestern range extension from Arkansas to Montgomery County in southeastern Texas (Map 1).

Michael and Matta (1977) stated "This is strictly a woodland pool species." Spangler (1973a) reported collecting both adults and immatures of *H. planatus* on several occasions in Talbot County, Maryland, in woodland ponds which lacked living vegetation but contained rotting leaves. In the same paper, he described the third instar larva and the pupa. The three specimens from Hardin County, in southeastern Texas, were collected by dip net from a swamp with a depth of less than 20 cm. The only macrophytes in the swamp were the black gum trees and the bottom was covered with decaying leaves over a firm sand substrate. The water had a pH of 4.5 and a very low dissolved oxygen level of 1.2 ppm. All specimens of *H. planatus* from Montgomery County were taken at lights (Wappes, pers. comm., 1995). Intensive collecting efforts with dipnets, underwater light traps, bottle traps, and both mercury vapor and ultraviolet lights at the Roy E. Larsen Sandyland Sanctuary failed to produce more specimens. This beetle indeed deserves its common name, "the rare predacious diving beetle." Eight specimens have been collected from two Texas counties.

TEXAS RECORDS. Hardin Co.: Roy E. Larsen Sandyland Sanctuary, swamp of *Nyssa sylvatica*, 19 Aug 1992, female; 18 May 1993, 2 males, SKJ. **Montgomery Co.**: The Woodlands, 5-7 Apr 1978, female; 20-23 Apr 1978, one male, one female; 12 May 1978; 2 May 1980, male, J.E. Wappes.

HYDROPHILIDAE

Genus *Dibolocelus* Bedel 1891

Dibolocelus ovatus (Gemminger and Harold)

Hydrophilus ovalis Ziegler 1844: 45 (nec Laporte 1840)
Hydrophilus ovatus Gemminger and Harold 1868: 476 (nom. nov.)
Dibolocelus ovatus; Young 1954: 196

The genus *Dibolocelus* is represented in the United States by a single species, *D. ovatus* (Gemminger and Harold). *Dibolocelus* superficially resembles *Hydrophilus* in general size and habitus, but differs in having the prosternum completely divided into two lobes, pubescence on the abdominal sternites, a characteristic body shape, and sexually dimorphic maxillary palpi. Hansen (1991) reduced *Dibolocelus* to a subgenus of *Hydrophilus* based on his claim that these characters are autapomorphies. After having studied his argument and obtained the opinions of other coleopterists specializing in the Hydrophiloidea (M. Archangelsky, A. Smetana, S. Testa, pers. comms., 1995), we have decided to accept the generic status of *Dibolocelus* in this paper based on several morphological characters in both the larval and adult stages. *Dibolocelus* has a strictly New World distribution while *Hydrophilus* (*s.s.*) is found worldwide.

Young (1954) reported *D. ovatus* as ranging from New York, west to Michigan and Indiana, and south to Florida. Wooldridge (1967) added Illinois to the range. This distribution in the eastern United States was extended northward into Canada with records from Ontario and Quebec (Bousquet 1991). In the southern United States, Testa and Lago (1994) extended the range of *D. ovatus* westward to Mississippi. Two adult specimens, used for producing offspring in studies of the preimaginal stages of the species, were reported by Archangelsky and Durand (1992) from a seemingly disjunct population in Latimer County, Oklahoma. The only documented previous collections of *D. ovatus* in Texas were recorded by Foster (1972) in his unpublished thesis. The two specimens he recorded were taken on 4 May 1959 and 5 May 1962 from unknown locations in Nacogdoches Co. in eastern Texas. The specimens were not examined, but because the identifications were made by D.P. Wooldridge, an authority on the Hydrophiloidea, they are considered reliable. Our records extend the known distribution of this species westward into Texas to Hidalgo and Cameron Counties (Map 1).

Several authors have documented the preference of *D. ovatus* for large, deep, well-vegetated bodies of standing water (Young 1954, Smetana 1988). This beetle has also displayed a propensity for being attracted to lights. Kirk (1970) reported *D. ovatus* being taken at lights in July at Myrtle Beach, South Carolina, and all of our specimens for which data are available were collected at lights. Testa and Lago (1994) concluded that specimens of *D. ovatus* are "not encountered frequently." This is a large beetle (27-32 mm) and our collections from Texas confirm that it is rarely taken as compared to other large aquatic beetles. Archangelsky and Durand (1992) added considerably to the knowledge about this genus and species by observing its bionomics and describing the preimaginal stages from specimens reared in the laboratory. Twenty-one specimens from eleven counties are recorded here.

TEXAS RECORDS. Bee Co.: Beeville, 7 Sep 1938, male, C.G. Johnson. **Brazos Co.**: College Station, 16 Apr 1951, female, H.J. Reinhard; 17 Apr 1977, male, R.S. Peigler; 10 Oct 1977, male, J.J. Smith. **Cameron Co.**: Brownsville, 23 Jun 1938, female; 15 Aug 1938, female, D.C. Earley. **Chambers Co.**: Anahuac, Mosquito Control District Building, at mercury vapor lights, 22 Apr 1994, male; 27 Jun 1994, male; 2 Oct 1994, female, RCV. **Hidalgo Co.**: Tex. Exp. Sta., light trap, 16 Jun 193?, female, J.C. Gaines. **Jefferson Co.**: J.D. Murphree Wildlife Management Area Main Office on SH 73, mercury vapor light, 28 Apr 1995, one male, one female, RCV. **Matagorda Co.**: 16 km N Palacios, 11 Mar 1991, male, Kenny Sexton. Mad Island Preserve, at light, 18 Jun 1993, SKJ & W.B. Godwin. **Montgomery Co.**: The Woodlands, 28-29 Apr 1978, one male, one female; 7 Apr 1980, female, J.E. Wappes. **Nacogdoches Co.**: 4 May 1959; 5 May 1962, det. D.P. Wooldridge. **San Patricio Co.**: Welder Wildlife Ref., 27 Jun 1969, female, Board & Hafernik. **Wood Co.**: Mineola Civic Center, at lights, 19 Mar 1987, male, W.B. Godwin.

Genus *Hydrobiomorpha* Blackburn 1889

Hydrobiomorpha casta (Say)

Hydrophilus castus Say 1835: 170
Hydrocharis obtusatus (Say); LeConte 1855: 369
Hydrous tenebrioides Jacquelin DuVal 1856: 50
Hydrocharis perfectus Sharp 1882: 61
Hydrocharis castus; Horn 1876: 251
Hydrophilus (*Neohydrophilus*) *castus*; d'Orchymont 1911: 62
Neohydrophilus castus; Knisch 1924: 234
Hydrobiomorpha casta; Mouchamps 1959: 328

Hydrobiomorpha casta (Say) was reported by Young (1954) as *Neohydrophilus castus* in the southern United States from Florida to Louisiana. Spangler (1973b) expanded this distribution to the south to include Cuba, Mexico, Guatemala, and Panama. Brigham *et al.* (1982) added both North and South Carolina to the known range, extending the distribution northward in the United States. Our records indicate a spread in distribution to Chambers and Hardin Counties in southeastern Texas which represent the westernmost range in the United States presently known for this hydrophilid (Map 1).

Young (1954) characterized the habitat of *H. casta* as "...cypress ponds, roadside ditches, sinkhole ponds, and swamps principally in the flatwoods" and further stated that this beetle was found "infrequently." Testa and Lago (1994) collected specimens only at lights, mostly near a small eutrophic woodland lake and a large, well-established lily pond. The majority of our specimens from Chambers County, Texas, were collected in a large marsh when the salinity ranged from 2 to 4 ppt. Specimens from Jefferson County, Texas, were collected in a marsh during a period when the salinity ranged from 2 to 9 ppt. Both marshes had experienced higher salinity levels than the ranges shown here, but none of these beetles were taken during those periods. The vegetation at both marshes is predominately *Spartina patens* (Ait.) Muhl. Ecological notes on Alligator Lake, in southeastern Texas, are included in the discussion of *Suphis inflatus*. Grass Pond, located in the Roy E. Larsen Sandyland Sanctuary in southeastern Texas, is a large, shallow pond which dries completely during some years. At its maximum extension, the outer portion is swamp with tree cover (*Pinus taeda* L. and *Nyssa sylvatica* Marsh.) and the firm sand bottom is completely covered with sphagnum moss. This grades into an area of grass which extends for about 30 meters. The large central area has more sphagnum and about 10% cover by *Nymphaea* sp. The pH was 5.6 in August, 1992. More than half of all specimens collected in this study were taken with submerged bottle traps like those described by Hilsenhoff (1987), and perhaps the success in collecting this species was due to use of these traps. The third instar larva of *H. casta* was described by Spangler (1973b) from a specimen collected in Bibb County, Alabama. Texas records include 40 specimens collected from three counties.

TEXAS RECORDS. Chambers Co.: Double Bayou, at light, 6 Jun 1975, J.S. Ashe & M.L. Holcomb. Anahuac National Wildlife Refuge, 4.9 km SE of Visitor Info Booth, marsh, 12 Jul 1993; 13 Jul 1993, 2 adults; 5 Mar 1994, 2 adults; 19 Mar 1994, 2 adults; 9 Apr 1994, 3 adults; 23 Apr 1994, 2 adults; 7 May 1994; 25 May 1994; 16 Jun 1994, 3 adults; 28 Jun 1994, 4 adults; 12 Jul 1994, 2 adults; 26 Jul 1994; 23 Aug 1994, 1 larva and 2 adults; 30 May 1995, RCV. **Hardin Co.**: Roy E. Larsen Sandyland Sanctuary, Grass Pond, 18 May 1993, SKJ; Roy E. Larsen Sandyland Sanctuary, mercury vapor light by Alligator Lake, 3 Sep 1994, 5 adults, SKJ. Alligator Lake, 3 Sep 1994, SKJ. **Jefferson Co.**: J.D. Murphree Wildlife Management Area, 11 km S of Port Arthur, 0.16 km E of Lost Lake, brackish marsh, 6 Mar 1994; 23 Aug 1994, RCV. J.D. Murphree Wildlife Management Area Main Office on SH 73, mercury vapor light, 28 Apr 1995, 2 adults, RCV.

Genus *Sperchopsis* LeConte 1862

Sperchopsis tessellata (Ziegler)

Spercheus tessellatus Ziegler 1844: 44
Sperchopsis tesselatus; LeConte 1862: 47
Hydrobius tesselatus; Horn 1873: 133
Hydrobius tessellatus; Horn 1890: 266
Spercheus tesselatus; Schwarz and Barber 1918: 135
Hydrocyclus tesselatus; Knisch 1921: 102
Hydrocyclus tessellatus; Winters 1926: 53
Sperchopsis tessellatus; d'Orchymont 1928: 93
Sperchopsis tessellata; Smetana 1988: 72

Sperchopsis is a monotypic genus originally described by LeConte (1862). Spangler (1961) provided an excellent review of the nomenclature, biology, and distribution of *Sperchopsis tessellata* (Ziegler), and described its larvae and pupa. This species has been recorded from numerous states and provinces in eastern North America, ranging from Nova Scotia and Ontario, Canada, south to Florida and Arkansas (Young 1954, Spangler 1961, Kirk 1969, 1970, Arnett 1973, 1983, Brigham *et al.* 1982, Warren 1985, White *et al.* 1985, Smetana 1988, Bousquet 1991, Testa and Lago 1994). Our records extend the known range of *S. tessellata* into East Texas, with Brazos County representing the westernmost point of known distribution in the United States (Map 1).

The typical habitat of *Sperchopsis* was characterized by Young (1954) as "...fairly swift, sand-bottomed streams, where it occurs in leaf drift in eddies and backwaters or clinging to logs and debris" and by Spangler (1961) as "margins of cold, clear, rapidly flowing streams," and especially "undercut gravelly and sandy stream banks with overhanging roots..." This type of lotic habitat is unusual for most hydrophilid beetles, and undersampling of this habitat is probably one of the reasons for its scarcity in most collections. Although Warren (1985) routinely sampled typical *Sperchopsis* habitat at 175 sites in Kentucky, he found only one adult and one larva in two streams which had sandy to gravelly undercut banks with overhanging roots or vegetation.

Kirk (1969, 1970) recorded *S. tessellata* in South Carolina from tanglefoot screens located between cotton fields, or between cotton fields and woodlands, and also from beach drift on the shores of lakes, bays or oceans. These habitats depart from the "typical" reported habitat for *Sperchopsis* and probably indicate dispersing individuals. The habitats recorded here (coarse particulate organic matter [CPOM], submerged dead limb, and drift in streams) agree with what is considered "typical" habitat for this species. Likewise, the

Winter's Bayou specimens, from San Jacinto County in southeastern Texas, were collected from dead branches in a sandy-bottomed stream. A total of twenty-nine specimens are reported from five counties in Texas.

TEXAS RECORDS. Anderson Co.: Boxes Creek (in drift), on submerged dead limb, 6 Nov 1960, 11 adults, H.R. Burke. 16 km SW of Elkhart, 15 Mar 1961, 2 adults, H.R. Burke. **Brazos Co.**: Bryan, Sep 1990, 2 adults, C. Moomaw. **San Augustine Co.**: Turkey Creek @ FM103, CPOM in gravel stream, 10 May 1994, 2 adults, SKJ. **San Jacinto Co.**: Sam Houston National Forest, Double Lake, 9 Apr 1977, Reed, Peigler, Plitt. Sam Houston National Forest, Big Creek @ Big Creek Scenic Area, 26 Sep 1992, SKJ; 11 Jun 1995, J.R. Gibson. Sam Houston National Forest, Winter's Bayou @ Lone Star Trail, N of FM 1725, 4 Dec 1993, 4 adults; 4 Jan 1994, 2 adults; 16 Sep 1994; 14 Oct 1994, J.R. Gibson. **Tyler Co.**: US190 @ Big Cypress Creek, 2.7 km W of FM256N, 7 Mar 1992, larva, SKJ.

Genus *Helobata* Bergroth 1888

Helobata larvalis (Horn)

Hydrophilus striatus Brullé 1841: 58

Helopeltis larvalis Horn 1873: 137

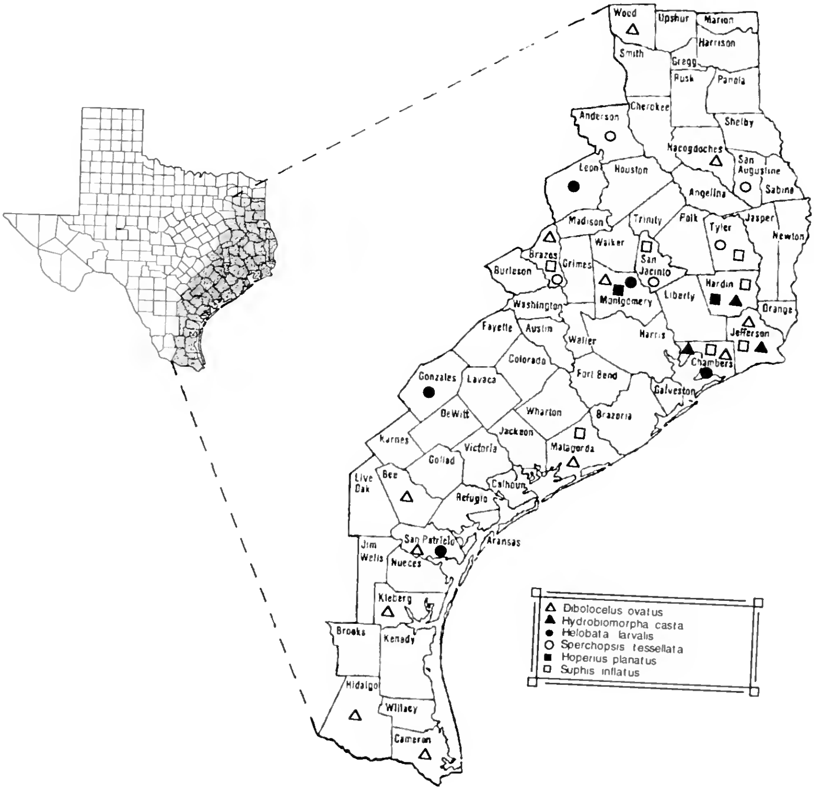
Helobata striata; Young 1954: 185, Richmond 1962: 88, Spangler and Cross 1972: 413, Arnett 1973: 223, Brigham *et al.* 1982: 10.79, Arnett 1983: 12-11, Fernandez and Bachmann 1987: 154, Testa and Lago 1994: 50

Helobata larvalis; Hansen 1991: 293

Helobata larvalis (Horn), the only species representing the genus *Helobata* in the United States, was until recently known as *Helobata striata* (Brullé). Hansen (1991) noted that the latter name was preoccupied by *Hydrophilus striatus* Say, 1825 (= *Berosus striatus)* and therefore was a primary homonym. The next available name was *Helobata larvalis* (Horn), 1873. The distribution of this species was reported (as *H. striata*) by Spangler and Cross (1972) to range from Buenos Aires, Argentina, north through the West Indies, Central America, Mexico, and along the Gulf Coast to Louisiana and Florida in the United States. Records in both North and South Carolina by Brigham *et al.* (1982) extended the known distribution northward from Florida. Testa and Lago (1994) listed this species from Texas, but because no precise locality data were given for Texas and no other references have been found citing *H. larvalis* in Texas, we are providing distributional data. Our records extend the known distribution of this beetle westward into Texas as far as San Patricio and Gonzales Counties (Map 1).

Young (1954) stated "The peculiar structure of the expanded sides of the body suggests that this insect lives on the surface of submerged vegetation, logs, and other objects in much the manner of a limpet." He also stated that it occurs in brackish as well as freshwater. Information gathered in the present studies agrees with his observations. Specimens of *Helobata larvalis* collected from the Anahuac National Wildlife Refuge marsh site in Chambers County, Texas (discussed under *Hydrobiomorpha casta*) were found clinging to the underside of floating, decaying vegetation. One noteworthy specimen was a female with the egg case attached beneath the abdomen as described by Spangler and Cross (1972), who also described the eggs and first instar larva of this species. Eighteen specimens are reported here from five Texas counties.

TEXAS RECORDS. Chambers Co.: Anahuac National Wildlife Refuge, 4.9 km SE of Visitor Info Booth, marsh, 30 Jun 1993, 2 adults; 13 Jul 1993; 20 Nov 1993; 9 Apr 1994; 25 May 1994; 15 Jun 1994, adult with egg case; 12 Jul 1994; 21 Nov 1994, RCV. Anahuac National Wildlife Refuge, at light near entrance, 20 Sep 1993, RCV. **Gonzales Co.**: Palmetto St. Park, 7 Jun 1969, 2 adults, Board & Hafernik. **Leon Co.**: Flynn, 8 km N at sand dune at UV light, 24 May 1994, W.B. Godwin & E.G. Riley. **Montgomery Co.**: The Woodlands, 1-2 Aug 1977; 2 Jun 1979, J.E. Wappes. **San Patricio Co.**: Lake Corpus Christi State Park, 9 Jun 1969, Board & Hafernik. Welder Wildlife Refuge, black light, 28 Jun 1969, 2 adults, Board & Hafernik.



Map 1. County records for beetles newly reported from Texas.

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THE MAYFLIES (EPHEMEROPTERA) OF NORTH AMERICA ONLINE[1]

W.P. McCafferty[2]

ABSTRACT: A continually updated, easy-to-use accounting of the Ephemeroptera of Canada, Mexico, and the continental United States is accessible on the World Wide Web. Distributional and nomenclatural information accompanies the comprehensive listing of species and subspecies. Documentation may be accessed directly via the Mayfly Central home page URL.

The first comprehensive accounting of the mayflies of North America is found in Eaton's (1883-88) monograph of the world Ephemeroptera, wherein he treated 92 nominal species. Next, Traver (1935) provided a descriptive treatment of all species known from north of Mexico. She included 546 species. Of those, however, only 423 are still considered valid. Updated checklists of species north of Mexico were later provided by Edmunds and Allen (1957) and Edmunds (1962). Edmunds *et al.* (1976) tabulated all North American species within treatments of each of the genera recognized at that time. Most recently, McCafferty (1996) provided an updated treatment of species found in North America, accounting for the considerable nomenclatural and revisionary changes that have taken place since 1976, and at the same time providing a complete index to all names that previously have been used for North American species.

Published accountings of any large faunas suffer from the fact that they are usually out-of-date by the time they become available. The modern electronic media, however, offer the ideal solution to this dilemma. The main purpose of this note is to announce the placement of a complete and continually updated accounting of the mayflies of North America on the World Wide Web. This web version not only will be regularly updated as new information is published, but it will be universally accessible for ready reference because of the client/server technology it incorporates and the platform-independence inherent in the web, *i.e.,* any computer format with appropriate browser software can use it without downloading or decoding. Browser functions will also allow search and find operations within the document so that, for example, taxonomic names or any combinations thereof may be easily searched, and other data such as geographic regions or current applications of old names present in the literature may be accessed. For further discussion of the operation and advantages of the World Wide Web, see, *e.g.,* Hayes (1994) and VanDyk (1995).

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"The Mayflies of North America" may be located on the World Wide Web via the Mayfly Central home page URL, which is

http:/ /www.entm.purdue.edu/entomology/mayfly/mayfly.html

Contents of the document are as follows: The current and last dates of coverage, the basis of the initial data, and the rationale for the treatment are given for general information purposes. User input is solicited, and users have the opportunity to communicate directly over the internet with Mayfly Central from within the "The Mayflies of North America" by using a simple select function. Any latest changes to the fauna, its nomenclature, or distribution are highlighted, and changes that are anticipated for the near future are also previewed. A section on how to read "The Mayflies of North America" includes a color-coded map of North America (Canada, Mexico, and continental United States) with the six broad geographic regions, adapted from McCafferty and Waltz (1990), that are cited for each species, and a complete explanation of the presentation of the information and how to interpret all other non-valid names that appear with the species. A separate listing of the higher classification of the Ephemeroptera of North America includes suborders, infraorders, superfamilies, families (and recent equivalents), and genera. These are presented in phylogenetic order, at least to the family level, as presented by McCafferty (1991) and modified by McCafferty and Wang (1994) and Wang and McCafferty (1995). Conveniently, the treatments of any family or any genus in the species list can be accessed by simply selecting the name in the higher classification list.

Finally, in "The Mayflies of North America," the entirely alphabetical list of species is given, listed first by family, and then by genus. The initial edition of the list contains 21 families, 84 genera, and 673 valid species and subspecies. Indented under each valid name are all other names that have historically referred to that species or subspecies in the literature, along with an indication of why the name is subordinate, *i.e.,* if it is a synonym, homonym, misspelling, different combination, or invalid replacement. All names, both valid and subordinate, are accompanied by the author of the name (not reviser) and the official date of publication of the name.

Treatments of the Ephemeroptera of other major geographic regions of the world are being planned as additions to the database of information available from Mayfly Central. Such electronic cataloguing certainly marks a new era of taxonomic services. Not only will non-specialists involved in ecology, surveys, and biodiversity be able to track name changes and new faunistic data, but curators of collections will have access to current data invaluable for managing their collections.

ACKNOWLEDGMENTS

I would like to thank all North American ephemeropterists for their contributions to the taxonomy and distribution of North American mayflies, but in particular I would like to mention those people who have worked closely with me in formulating the electronic version of "The Mayflies of North America." These include George Edmunds, Carlos Lugo-Ortiz, Arwin Provonsha, Pat Randolph, Bob Waltz, and Tianqi Wang. I would also like to thank Carl Geiger and Elizabeth Thelen for their technical assistance. This paper has been assigned Purdue Agricultural Research Program Journal Number 14845.

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BOOKS RECEIVED AND BRIEFLY NOTED

ENTOMOLOGY. 2nd ed. 1995. C. Gillott. Plenum Press. 798 pp. $85 hard; $49.95 softcover.

Introductory entomology course textbook, arranged in four sections: Evolution and Diversity, Anatomy and Physiology, Reproduction and Development, and Ecology.

BIOLOGICAL CONTROL: BENEFITS AND RISKS. 1995. H.M.T. Hokkanen and J.M. Lynch, eds. Cambridge Univ. Press. 304 pp. $74.95 hardcover.

Starting with an overview of benefits and risks of biological control introductions, this book consists of 28 chapters written by 47 contributors, arranged in five parts: Biological Invasions, Classical Biocontrol, Augmentative Biocontrol, Use of Genetically Modified Organisms, and Economics and Registration.

SOCIAL EVOLUTION IN ANTS. 1995. A.F.G. Bourke and N.R. Franks. Princeton Univ. Press. 529 pp. $75 hard; $29.95 softcover.

A detailed overview of the current state of scientific knowledge about social evolution in ants and how studies on ants have contributed to an understanding of many fundamental topics in behavioral ecology and evolutionary biology. Included is a clear explanation of kin selection theory and sex ratio theory and their applications to social evolution in insects.

INSECT MIGRATION: TRACKING RESOURCES THROUGH SPACE AND TIME. 1995. V.A. Drake and A.G. Gatehouse, eds. Cambridge Univ. Press. 478 pp. $74.95 hardcover.

Migration is a key process in the population dynamics of many insects. This book reviews current understandings of the ecological, behavioral, physiological, and genetic bases of insect migration, in three parts: Migration in relation to weather and climate, Adaptations for migration, and Forecasting migrant pests.

HOST-PLANTS OF CHRYSOMELIDAE OF THE WORLD. 1995. P. Jolivet and T.J. Hawkeswood. Backhuys Pubs., Leiden. 281 pp. $96 hardcover.

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TORYMINAE (Hymenoptera: Torymidae): A REDEFINITION, GENERIC CLASSIFICATION, AND ANNOTATED WORLD CATALOG OF SPECIES By E. E. Grissell. *Memoirs on Entomology International*, Vol. 57. May 1995. 480 pages. ISBN: 1-56665-057-7. Price US $60.00.

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THE ERIOPHYOID MITES OF CHINA: AN ILLUSTRATED CATALOG & IDENTIFICATION KEYS (ACARI: MESOSTIGMATA: ERIOPHYOIDEA). By Xiaoyue Hong & Zhi-Qiang Zhang. Vol. 7, 1996. 328 pages. Price $45.00.

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DESCRIPTIONS OF THE FEMALE, NYMPH, AND VARIATION IN MALE CHARACTERS OF THE STONEFLY *LEUCTRA SZCZYTKOI* (PLECOPTERA: LEUCTRIDAE)[1]

R. Edward DeWalt[2], Bill P. Stark[3]

ABSTRACT: *Leuctra szczytkoi* until recently was known only from the holotype male collected from Schoolhouse Springs of northcentral Louisiana. Collections in the late fall and winter of 1993-1995 provided additional specimens for describing the variation in the male characters and primary descriptions of the female and nymph of this species of the *Leuctra ferruginea* species group. Males are separated from all others in the group by a combination of a prominent subapical specillium spine, paraprocts and specillia being subequal, and by a triangular specillium. Females were distinguished by a shallow u-shaped notch on the subgenital plate. Nymphs apparently differ from others in the group by lacking sternal bristles anterior to segment 8. *Leuctra szczytkoi* is endemic to central and northcentral Louisiana in slow-flowing, lowland headwater streams of the Red River drainage.

Leuctra szczytkoi Stark and Stewart (Stark and Stewart, 1981) is a member of the *L. ferruginea* (Walker) species group. Members of this group have tapering specillia, often with one or more subapical spines of various lengths. Other members include *L. paleo* Poulton and Stewart, *L. crossi* James, *L. ferruginea* (Walker), *L. rickeri* James, and *L. alabama* James (James, 1974 and 1976; Poulton and Stewart, 1991). Since the original description of *L. szczytkoi* from a male specimen collected in Louisiana (Stark and Stewart, 1981), no additional records of this species have been published. Attempts to collect additional specimens initially concentrated around the March collection date and the remote Schoolhouse Springs site in Jackson Parish where the holotype was collected. This site, now owned by the Nature Conservancy, was described by Morse and Barr (1990).

A series of males, females, and nymphs from several Louisiana streams south of the type locality were recently collected by R. E. DeWalt. These collections enable the authors to describe the female and nymphal stages and also allow for additional information on variation in the male.

Leuctra szczytkoi Stark and Stewart

Leuctra szczytkoi Stark and Stewart, 1981, holotype male, Schoolhouse Springs, Jackson Parish, Louisiana.

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[1] Received August 31, 1995. Accepted October 16, 1995.

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Male. – Forewing length 6-7 mm. Tergum 7 with at most slightly thickened process on the mid-anterodorsal line. Tergum 8 with basal sclerotized band expanded medially into at most slightly elevated process which varies from rounded to triangular in outline (Fig. 1). Vesicle on sternum 9 triangular in outline (Fig. 2). Paraprocts slightly shorter than specillia, ventrolateral aspect with weak basal keel (Figs. 1, 3). Ventrobasal aspect of specillia angular and giving nearly pyramidal appearance, medial edges divergent.

Female. – Forewing length 8 mm. Sclerites on sterna 7 and 8 connected by pair of obscure lateral bridges. Lobes of subgenital plate truncate, notch shallow and u-shaped. Intersegmental membrane of sternum 9 with pair of small, basal sclerites (Fig. 4).

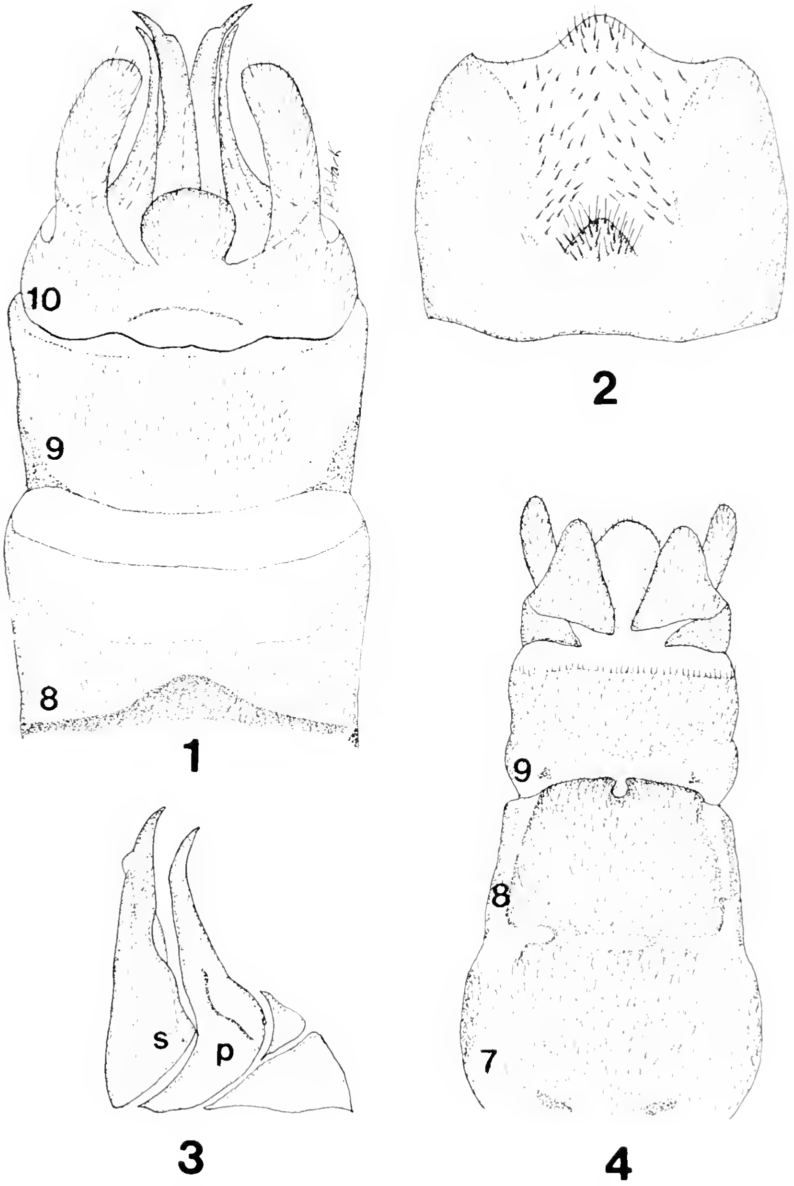
Nymph. – Body length 5-6 mm. General color pale brown, occiput with obscure mottled areas (Fig. 5). Post-ocular bristles 2, lower frontal and anterior clypeal bristles 1 each. Right and left anterior pronotal bristles 6-7 each, length variable; 2 posterior pronotal bristles located forward of posterior angles. Anterolateral mesonotal tuft with 8 short bristles; 6 outer marginal mesonotal bristles located at wing pad base; pair of fine bristles on posterodorsal margin of mesonotum; inner marginal mesonotal bristles absent (Fig. 5).

All terga of abdomen with band of short bristles extending to near pleura; abdominal sterna 8 and 9 each with single long posterior bristle in lateral aspect; sternal bristles absent on more anterior segments (Fig. 6). Basal cercal segments with apical whorls of moderately long bristles, mesal segments with progressively longer bristles through segment 14; apical segments with few, short bristles in apical whorls. Cercal segments present 20-22 (Fig. 7).

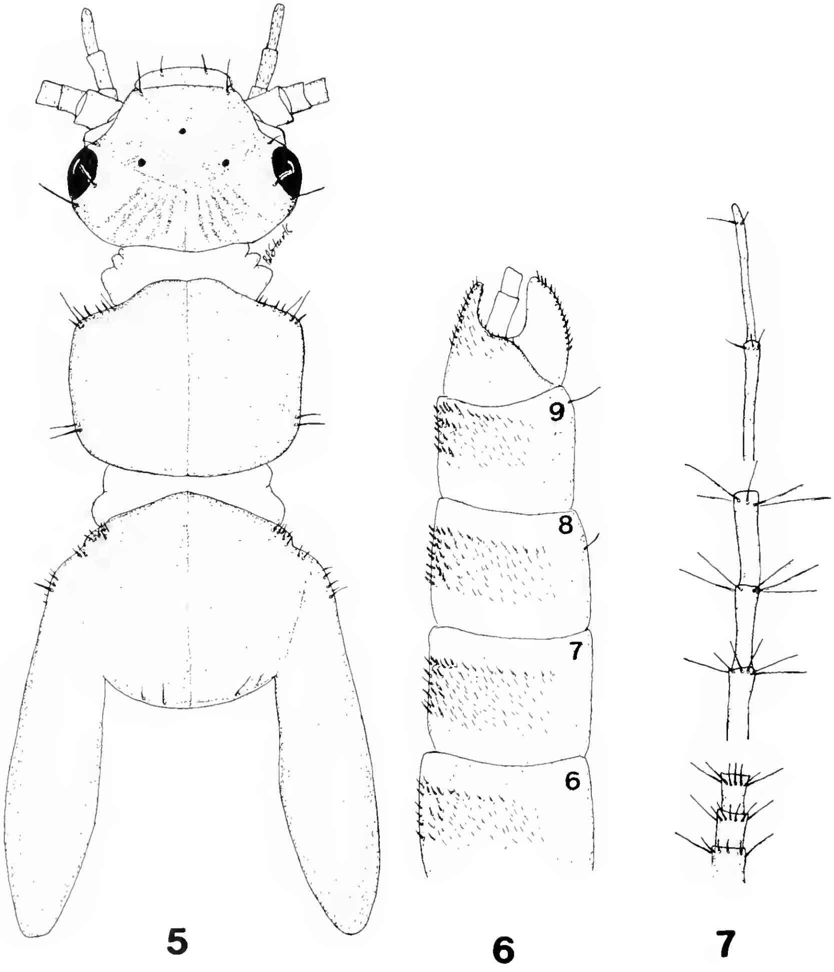
Distribution and ecology. – Additional collections (Table 1) seem to limit the geographical distribution of *L. szczytkoi* to lower elevations (21 to 46 m asl) of Omernik's (1987) South Central Plains Ecoregion (SCPE) in central and northern Louisiana (Fig. 8). Collections to date have been from west of the Mississippi River in 1 to 5 m-wide, first and second order drainages of the Red River basin (Fig. 8). Efforts to locate this species in the upland areas further west of recent localities, and to the east of the Mississippi River, have been unsuccessful. *Leuctra rickeri* and possibly an undescribed species in the group have recently been collected from Washington Parish, in eastern Louisiana.

Slopes of the streams in the vicinity of recent collections were 1.3 m/km for Loving Creek, 1.6 m/km for Jordan Creek, and 2.79 m/km for Beaver Creek. Substrates in these streams consisted of mostly sand, small amounts of fine gravel, and abundant woody debris. Natural riparian vegetation included bald cypress, oaks, shortleaf pine, and various ericaceous shrubs. These streams exhibited dark tea-colored water, accumulations of fine brown organic matter, and an abundant aufwuchs (attached microbial) community. Springs were common along the banks of these streams, as described for the type locality by Morse and Barr (1990). These descriptions are also consistent with Hitchcock's (1974) assertion that leuctrids prefer small, slow-flowing streams. The threatened Louisiana pearlshell mussel, *Margaritifera hembeli* (Conrad) also occurs at the sites of the 1993-1995 collections (P. D. Johnson, pers. comm.).

The emergence of adults at the sites listed in Table 1 was well under way by late October. Pre-emergent nymphs of *L. szczytkoi* were collected from leafpacks associated with wood. Exuviae were left near the water's edge on emergent woody substrates. Adults were often collected from just above the water level



Figs. 1-4. *Leuctra szczytkoi*, adult features. 1. Male terminalia, dorsal. 2. Male eighth sternite. 3. Male ventrolateral aspect of left specillium (s) and paraproct (p). 4. Female terminalia, ventral.



Figs. 5-7. *Leuctra szczytkoi*, nymphal features. 5. Head, pronotum, and mesonotum. 6. abdominal segments 6-10, lateral. 7. Right cercus, lateral.

on the undersides of wood or from dry leafpacks. Hand picking adults from the stream margin was more effective than using a beating sheet in riparian shrubs. This species may prefer to remain low in the vegetation rather than climb shrubs.

DISCUSSION

Males in this sample had a more rounded lobe on tergum 8, whereas the holotype had a triangular lobe (see Fig. 1 in Stark and Stewart, 1981), otherwise the holotype and these additional males were indistinguishable. *Leuctra paleo* and *L. szczytkoi* appeared to be indistinguishable using descriptions in the literature (Stark and Stewart, 1981; Poulton and Stewart, 1991), this coupled with their ranges in the SCPE and emergence beginning in October, necessitated examination of the holotypes. *Leuctra paleo* differed by having a more acute specillium spine, a rounded outline for the specillium, and by having parallel medial sides of the specillium.

Leuctra ferruginea and *L. rickeri* possess only small, and sometimes inconspicuous, spines atop the specillium. Their paraprocts are shorter than the specillia. *Leuctra alabama* may possess these spines, but its paraprocts and specillia are subequal in length (James, 1974 and 1976).

Females in this sample were also distinct from other members of the *ferruginea* group. Poulton and Stewart (1991) show that subgenital plate lobes

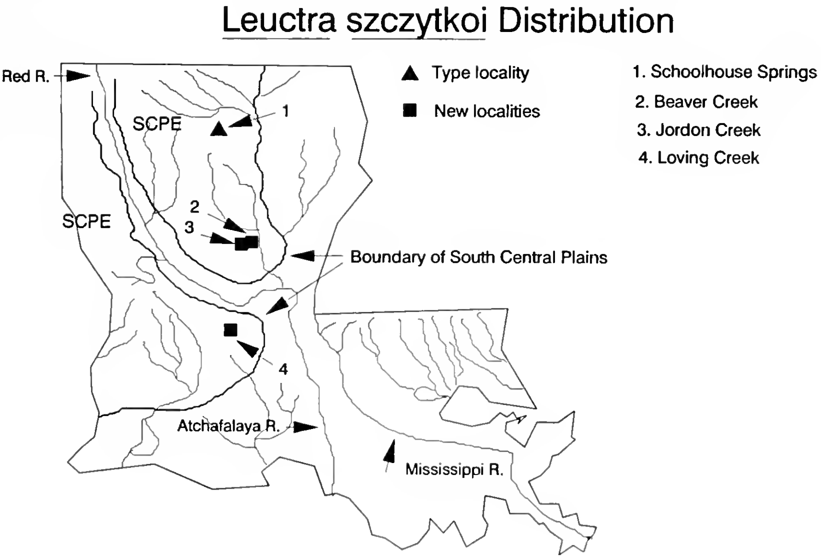


Fig. 8. Distribution of *Leuctra szczytkoi* in Louisiana. SCPE = South Central Plains Ecoregion.

of *L. paleo* are rounded, with an evenly curving median notch. James (1974, 1976) illustrates other members of the group as having truncate to broadly rounded lobes of the subgenital plate with deep parabolic notches.

Nymphs were quite similar to *L. ferruginea* and could be determined as this species by using keys in Harper and Hynes (1971). The two species appeared to be distinct in the nymphal stage because *L. szczytkoi* lacked sternal bristles anterior to segment 8 (see Fig. 17 in Harper and Hynes, 1971). Due to the fragile nature of these bristles, a larger sample size of mature nymphs would be needed to confirm this character.

Leuctra szczytkoi emerged in October, with most nymphs having transformed shortly thereafter. The scattered January records and the late March collection date for the holotype suggested that *L. szczytkoi* exhibited an extended emergence throughout the fall and winter. In contrast, most species of the *L. ferruginea* group emerge in spring and summer (Harper and Hynes, 1971; James, 1974 and 1976).

The Louisiana Department of Wildlife and Fisheries, Natural Heritage Program, has designated this species as S1, meaning that it is critically imperiled due to its extreme rarity, being known from five or fewer extant populations (S. H. Shively, pers. comm.). This ranking was given because the only published record of its occurrence was from Schoolhouse Springs. The status might well be downgraded to S3, a species found in a restricted region of the state, but locally abundant where found.

Table 1. Localities and collection information for *Leuctra szczytkoi* collected from Louisiana. N = number of nymphs collected.

Stream	Parish	Dates D-M-Y	Latitude Longitude	Transect Range, Section	Specimens
Schoolhouse Springs	Jackson	30-III-73	32°28.63'N 92°25.48'W	T17N R1W S12	♂
Beaver Creek	Grant	24-X-93	31°36.60'N 92°36.10'W	T7N R2W S5	♂ 3N
		30-X-93			2♂ 3♀
		24-I-94			♀
Jordan Creek	Grant	30-X-93	31°31.17'N 92°31.79'N	T6N R2W S12	5♂ 5♀ 10N
		8-I-95			♂
Loving Creek	Rapides	30-X-93	31°12.00'N 92°34.40'W	T3N R2W S28	♂ 2N
		7-I-95			♂ ♀

Voucher specimens have been deposited in the National Museum of Natural History, in the Louisiana State University Insect Collection, and in the author's personal collection.

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NEW FIELD OBSERVATIONS ON BURROWING IN EPHEMEROPTERA FROM AROUND THE WORLD[1]

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ABSTRACT: New observations on burrowing behavior of mayfly larvae are given for the leptophlebiids *Paraleptophlebia packi* and *P. bicornuta* in North America, and *Jappa kutera* in Australia; for the potamanthids *Potamanthus idiocerus* in Taiwan, and *P. formosus* and *Rhoenanthus speciosus in* Malaysia; for the polymitarcyids *Proboscidoplocia* spp. in Madagascar, *Afroplocia sampsoni* in South Africa, and *Ephoron album* in North America; and for the ephemerids *Ephemera simulans* and *Litobrancha recurvata* in North America, and *Palingenia fuliginosa* in east Europe. *Paraleptophlebia packi* forms burrows in silt, whereas *P. bicornuta* is an interstitial dweller. *Potamanthus idiocerus* and *R. speciosus* are the first species of Potamanthidae known to form burrows in silt; however, *P. formosus* is more typical of the family in that it is an interstitial dweller. Silt burrows made by Leptophlebiidae and Potamanthidae are formed along a rock interface and are never U-shaped, but those formed by advanced burrowers in the Polymitarcyidae and Ephemeridae are independent of rocks and often U-shaped. New evidence of burrowing in plesiotypic polymitarcyid lineages with flat-bodied larvae, represented by *Proboscidoplocia* and *Afroplocia,* is provided. *Ephoron album* is a highly flexible burrower; its larvae form burrows in depositional substrates, but are interstitial dwellers in erosional substrates. *Palingenia fuliginosa* is the first non-polymitarcyid burrower to be found burrowing in wood.

Many mayflies live within the substrate of bodies of freshwater during at least part of their larval life. Some inhabit interstitial areas of substrate temporarily as very young larvae (see *e.g.*, Coleman and Hynes 1970, Williams 1984), evidently acquiring some protection in such habitats during this part of their lives, but otherwise showing no particular adaptations for subbenthic habitats. Although these mayflies may be associated with hyporheic nurseries as early instars, they are generally surface benthos. Some sprawler and clinger mayfly larvae are known to move vertically through the substrate on a daily basis (*e.g.*, see Glozier and Culp 1989), and some of these may occur under the buried undersides of stones or other surface substrates especially during daylight hours. Many mayflies are associated with fine sand or sand/silt habitats, and are notable in lotic environments with shifting sand substrates. Those known as psammophilous mayflies typically show adaptations for living on, or partially to completely buried within, the sandy substrate (see *e.g.*, McCafferty 1991b).

The above mentioned mayflies, although they may move into interstitial areas temporarily or may settle in fine substrates, have not traditionally been known as burrowing mayflies. The term burrowing, when applied to Ephemeroptera, has generally been applied to those mayflies that demonstrate adaptations for excavating and residing more-or-less permanently within substrates

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that include coarse sand, silt, sand/marl, clay, mixed gravel, wood, and freshwater sponges.

Bae and McCafferty (1994) indicated that there were two main categories of burrowing mayflies, based on their ecology and behavior. Those that have been designated as interstitial dwellers by Bae and McCafferty (1995) actively burrow in interstices or available crevices, and although capable of excavating, they are limited in their ability to manufacture and maintain actual tunnels, or burrows, within the substrate. Burrowers in coarse sand and mixed gravel, such as *Dolania americana* Edmunds and Traver (*e.g.*, see McCafferty 1975, Edmunds *et al.* 1976) and *Anthopotamus verticis* (Say) (see Bae and McCafferty 1994) generally fit the interstitial dweller category. Burrow dwellers (Bae and McCafferty 1995), on the other hand, construct and dwell within walled, sometimes U-shaped burrows in finer and more compacted materials or solid substrates. The most detailed study of such burrowers was provided by Keltner and McCafferty (1986) in their videomacroscopic study of *Hexagenia limbata* (Serville) and *Pentagenia vittigera* (Walsh).

Burrowing, as it is known in Ephemeroptera, is also associated with one particular evolutionary lineage of mayflies known as the infraorder Lanceolata (McCafferty 1991a). This grouping includes the superfamilies Leptophlebioidea, Behningioidea, and Ephemeroidea. Fossorial adaptations are most highly evolved in the Ephemeroidea.

Mandibular tusks are structural adaptations most commonly associated with burrowing mayfly larvae. Tusks are present in all ephemeroid mayfly larvae, and only in a few cases have become secondarily reduced (McCafferty and Edmunds 1973, McCafferty and Gillies 1979, Bae and McCafferty 1991). Burrowing is not widespread in the large superfamily Leptophlebioidea, but tusks are present in larvae of most of the few leptophlebioids that are known to burrow. Leptophlebioid mandibular tusks are not homologous with ephemeroid tusks (Needham *et al.* 1935). Mandibular tusks are entirely absent in the behningioid burrowers. Bae and McCafferty (1995) recently treated the origin of Ephemeroptera tusks and their radiation and structural adaptations in relation to the evolution of burrowing behavior and ecology.

Over 100 literature sources of published information on burrowing in mayflies was reviewed by Bae and McCafferty (1995). The purpose of this paper is to present new field observations on Ephemeroptera burrowing, and to draw pertinent comparisons with previously published data. Many of the new observations were made on foreign collecting expeditions, where time was limited and experimental facilities were not available.

Paraleptophlebia (Leptophlebioidea: Leptophlebiidae)

Within the genus *Paraleptophlebia*, stream-dwelling larvae of four of the western North American species have mandibular tusks. These tusks, however, are not derived from the body of the mandible as in Ephemeroidea, but rather from the incisors of the mandibles. The habitats of *P. bicornuta* (McDunnough) and *P. packi* (Needham) were treated somewhat by Lehmkuhl and Anderson (1971) and Needham (1927), respectively. We have new observations regarding the behavior of these species: The most abundant tusked *Paraleptophlebia* species, *P. bicornuta,* moves freely through interstices of gravel and cobble substrate. *Paraleptophlebia packi* in Utah, however, maintains long burrows, up to 40 cm in length, along the interface between large boulders and silt deposits. When boulders are disturbed, the burrows collapse, but the burrow tracks along the boulder often remain evident. Our observations thus indicate that both interstitial dwelling and a crude type of burrow dwelling exist in Leptophlebiidae with mandibular tusks. Nothing is known of the presumed burrowing habit of *P. helena* (Day) or *P. zayante* (Day) of California.

Jappa (Leptophlebioidea: Leptophlebiidae)

Larvae of the eastern Australia genus *Jappa* are also known to burrow (see Peters and Campbell 1991, and review by Bae and McCafferty 1995). These larvae do not have mandibular tusks, but instead possess cephalic tusks (elongated frontal horns on the head). Bae and McCafferty (1995) regarded these as most analogous with the mandibular tusks of *Rhoenanthus* (Ephemeroidea: Potamanthidae). Larvae are known to burrow along mud/rock interfaces, and in gravel and sand. The new observation reported here is that in New England National Park N.S.W., larvae of *J. kutera* Harker burrow along rocks only ca 10-15 cm in diameter, the largest available for burrow interfacing. The habitat of these larvae was a large diffuse spring-saturated area having many rivulets and a mud substrate with moss and other low vegetation.

Potamanthus (Ephemeroidea: Potamanthidae)

Bae and McCafferty (1991) indicated that all genera of the Potamanthidae had been confirmed to burrow (see also review of Bae and McCafferty 1995). A critical laboratory study of the eastern North American species *Anthopotamus verticis* by Bae and McCafferty (1994) clearly demonstrated the burrowing habit, and therefore substantiated anecdotal and incomplete field observations that had appeared up to that time. This, in part, also refuted the popular notion that potamanthid larvae were typical sprawling benthos because they had flattened bodies. We have made additional observations of burrowing in the family Potamanthidae.

Larvae of *P. (Potamanthodes) idiocerus* Bae and McCafferty were observed and collected in a silted river in Taiwan. Mature larvae were found in distinct, long burrows, ca 30 cm long. The burrows were at the interface of silt and boulders. When boulders were moved the burrows collapsed, but the paths of the burrows on the boulders were evident. The larval microhabitat was similar to that of *Paraleptophlebia packi*, as reported above. Larvae of *P. (Potamanthodes) formosus* Eaton in Korea had been found to live interstitially by Bae (in Bae and McCafferty 1991); however, no details were provided at that time. Additional observations of this species were made from north of Kuala Lumpur, Malaysia. Larvae occurred in stream bottoms with a mix of rocks, gravel, and sand, where they occupied, perhaps exclusively, interstices in gravel beneath moderate to large boulders. Their habit and habitat is evidently similar, at least in part, to that detailed for *Anthopotamus* in North America by Bae and McCafferty (1994).

Rhoenanthus (Ephemeroidea: Potamanthidae)

The only comprehensive study of burrowing in Potamanthidae (Bae and McCafferty 1994) indicated that the American genus *Anthopotamus* is an interstitial dweller. Observations of *Rhoenanthus speciosus* Eaton from Sabah indicate that mature and nearly mature larvae of this species burrow at the interface of silt and 10-15 cm diameter rocks. This observation, along with the observations of the larvae of *P. idiocerus* in Taiwan, reported above for the first time, indicate that structural burrows can be formed in silt along the interface of rocks by certain species of Potamanthidae. Technically, this would qualify them as burrow dwellers (*sensu* Bae and McCafferty 1994).

Proboscidoplocia (Ephemeroidea: Polymitarcyidae)

Proboscidoplocia belongs to the subfamily Euthyplociinae, one of the primitive lineages of Polymitarcyidae (McCafferty 1991a) that has dorsoventrally flattened larvae. Very little information on the microhabitat of this subfamily has been available, except for some recent observations of *Euthyplocia hecuba* (Hagen) from Costa Rica. Sweeney *et al.* (1995) reported that larvae of *Euthyplocia* burrow under small to large cobbles embedded in stream beds with a sandy matrix. Given such substrate type and the fact that filtering setae occur in rows along the mandibular tusks in this genus (Bae and McCafferty 1995), we deduce that these larvae feed within the substrate, similar to that described for *Anthopotamus verticis* by McCafferty and Bae (1992). An additional observation from this subfamily is of *Proboscidoplocia* spp. from Madagascar, including *P. sikorai* (Vaysierre) and possibly undescribed species. Larvae were collected from the upper 15 cm of sand around the base of cobble. This suggests a habit and habitat somewhat similar to that of *E. hecuba* (see above). We do not know if any of these Euthyplociinae larvae form burrows along the rock interface.

Afroplocia (Ephemeroidea: Polymitarcyidae)

Another primitive subfamily of Polymitarcyidae is the Exeuthyplociinae (McCafferty 1991a), which consists of two African genera, *Afroplocia* and *Exeuthyplocia*. Although Gillies (1980) suggested that larvae of this group may indeed burrow, there have thus far been no actual observations of such. Adding to this distinct possibility is the new observation from the Mooi River in Natal, South Africa, where larvae of *Afroplocia sampsoni* (Barnard) were kicked from within mixed substrate ranging from silt/sand to small cobble. From this incidental data, we do not know whether *Afroplocia* larvae are interstitial dwellers or burrow dwellers utilizing rock interface, although the absence of pure silt may preclude burrow formation.

Ephoron (Ephemeroidea: Polymitarcyidae)

Bae and McCafferty (1995) reported that *Ephoron* larvae (subfamily Polymitarcyinae) form and maintain distinct burrows when the substrate is appropriate, but can be interstitial dwellers under other substrate conditions. New observations corroborate this flexible range of burrowing. In Utah, *E. album* (Say) larvae burrow in the clay banks and bottoms of the Jordan River and associated irrigation canals, and appear to form U-shaped burrows typical of many advanced burrowers. When the water level drops, the honeycombed banks are reminiscent of those of *Tortopus* (another polymitarcyid in the subfamily Campsurinae), as illustrated by Scott *et al.* (1959). In contrast, *E. album* larvae from the Green River, where cobbles are embedded in clay, burrow along the clay-rock interface and the burrow is apparently not U-shaped. In erosional areas of the Tippecanoe River in Indiana, *E. album* larvae have commonly been taken from mixed gravel and cobble substrate, where they exist as interstitial dwellers. In depositional areas of the Tippecanoe River, this same species forms burrows in silt and marl substrates. *Ephoron leukon* Williamson, a species that cohabits the Tippecanoe River with *E. album*, is only known from erosional areas where it is an interstitial dweller. Based on collecting data, *E. savignyi* (Pictet) in southern Africa may also be as flexible as *E. album* with respect to being an interstitial dweller or burrow dweller.

Ephemera (Ephemeroidea: Ephemeridae)

Among the subfamily Ephemerinae of the Ephemeridae, we have found *Ephemera simulans* Walker in a variety of habitats. The species occurs in a broad spectrum of streams and lakes throughout much of North America. In Crawfish Creek and the Firehole River in Yellowstone National Park, larvae inhabit loose sand, including small sandy pockets in cavities of volcanic rock, ca 2-3 cm in diameter. In the Uintah River in Utah, larvae occur near the stream margin in silt and sand mixture. This species cohabits the river with the burrowing ephemerid *Hexagenia limbata* (Serville), which forms burrows in silt and marl. In Indiana, *E. simulans* larvae occur mainly in erosional areas of streams with mixed sand and gravel substrates. The species is apparently an interstitial dweller, and our observations support those of Eriksen (1964), who demonstrated in laboratory studies that the species tended to select fine gravel. Although the larvae could burrow in a variety of substrate types, the relatively low DO of finer sediments, such as silt, limited this species to substrates with larger interstices (Eriksen 1968). *Ephemera danica* Müller in Europe is known to occur in sand and gravel as young larvae and in gravel as mature larvae (Tolkamp and Both 1978). *Ephemera vulgata* L., in contrast, is known to be a burrow dweller (*e.g.*, Verrier 1956), often in clay substrates.

Litobrancha (Ephemeroidea: Ephemeridae)

The eastern North American burrowing mayfly *Litobrancha recurvata* (Morgan) is a member of the subfamily Hexageniinae, all members of which are known to be burrow dwellers with advanced burrowing behavior (Bae and McCafferty 1995). Classic respiratory studies by Morgan and Grierson (1932) and Morgan and Wilder (1936) were performed on *L. recurvata* from small sand bottomed streams in Massachusetts. New observations of *L. recurvata* larvae from streams in the upper peninsula of Michigan clearly show them to be U-shaped burrow dwellers in heavy, organically rich silt. Given the fact that *Litobrancha* larvae have similar structural adaptations to those of the closely related *Hexagenia* (see Keltner and McCafferty 1986), there can be little doubt that the larvae studied by Morgan and her coworkers were also taken from silt deposits.

Palingenia (Ephemeroidea: Ephemeridae)

Palingenia is a member of the subfamily Palingeniinae of the Ephemeridae. Its members, like those of the Hexageniinae and Pentageniinae, are known to be burrow dwellers exclusively (see Bae and McCafferty 1995). Along with the Pentageniinae, the Palingeniinae is considered the most apotypic lineage in the family (McCafferty 1991a). *Palingenia fuliginosa* (Georgi) is a European species known to burrow in river silt (*e.g.*, Soldán 1978). While collecting in Slovakia, a decayed log of driftwood about 10 cm in diameter was broken open to reveal a larva of this species. Although wood burrowing, even in teak and bamboo, is well documented in the subfamily Asthenopodinae (family Polymitarcyidae) in the Orient, Africa, and South America (*e.g.*, Vejabhongse 1937, Hartland-Rowe 1953, Sattler 1967), this is a new and unexpected observation for the family Ephemeridae.

EVOLUTIONARY IMPLICATIONS

Silt burrows in Potamanthidae and Leptophlebiidae evidently require a rock interface, and they do not appear to be as structurally advanced as the uniformly walled and often U-shaped burrows constructed by the more advanced burrow dwellers in the apotypic lineages of Polymitarcyidae and Ephemeridae (see Bae and McCafferty 1995). Based on phylogenetic relationships (McCafferty 1991a, Bae and McCafferty 1995), interstitial dwelling, which may or may not require a rock interface, may be deduced to be the most primitive type of burrowing. Some close relatives of interstitial dwellers can form burrows. These burrow dwelling larvae apparently require a rock interface for mobility and purchase by the larvae, because they do not have adaptations for moving in silt as are present on the legs of the more advanced burrow dwellers (see Keltner and McCafferty 1986). Such adaptations include, for example, large spurs, expanded tibiae, and developed tibial processes. Primitive burrows formed along rock surfaces represent a likely step in the evolution from interstitial dwelling to burrow dwelling independent of rock surfaces, at least in the Potamanthidae-Ephemeridae lineage.

The more advanced type of burrowing and burrow formation developed independently in the Polymitarcyidae lineage and the Potamanthidae-Ephemeridae lineage, as detailed by Bae and McCafferty (1995). This dichotomy is evidenced by functional similarities, but adaptive structural differences, in the two lineages. The flat bodied burrowers in the plesiotypic subfamilies Euthyplociinae and Exeuthyplociinae of the Polymitarcyidae, just as the flat-bodied potamanthid larvae of the Potamanthidae-Ephemeridae lineage, are evidently interstitial dwellers or primitive burrow dwellers. Observations of Euthyplociinae larvae, at least, indicate that a rock interface is used in burrowing, but the observations of sand or sand matrix leaves some doubt as to whether an actual burrow can be maintained, depending on the quality of silt present. Nevertheless, we would not be surprised to find both interstitial dwelling and primitive burrow dwelling, which requires a rock interface, in these groups. An advanced type of burrow dwelling, independent of a rock surface, would seem to be out of the question for these groups because their larvae, like those of the Potamanthidae, demonstrate no adaptations for moving in silt. At least one species of more advanced Polymitarcyidae (see *E. album*, above) demonstrates all evolutionary gradations of burrowing habitat and burrow formation. As deduced for the Potamanthidae-Ephemeridae lineage, burrow dwelling along a rock interface also could have been the intermediate step in the evolution of more advanced burrowing in the polymitarcyid lineage.

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DENSITY AND DIVERSITY OF NONTARGET INSECTS KILLED BY SUBURBAN ELECTRIC INSECT TRAPS[1]

Timothy B. Frick, Douglas W. Tallamy[2]

ABSTRACT: Our survey of insects electrocuted during routine use of electric insect traps revealed only 31 biting flies, a minute proportion (0.22%) of the 13,789 total insects counted. In contrast, species from 12 orders and more than 104 nontarget insect families, including 1,868 predators and parasites (13.5%) and 6,670 nonbiting aquatic insects (48.4%) were destroyed. The heavy toll on nontarget insects and the near absence of biting flies in catches suggests that electric insect traps are worthless for biting fly reduction — and probably are counterproductive — to homeowners and other consumers.

Electric insect traps (*e.g.*, Zapper™, Bugwacker™ and Bug Blaster™; hereafter, "zappers") use ultraviolet light to lure flying insects toward an electrified metal grid, where they are destroyed by the thousands on warm summer nights. Homeowners buy traps to rid their surroundings of annoying biting flies, and continuous snaps, crackles, and pops emanating from an active zapper seem to confirm their effectiveness. Traps are commonly used near aquatic habitats, waterfront areas, toll booths, campgrounds, industrial parks, restaurants, swimming pools, and suburban backyards. In suburban yards, traps are often run throughout the summer months, some only during the evening hours and some continually.

Although the target insects are primarily mosquitoes (Culicidae) and no-see-ums (Ceratopogonidae) that seek blood meals at the expense of homeowners, several factors make electric traps ineffective in reducing local mosquito populations (Surgeoner & Helson 1977, Nasci *et al.* 1983). Ultraviolet lamps that emit considerable amounts of visible light (as do the lamps sold in commercial electric traps) are less attractive to mosquitoes than lamps emitting only ultraviolet wavelengths (Ikeuchi 1967). Furthermore, many species of mosquitoes are not attracted to light traps at all (Pippin 1965, Miller *et al.* 1969) and those species that are are often not trapped in numbers proportionate to their population sizes (Bradley 1943, Huffaker & Back 1943, Fox 1958). But perhaps the most important reasons electric insect traps fail to reduce mosquito problems are that 1) carbon dioxide exhaled by homeowners is far more attractive to mosquitoes than are light traps (Headlee 1941, Huffaker & Back 1943, Nascit *et al.* 1983), and 2) mosquitoes that do move toward traps are rarely killed by electrocution devices (Service 1993).

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Electric insect traps are, however, effective at killing large numbers of nontarget insects. Nasci *et al.* (1983) found that the average zapper in South Bend, Indiana killed more than 3000 insects per day, 96.7% of which were not female mosquitoes. Little beyond ordinal totals is known about the diversity and seasonal distribution of nontarget insects killed by zappers. As an initial step toward understanding the ecological consequences of indiscriminant removal by zappers of nontarget predators, parasitoids, and prey species from aquatic and terrestrial ecosystems, we quantified at the family level the numbers and kinds of insects killed over a season by homeowners' zappers in a suburban setting.

MATERIALS AND METHODS

We asked six homeowners with active bug zappers in suburban Newark, Delaware to participate in a summer-long study in 1994. All houses were within 3 km of a body of water. The house closest to water was about 65 meters from a large stream containing many stagnant eddies. Another house abutted a wooded area and was less than 1 km from a creek. The third house was about 1.5 km from the same creek but farther upstream. The fourth was in a wooded cul-de-sac through which ran a different creek; several permanent pools lay within 200 meters. The fifth house was situated in a residential development containing a stream and scattered wooded areas; a small pond about 30 meters long and 15 meters wide was less than a kilometer away. A small stream about 3 km distant was the nearest body of permanent water to the sixth house. Temporary pools, tree holes and water-filled containers were scattered throughout the study area. Thus, all traps were well within flight range of culicid and ceratopogonid breeding sites.

From June 20 to July 9, 1994, homeowners were asked to run the traps one night per week for at least two hours. Beginning on July 10, participants were asked to run their zappers one night per week every other week for the nine weeks ending August 27. A device constructed from a plastic dish 32 centimeters in diameter was suspended beneath each trap to collect electrocuted insects. Each morning after the traps were run, we collected the samples from the six sites and stored them in a freezer until they could be counted and identified to family (except for Ephemeroptera, Psocoptera, Thysanoptera, and Trichoptera, which were identified only to order, and several families of moths, which were grouped as "Microlepidoptera").

RESULTS

We collected 31 samples from the traps over our ten-week study period in the summer of 1994. Nearly all electrocuted specimens, including the tiniest

Cecidomyiidae, were well-preserved and easily identified. Twelve orders and more than 104 families were present in these samples and ranged in abundance from a single individual (several families) to more than 4,600 individuals (Chironomidae; Table 1). Of the 13,789 insects killed by electric zappers in our study, only 31 individuals (0.22%) were biting flies (female Culicidae, Simuliidae, and Ceratopogonidae). In contrast, insect predators, parasitoids, and nonbiting aquatic insects were abundant (Table 1). Present in our counts were representatives of 27 families of predators and nine families of parasitoids, totaling 1,868 individuals (13.5%). Carabid beetles, staphylinid beetles, cicadellid leafhoppers, microlepidoptera, and braconid parasitoids were particularly common victims. Large numbers of aquatic insects, such as caddisflies (Trichoptera) and midges (Chironomidae), were also destroyed; species from these families represented nearly half (48.4%) of sample totals.

Average numbers of insects per trap declined sharply over the season (Fig. 1), ranging from a mean of 1,304 insects per trap on June 20 to just 106 insects per trap on August 27. This probably reflects seasonal declines in the popula-

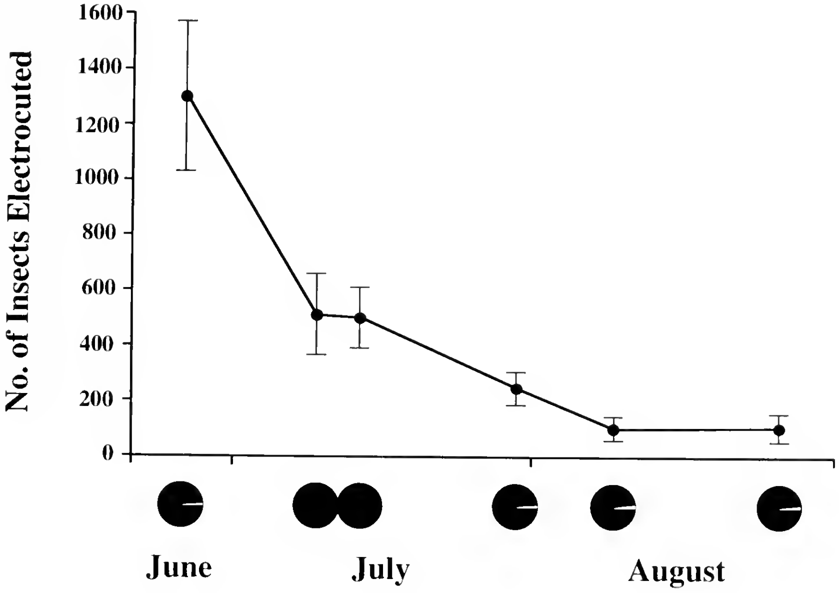

Fig. 1. Seasonal pattern of insects killed at six electric insect traps in Newark, DE on six dates from June 20 to August 27, 1994. Statistical interval = Standard Error. Pie charts depict the percentage of the total catch consisting of nontarget insects (black portion) and biting flies (white portion) on each trapping date

tions of species attracted to these traps. Although biting insects generally increased in proportion as the season progressed (from 0.26% of the total catch on June 20 to 1.88% on August 20), they still comprised a minuscule portion of the total sample.

DISCUSSION

These data are straightforward: many thousands of nontarget insects representing a rich taxonomic diversity were destroyed by these traps. Only a tiny fraction of trap victims were biting flies, the primary targets of electric zappers. Since we did not independently measure mosquito populations in our study sites we cannot definitively conclude that the zappers used in our study were ineffective mosquito killers. However, three types of circumstantial evidence suggest that this was indeed the case. First, it is highly unlikely that our lowland, wooded sites which were rich in aquatic breeding habitats, produced so few adult mosquitoes in the course of 9 weeks that 18 electrocuted females would represent adequate control of these flies. Second, the preponderance of aquatic insects in the samples suggests that our study traps were well within the flight range of biting flies that breed in water (culicids, ceratopogonids). Finally, our results are similar to those of Nasci *et al.* (1983) in which an independent measure of culicid populations confirmed the inability of zappers to attract mosquitoes that **are** present in suburban settings.

As we better understand the critical role insects play in the cohesion of most non-marine ecosystems, the sale and use of electric insect traps that so completely miss their advertised mark becomes increasingly irresponsible. It is insects and other invertebrates, not vertebrates, that are the "glue" of ecosystems; their elimination would inevitably lead to the rapid demise of those ecosystems and their members, including *Homo sapiens* (Wilson 1987). Even if targeted biting flies were effectively controlled by electric zappers, the resulting destruction of thousands of parasitoids, predators, aquatic insects, and other members of the nocturnally active fauna would be difficult to justify.

Although we recognize its speculative shortcomings, a simple calculation underscores the degree to which electric zappers may affect nontarget insect populations. The seasonal mean catch per night (of at least 2 hr of trap time) as quantified by our study totaled 445 insects per trap. Approximately one million zappers are sold in the U.S. each year (Philadelphia Inquirer, 26 June 1995 p. 63). Electrocution devices are quite durable; the homeowners in our study had been operating their units for an average of 7 yrs prior to 1994. If, in any given year, 4 million traps are used for 40 nights during the summer, then 71,200,000,000 — more than ***71 billion*** nontarget insects — are needlessly destroyed in the U.S. each year by misinformed homeowners. If we substitute into our calculations the trap means obtained by Nasci *et al.* (1983) in Indiana (2163 insects during a 2 h trapping period; N = 10), this figure rises to nearly

Table 1. Seasonal totals of biting flies (in **bold**), predators and parasitoids *(italicized)*, plus other taxa killed by electric insect traps at six sites in Newark, DE.

Order and Family	*No. Killed*	*% of Total*
Ephemeroptera	15	0.11
Dermaptera		
Labiidae	2	0.02
Psocoptera	14	0.10
Hemiptera		
Corixidae	10	0.07
Hebridae	2	0.02
Miridae	89	0.64
Nabidae	2	0.02
Lygaeidae	32	0.23
Rhopalidae	1	0.01
Cydnidae	14	0.10
Homoptera		
Cicadidae	33	0.24
Cicadellidae	2421	17.56
Flatidae	8	0.05
Acanaloniidae	1	0.01
Psyllidae	41	0.30
Delphacidae	1	0.01
Cixiidae	1	0.01
Aphididae	25	0.18
Thysanoptera	16	0.12
Neuroptera		
Corydalidae	1	0.01
Chrysopidae	8	0.05
Coleoptera		
Carabidae	661	4.79
Dytiscidae	21	0.15
Hydrophilidae	83	0.60
Staphylinidae	306	2.22
Lucanidae	1	0.01
Scarabaeidae	219	1.58
Buprestidae	3	0.02
Elateridae	46	0.33
Lampyridae	12	0.09
Cantharidae	104	0.754
Dermestidae	11	0.08
Anobiidae	30	0.22
Cleridae	4	0.03
Nitidulidae	27	0.20
Coccinellidae	15	0.11
Tenebrionidae	13	0.09
Mordellidae	10	0.07
Cerambycidae	11	0.08
Chrysomelidae	22	0.16
Curculionidae	7	0.05
Scolytidae	27	0.20
Diptera		
Tipulidae	223	1.62
Psychodidae	11	0.08
Culicidae	♂ 25, ♀ **18**	0.31
Ceratopogonidae	♂ 30, ♀ **12**	0.30
Chironomidae	4612	33.45
Scatopsidae	13	0.09
Simuliidae	**1**	0.01
Bibionidae	1	0.01
Mycetophilidae	34	0.25
Anisopodidae	13	0.09
Sciaridae	89	0.65
Dixidae	3	0.02
Cecidomyiidae	316	2.29
Stratiomyidae	5	0.04
Xylophagidae	1	0.01
Asilidae	1	0.01
Scenopinidae	1	0.01
Rhagionidae	2	0.02
Empididae	58	0.42
Dolichopodidae	70	0.51
Pipunculidae	1	0.01
Phoridae	12	0.09
Platypezidae	4	0.03
Otitidae	2	0.02
Tephritidae	2	0.02
Sciomyzidae	1	0.01
Ephydridae	8	0.05
Drosophilidae	7	0.05
Agromyzidae	14	0.10
Lonchaeidae	5	0.04
Lonchopteridae	8	0.05
Heleomyzidae	1	0.01
Sphaeroceridae	2	0.02
Anthomyiidae	28	0.20
Calliphoridae	17	0.12
Sarcophagidae	8	0.05
Tachinidae	16	0.12
Trichoptera	1597	11.58
Lepidoptera		
Microlepidoptera	1121	8.13
Tortricidae	19	0.14
Pyralidae	316	2.29
Geometridae	35	0.25
Lasiocampidae	3	0.02
Arctiidae	11	0.08
Noctuidae	64	0.46
Notodontidae	2	0.02
Epipyropidae	5	0.04
Yponomeutidae	10	0.07
Hymenoptera		
Braconidae	377	2.73
Ichneumonidae	77	0.56
Mymaridae	1	0.01
Perilampidae	1	0.01
Eulophidae	1	0.01
Encyrtidae	1	0.01
Pteromalidae	1	0.01
Torymidae	2	0.02
Eurytomidae	1	0.01
Chrysididae	3	0.02
Formicidae	84	0.61
Vespi	3	0.02
Halictidae	1	0.01

350 billion nontarget insects. We suggest, therefore, that while there is no evidence that zappers control nuisance insects, their effects may be anything but benign. Studies investigating the effects of insect defaunation on local ecosystems in general and on specialized insectivores such as bats and nighthawks in particular are needed to evaluate the ecological costs of zappers and other human activities destructive to insects. The results of our study indicate that entomologists, especially those active in extension, should be educating the public about the possible costs and lack of benefits from these gadgets.

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AN ATYPICAL LARVAL COLOR FORM OF *BAETIS INTERCALARIS* (EPHEMEROPTERA: BAETIDAE) FROM PENNSYLVANIA AND THE KIAMICHI RIVER BASIN OF SOUTHEASTERN OKLAHOMA[1]

R.D. Waltz[2], D.E. Baumgardner[3,4], J.H. Kennedy[4,5]

ABSTRACT: An atypical larval color form of *Baetis intercalaris* was discovered and reared from the Kiamichi River basin of southeastern Oklahoma. Identical nymphs were also recently discovered in northeastern Pennsylvania. This atypical larval color form has been previously reported only from Wisconsin. Larvae of this color form are visually distinctive because they lack the pale triad of spots along the posterior margins of most abdominal tergites diagnostic of the typical color form. The atypical form is uniformly marked on each tergite with pale, anterior, paired incurved lines (parentheses like) on a gray or brown background, lacking the paler abdominal tergites and spots characteristic of typical *B. intercalaris*. No morphological characters in the adult stage or the larval stage were found to support establishment of a new species.

Independently conducted ecological studies of the macroinvertebrates inhabiting two disjunct river systems of North America resulted in the collection of a little reported form of *Baetis intercalaris* McDunnough. This larval color form is characterized by its lack of well developed and contrasting color patterns of the abdominal tergites when compared with the typical color form (see Morihara and McCafferty 1979). Bergman and Hilsenhoff (1978) first reported this unpatterned form in their studies of the Wisconsin Baetidae. The unpatterned form is visually distinctive in field samples and is readily identified as unique due to the flat gray or brown, non-contrasting background color of the abdominal tergites (Fig. 1), typical "*intercalaris*" type of prothorax pattern (Morihara and McCafferty 1979), and medially banded cerci and terminal filament. No other *Baetis* species in North America is similarly colored.

Larval specimens of the unpatterned form of *B. intercalaris* were collected and reared (by DEB) from the Kiamichi River basin of southeastern Oklahoma. Another series of identical specimens was collected and brought to the attention of the senior author by James B. Munro, East Stroudsburg University, based on material that he collected in northeastern Pennsylvania. In each of the above cases, the unpatterned larval form was the only color form of this species found

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at the site. Typical color forms of *B. intercalaris* were not present in sites where collections were made of the unpatterned form.

MATERIAL EXAMINED

Material which formed the basis for this report includes the following larval, adult, and reared adult specimens:

OKLAHOMA: Pushmataha Co., Kiamichi R. at Hwy 2, 16.3. mi N Hwy 2-3 jct, D.E. Baumgardner, 16-IX-1993, 2L, and 14-X-1993, 2 reared male adults, 1 reared female adult, 7L. OK: Le Flore Co., Kiamichi R. at Hwy 259, approx. 0.5 mi S Hwy 63-259 jct, 18-VII-1993, D.E. Baumgardner, 2L. OK: Le Flore Co., Pigeon Crk at Hwy 63, approx. 5.5 mi W Oklahoma-Arkansas border, 19-VI- 1993, D.E. Baumgardner, 1 male adult. OK: Pushmataha Co., Dry Crk at unnamed low water crossing, approx. 2.5 mi E Tuskahoma, 17-VII-1993, D.E. Baumgardner, 1L.

PENNSYLVANIA: Pike County, Blooming Grove Creek, 6, 27-VII 1993; 10, 24-VIII-1993; 9-IX-1993, and 4-X-1993, James B. Munro.

Representative vouchers have been deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana, and University of North Texas, Denton, Texas.

IDENTIFICATION

Larvae of the unpatterned form will reach an impasse in the key couplet separating *Baetis intercalaris* from *B. flavistriga* McDunnough in Morihara and McCafferty (1979: couplet 19) because the tergal pale spots are not present. To accommodate identification of the unpatterned form, couplet 19 of the key may be modified to read:

19. Darker, well-marked abdominal tergites with two large submedian pale areas, often kidney shaped ....*B. flavistriga*

19'. Darker, well-marked abdominal tergites with 3 posterior round pale areas, middle spot often smaller than laterals *or abdominal tergites uniformly gray or brown with pale parentheses-like marks at middle, anterior margin of each tergite* ...... *B. intercalaris*

Confirmation of tentative larval identifications using this modified couplet should continue to be accomplished by using the expanded diagnosis under the species discussion of *B. intercalaris* in Morihara and McCafferty (1979). In some specimens, the slide mounted larval exuviae of the unpatterned form showed indication of pale tergal areas on the anterior tergites when examined with indirect substage lighting.

The adult of the reared, atypical larva keys readily to *B. intercalaris* in the most recent keys to the *Baetis* species adults (Traver 1935) based on the elongated marginal intercalaries of the first interspace in the forewing. However, adults of the reared atypical specimens possessed a dark-brown thorax, rather

Figure 1. *Baetis intercalaris* (unpatterned form). Dorsal habitus (photograph).

than the black thorax of typical *B. intercalaris*. Such color differences in the adult stage have been regarded as within the observed limits of intraspecific variation in closely allied species, *e.g., B. flavistriga* (see Morihara and McCafferty 1979 and Traver 1935) and in *Baetis dubius* (Walsh) (Waltz, personal observation). Further comparisons of the adult male reared from the unpatterned larval form with adult males reared from typical *B. intercalaris* larvae showed no discernible morphological differences.

BIOLOGY AND DISCUSSION

Baetis intercalaris, widely distributed in the Kiamichi River drainage, was collected from third through fifth order streams in the upper, middle, and lower reaches of the drainage. Larvae were collected from gravel/pebble substrate in riffles. Other studies have reported similar habitats for this species (Bergman and Hilsenhoff 1978; Berner and Pescador 1988).

Baetis intercalaris may have two generations per year in the Kiamichi River drainage, consisting of a spring and a fall generation. Immature larvae were first collected in June 1993, with late instar and emerging larvae collected in October, indicating the fall generation. Although no larvae were collected before June, a single adult was collected in June 1993, suggesting the occurrence of a spring generation. In the northern regions of its range, *B. intercalaris* has been reported variously as univoltine (Bergman and Hilsenhoff 1978; Harper and Harper 1984), or bivoltine (McDunnough 1921, 1923; Ide 1935). Emergence of *B. intercalaris* occurs throughout the year in the southern regions of its range (Berner and Pescador 1988), and often has no cohort synchronization (Jacobi and Benke 1991).

The cause of the atypical color variation is unclear at this time. The atypical color form could represent a cryptic species. A second, and more probable cause, is that this atypical color form may be a result of some, as yet not identified, environmental factor causing the differences in color. Not only are there no obvious morphological differences in the typical versus the atypical forms, but the presence of patterning common to the typical form, that is vaguely discernible in at least some larvae of the atypical form, leads us to seek an environmental cause for the atypical coloration. All of the unpatterned form larvae reported herein were collected in the mid to late summer, or the second generation cycle. No earlier, or spring generation, collections of the unpatterned form are known to us. Additional studies, including rearings of both typical and atypical color forms from throughout the range of this species, and life history studies, will be required to better understand the source of this atypical coloration.

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A NEW PERUVIAN MUSAPSOCID GENUS AND SPECIES (PSOCOPTERA: MUSAPSOCIDAE)[1]

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ABSTRACT: *Musapsocoides nadleri*, n. gen., n. sp., is described from a pair of specimens collected in Tarma, Perú. It is the sister group to *Musapsocus*, the only other known genus of the family, from which it differs in having three-segmented tarsi, male clunium without papillar or spinous fields, third valvula bilobed apically, subgenital plate with only a few stout setae located medially on distal margin, and in shape and structure of the male epiproct and phallosome and the female spermathecal duct. The discovery of this genus will probably have a considerable impact on the interpretation of the phylogeny of the electrentomoid Psocoptera.

The family Musapsocidae has hitherto included only the genus *Musapsocus* Mockford (1967), which stands well apart from other electrentomoid genera. The genus currently includes eight described species ranging from the tropical lowlands of Mexico south to central Brazil and central Perú (Mockford 1967, 1991). This paper describes a sister taxon to *Musapsocus* collected in west-central Perú. The pair of specimens on which the study was based were mounted in part on slides in Euparal and modified (low chloral hydrate) Hoyer's medium. Measurements were taken with a filar micrometer with measuring unit either 1.36 or 0.99 microns for larger structures and 0.53μ for smaller structures. The following abbreviations were used for parts measured: FW: forewing; HW: hind wing F: hind femur; T: hind tibia; tl, t2, t3: hind tarsomeres 1, 2, 3; P4: fourth segment of maxillary palpus; fl ...fl0: flagellomeres 1 ...10, IO: minimal distance between compound eyes; d: transverse diameter of compound eye. The holotype and allotype will be deposited in the American Museum of Natural History, New York City (AMNH).

Musapsocoides Garcia Aldrete and Mockford, NEW GENUS

Type species: *Musapsocoides nadleri* Garcia Aldrete and Mockford, new species.

Diagnosis. Genus of Family Musapsocidae, sharing with *Musapsocus* the following characters: antennae with 12 segments; frontal ecdysial lines absent; front tibia with well developed comb of stout setae distally on inner margin; anterior pretarsal claw of each foot foliaceous, posterior claw normal with large preapical denticle; wings clear; pterostigma open basally, first segment of Rs in hindwing absent. Differing from *Musapsocus* in the following characters: lacinial tip with lateral cusp relatively short, bifid distally, lacking subapical denticle; tarsi three-segmented; phallo-

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some and hypandrium closely fused, the hypandrium a broad plate fused on its inner surface with phallobase of two rods and connecting membrane; male epiproct a broad, blunt cone with setae limited to a sclerotized band along sides and distal margin; stout setae of distal margin of subgenital plate limited to the middle of the margin and five in number; spermathecal duct bifid.

Musapsocoides nadleri Garcia Aldrete and Mockford, NEW SPECIES

Male color (36 years in 80% alcohol). Body in general and appendages pale straw brown; diffuse reddish purple pigment granules over leg bases and along thoracic pleural sutures. Compound eyes black, ocelli rimmed on inner margins with reddish purple. Wings clear, unmarked, veins brown. Preclunial abdominal segments each with a diffuse, dorso-ventrally oriented subcuticular band of reddish purple pigment; band of segment 2 continuous over the tergum. Genital segments brown.

Male structural characters. Lacinial tip (Fig. 2) with small median cusp, large lateral cusp bifid at apex, and well defined denticle at base of lateral cusp. Wings (Fig. 1) as in *Musapsocus* with vein 2A of forewing ending in membrane. Leg characters as noted in generic diagnosis, also with details as noted in female description. Clunium (Fig. 5) with fields of setae as illustrated. Epiproct (Fig. 5) as noted in generic diagnosis. Paraprocts (Fig. 5) with a pigmented band along mesal edge; sensorium with six trichobothria on weakly defined basal rosettes and three without basal rosettes. Hypandrium (Fig. 4) broad, sparsely setose, slightly concave along hind margin, fused to phallosome internally except hind margin of phallosome deeply emarginate, phallobase mostly semi-membranous except for two rods running most of length of hypandrium, one on each side of posterior emargination of phallosome; distally phallosomal appendages on each side (Fig 4) consisting of a strongly pigmented elongate arm dilated apically, a broad sac bluntly rounded apically with serrate edge, and a membranous mass, probably endophallic, containing round granules

Male measurements (in microns). P4: 69, IO: 198; d: 140; IO/d: 1.41; f1: 160; f2: 160; f3: 178; f4: 208; f5: 148; f6: 144; f7: 87; f8: 108; f9: 101, f10: 94; FW: 1845; HW: 1538; F: 403; T: 752; t1: 295; t2: 72; t3: 63.

Female color (preservation as noted for male). As described for male.

Female structural characters. Lacinial tip (Fig. 6) as described for male, but lateral cusp and denticle at its base shorter and broader. Wings as described and figured for male but vein Sc in forewing very distinct and well separated from R to very near its distal ending in R; areola postica relatively longer (length/greatest height = 4.44, vs. 3.54 in male); vein 2A almost reaching 1A distally. Distal comb of front tibia with 11 stout setae becoming gradually stouter distally, the apical seta (spur) abruptly stouter than the one before it; hind tibia also with row of stout setae in same position, but setae more widely spaced, not forming a comb, and terminating in a single stout spur; hind t1 with eight stout setae ventrally along its length (these setal characters shared with *Musapsocus* but not previously described for that genus). Clunium with scattered setae, its surface sculptured with reticulate areoles bearing minute tubercles. Paraproctal sensorium with 7/8 trichobothria with weakly defined basal rosettes and 7 minute setae without basal rosettes Subgenital plate (Fig. 7) with pair of rounded disto-lateral lobes and slightly raised median distal area bearing transverse row of 5 stout setae; plate internally thickened with 2 pigmented areas sculptured with irregular vermiculations; T sclerite represented by a rod protruding from distal end of plate. Ovipositor valvulae (Fig. 8): v1 a curved blade; v2 hinged to v3 on its outer surface and fused to v3 on its inner surface most of its length, pointed distally; v3 bilobed distally. Spermatheca (Fig. 9): duct broad from external opening to a point ca. one-third distance to sac, there abruptly narrowed and once-branched; one of the resulting two ducts broken in preparation. its final destination unknown; the other duct leading to the sac and widening near sac; sac with a rounded, presumably glandular, area on surface distad of duct opening.

Female measurements (in microns). P4: 69; IO: 212; d: 147; IO/d: 1.45; f1: 148; f2: 191; f3: 205; f4: 212, f5: 155; F6: 146; f7: 94; f8: 114; f9: 114; f10: 102; FW: 1802; HW: 1542; F: 400; T: 726; t1: 282; t2: 52; t3: 60.

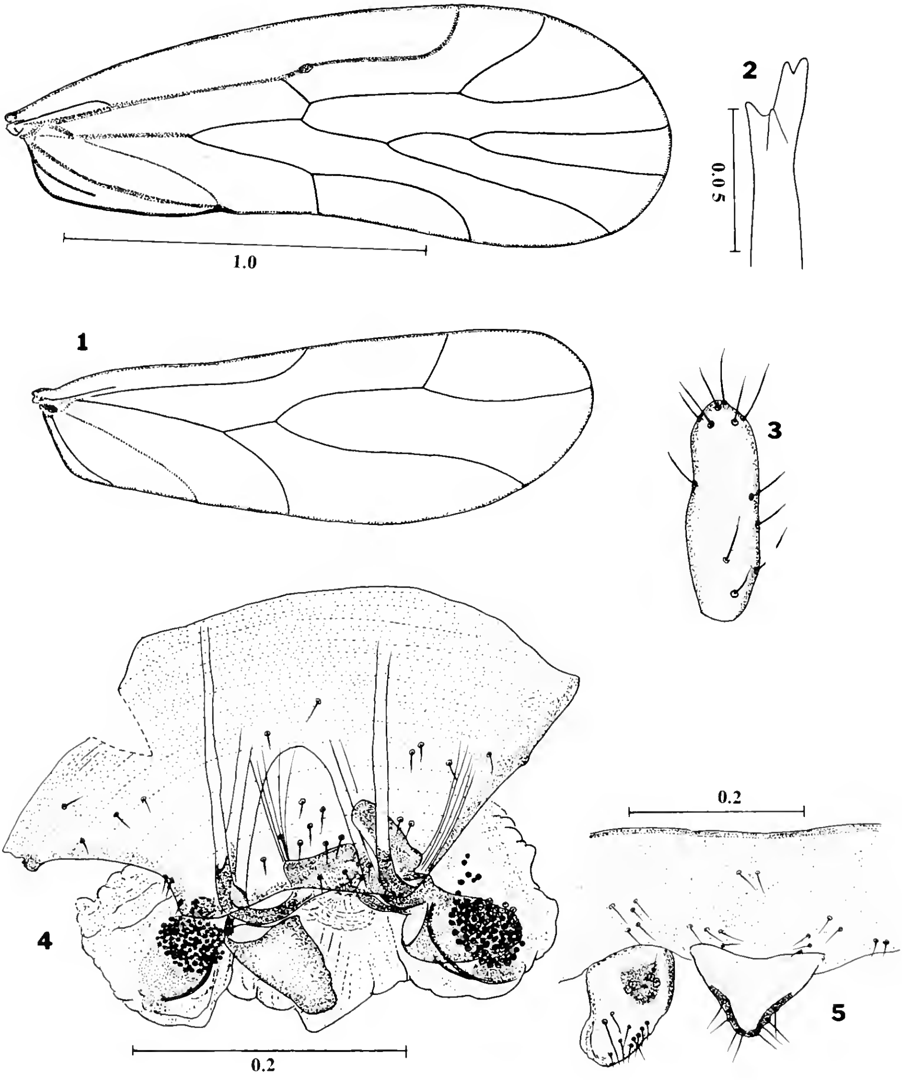

Fig. 1-5. *Musapsocoides nadleri* García Aldrete and Mockford ♂. Fig. 1. Forewing and hind wing. Fig. 2. Lacinial tip. Fig. 3. Fourth segment of maxillary palpus. Fig. 4. Hypandrium and phallosome. Fig. 5. Clunium, left paraproct, and epiproct. Scales in mm. Fig. 3 to scale of Fig. 2.

Material examined Perú: Junín: Río Tarma, Pan de Azúcar (2256 M), 31-xii-1958, A M. Nadler collector, holotype (♂), allotype (♀), AMNH.

Note. Although the collector did not indicate that these two specimens were collected in copula, it seems possible that they were, as the distal structures of the male's phallosome appear to be in copulatory positions.

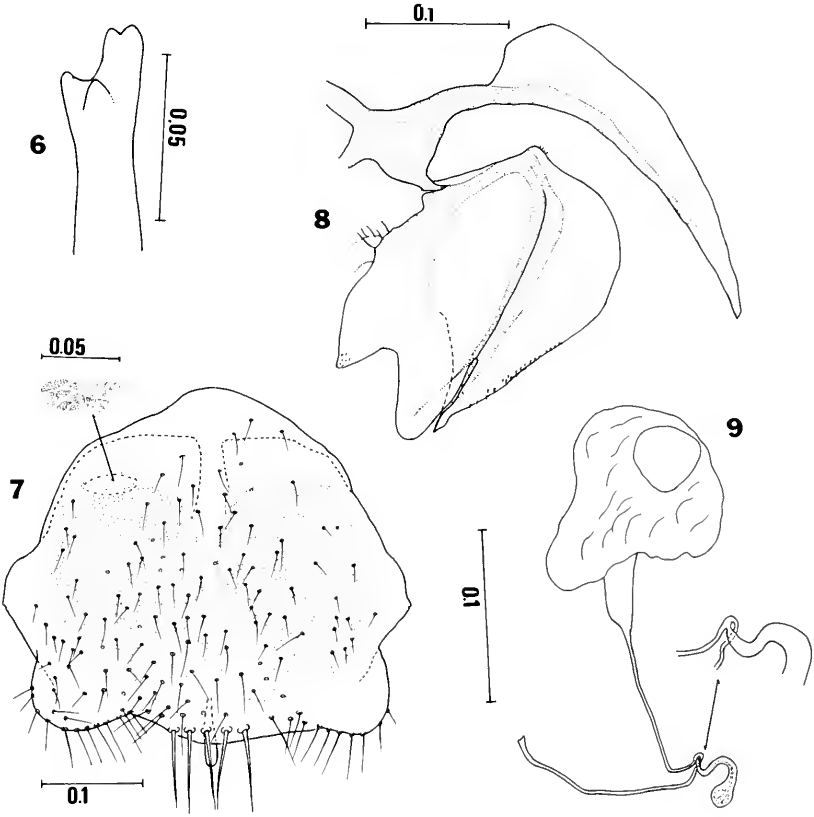

Fig. 6-9. *Musapsocoides nadleri* García Aldrete and Mockford ♀. Fig. 6. Lacinial tip. Fig. 7. Subgenital plate. Fig. 8. Ovipositor valvulae. Fig. 9. Spermatheca.

DISCUSSION

The characters three tarsomeres, short lateral cusp of the lacinia tip, few and centrally located stout setae of distal margin of subgenital plate, and bilobed v3 are probable plesiomorphies for the Musapsocidae. Prior to the discovery of *Musapsocoides,* our lack of knowledge of these characters presented a wide gap between this family (*i.e.,* genus *Musapsocus*) and other electrentomoid groups. This gap is now narrowed. The probable apomorphies of a comb of stout setae distally on the front tibia and reduced number of flagellar segments are shared with several genera of family Troctopsocidae as currently classified, namely *Troctopsocus* Mockford (1967) *Troctopsocopsis* Mockford (1967), *Troctopsoculus* Mockford (1967), and *Coleotroctellus* Lienhard (1988). It seems likely therefore, that the Musapsocidae are most closely related to this cluster of troctopsocid genera, and that the electrentomoid psocids (*sensu* Mockford, 1967) will require re-classification.

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ATTRACTING PARASITIC FLIES (DIPTERA: PHORIDAE) TO INJURED WORKERS OF THE GIANT ANT *DINOPONERA GIGANTEA* (HYMENOPTERA: FORMICIDAE)[1]

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ABSTRACT: Flies of the genus *Apocephalus* are common parasites of worker ants. Although the mechanisms used by parasitic flies to find their host are not well understood, olfactory cues have been suggested as the mechanism for host location, especially when the host ant is injured. In this study we describe, for the first time, parasitism of *Dinoponera gigantea*, a monomorphic neotropical ant species, by flies of the genus *Apocephalus* and test the hypothesis that injured worker ants attract more parasites than uninjured ones. We also evaluate the attractiveness of haemolynph produced by injury. To test the attractiveness of worker ants to *Apocephalus* flies, ants were divided into three groups. Group A was composed of injured workers, group B of workers with no injury, and group C of uninjured workers, but with a drop of the haemolynph from the injury of workers. Injured workers suffered more attacks by flies than uninjured ones, but there was no difference between uninjured workers with and without haemolynph on the body. Our data suggest that injury on the worker body of *Dinoponera gigantea* represents an important attracting stimulus for parasitic Phoridae, as demonstrated for other ponerine ants.

Parasitic flies (Diptera: Phoridae) attack a variety of species of ants (Borgmeier 1931, Brown and Feener 1991a, Feener 1981, Feener and Brown 1992, Feener and Moss 1990, Orr 1992, Pesquero *et al.* 1993). Female phorids use a sclerotized ovipositor to place their eggs in worker ants. The presence of these flies may cause dramatic reduction in the competitive ability and foraging activity of ant colonies and workers (Feener 1981, Feener 1988, Feener and Brown 1992, Feener and Moss 1990, Orr *et al.* 1995). These flies are recognized as potential biological control species for some pest ants, for example, the imported fire ant, *Solenopsis invicta* (Feener and Brown 1992, Orr *et al.* 1995). Very little is known, however, about how these phorids locate their hosts. Visual, olfactory or audio cues, or some combination of the three, may be used by phorids. In host ant species that present morphological castes (for example *Pheidole* spp., *Solenopsis* spp. and *Atta* spp.), phorid flies frequently attack large-sized workers (i.e. soldiers), indicating host selection through visual cues (Feener 1981, Feener 1987, Feener and Moss 1990). Nevertheless, the mechanism used

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by phorids to find monomorphic ant species may be through olfactory cues. Brown and Feener (1991a) found that *Apocephalus paraponerae* was attracted by extracts of crushed ant workers of a giant and common neotropical ant *Paraponera clavata.* These results suggested that phorid flies use olfactory cues to find host ant species, and showed that phorids may select injured workers to place their eggs. We searched for evidence of parasitism by phorids on the neotropical giant ant *Dinoponera gigantea,* and tested the hypothesis that injured workers attract more phorid flies than uninjured ones. This study is the first record for parasitism by two phorid species, *Apocephalus miricauda* and *Apocephalus* sp. (probably a new species, B.V. Brown pers. com.) on *D. gigantea,* as well as the first host record for *Apocephalus miricauda.* We present evidence about the cues used by phorid flies to attack monomorphic ant species.

MATERIAL AND METHODS

Study Area

This work was carried out in a secondary forest area in Vitória Farm (2° 55' S, 47° 35' W), Paragominas, northeastern Pará State, Brazil (see Nepstad *et al.* 1991 for detailed description of the area), between 6 and 14 May, 1994. In this area, *Dinoponera gigantea* is a common ant species, easily found on the forest floor. Phorid flies are also easily found, especially during the day.

Attractiveness experiments

We tested the hypothesis that injured workers of *D. gigantea* attract more phorid flies than uninjured ones by subjecting 111 workers, divided in three experimental groups, to attacks of phorids. The experimental groups were: group A – injured workers; group B – uninjured; and group C – uninjured workers, on which a drop of haemolymph extracted from injured workers was placed upon the pronotum with the aid of a small brush. The injury on workers of group A was caused by a small incision between pronotum and mesonotum, using an entomological pin. All workers from different groups were handled in the same way as workers from group A, (including a simulation of perforation of pronotum, i.e. touching the worker body with the pin but with no perforation) to control for effects of alarm pheromone on the attraction of phorid flies. To quantify the number of attacks by phorids on workers from each experimental group, each worker was placed only once (no repetition) in a box (51x43x7 cm) covered on the borders with Fluon (a substance that prevents ants from escaping), immediately after its capture in the field. Each experiment lasted 10 minutes and was conducted between 7:00 h and 18:00 h, under field conditions. After each attack, phorids were collected with an aspirator to avoid recording attacks for the same fly.

The differences among mean number of phorid attacks on ant workers *D. gigantea* between groups were tested by nonparametric Kruskal-Wallis test, due to non-normality of the data and heteroscedasticity of the variances. Significant differences among means were analyzed by nonparametric Tukey-type multiple comparisons (Zar 1984). Differences between number of workers attacked by group was determined by Chi-Square Analysis.

RESULTS

Two phorid species of the genus *Apocephalus* attacked workers of *D. gigantea*—*A. miricauda* Borgmeier and another species possibly not described in the literature (Brown, B.V. pers. com.). Phorid attack frequency on worker ants differed between the three experimental groups ($X^2 = 17.8$, df = 1, $p < 0.001$) (Table 1). The attacks may be described as a pass over or swoop, followed by the fly landing on the worker's body. During phorid attacks, workers frequently put their forelegs or antennae over the part of the body where the parasitic fly was located, or moved through the arena at a higher speed than when foraging. Sometimes this escape behavior was sufficient to remove phorids from the ant body, as also reported for other ant species generally attacked by phorids (Feener and Moss 1990, Feener 1988). Most of the worker ants that were attacked suffered one to three attacks (maximum of 15 attacks on injured workers) during their time in the box, irrespective of the experimental group (Figure 1). Workers from group A (injured workers) were attacked in higher frequency in relation to group B (uninjured workers) ($q = 5.514$, $p < 0.001$ nonparametric multiple comparation) and group C (uninjured workers with haemolymph) ($q = 3.795$, $p < 0.05$). There was no difference, however, between group B and C ($q = 1.179$, $p > 0.05$, Table 1).

DISCUSSION

The occurrence of attacks by two *Apocephalus* species on injured workers of *Dinoponera gigantea,* supports the idea that attraction to injured workers is common among phorid species, especially to injured ponerines, although some injured ants of *Atta* and *Eciton* genera do not attract parasitic flies (Brown and Feener 1991a,b and references there in). Brown and Feener (1991a) found a phorid species of the same genus, *A. paraponerae,* can attack injured workers of another giant ant species — *Paraponera clavata.* Results from our experiments suggest the possibility that phorids use an olfactory cue for locating potential host ants, as indicated by their preference for injured workers. However, we can not isolate the influence of visual detection of workers by the flies, due to the absence in our experiments of extracts of crushed workers, as used by Brown and Feener (1991a). The absence of a significant difference in the num-

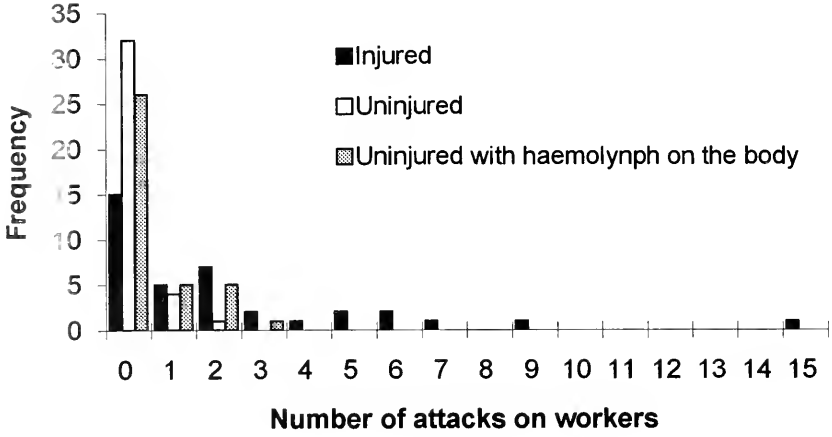

Figure 1. Frequency of attacks by Phoridae flies on workers of the giant ant *Dinoponera gigantea* from three experimental groups (see text).

Table 1. Number of attacks (mean ± SD) by Phoridae on ant workers (n = 111) of *Dinoponera gigantea* from three experimental groups (37 workers/group) (see text for details).

Experimental Group of ants	Number of workers attacked§	Number of attacks by phorids‡ (mean ± SD)
Injured	22 ^{a}	82 (2.22 ± 3.17)^{a}
Uninjured	5 ^{b}	6 (0.16 ± 0.44)^{b}
Uninjured with injury-derived substance	11 ^{b}	18 (0.49 ± 0.84)^{b}

The letters a and b indicate the statistical comparison between the means. Different letters indicate the presence of statistical difference ($p < 0.05$).

§ Chi-Square Analysis ($X^2_{0.05,1} = 3.841$)

‡ Nonparametric Tukey-type multiple comparation test ($q_{0.05,\infty,3} = 3.314$)

ber of attacks between groups B and C, however, indicates that the source of attraction is not in the substance extracted from the injury. During the process of injuring workers (group A), they released an extremely strong odor, not noted in groups B and C (despite the injuring simulation in workers of these two groups). It is therefore possible that a different substance from that extracted from the injury (*e.g.* an alarm or territorial pheromone) may attract phorids to injured workers (Ali and Morgan 1990). On the other hand, it is possible that the evaporation rate of the injury-derived substance on workers of group C was higher than the experiment duration, resulting in a low frequency of attacks by phorids.

Injured workers of *D. gigantea* as in *Paraponera clavata* (Brown and Feener 1991a) may be common in nature due to predation or intra-specific and inter-specific competition. Ants probably use an alarm pheromone during predation or competition by interference, so phorids could use the pheromone to find injured workers (Hölldobler and Wilson 1990).

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REDESCRIPTION AND RECLASSIFICATION OF THE SOUTH AMERICAN MAYFLY *MELANEMERELLA BRASILIANA* (EPHEMEROPTERA: LEPTOPHLEBIIDAE)[1]

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ABSTRACT: Study of the type specimen indicates that the mayfly *Melanemerella brasiliana* from Brazil (known only from the holotype female adult) does not belong to the family Ephemerellidae or Tricorythidae, where historically it has been placed and remained an anomaly. *Melanemerella* also does not appear to be a member of any other family of the infraorder Pannota, but based on all characters taken together, it most closely fits the family Leptophlebiidae (infraorder Lanceolata), where it is provisionally placed.A short redescription of the species is given,and important characters are illustrated. Detached marginal intercalaries and gill socket vestiges presence and position on abdominal segments, however, show *Melanemerella* to be an unusual leptophlebiid, and possibly related to the leptophlebiid genus *Massartella*.

The Ephemeroptera genus *Melanemerella* was established by Ulmer (1920) based on a single female adult collected in Espirito Santo, Brazil. The holotype of *M. brasiliana* Ulmer remains the only known representative of the genus. Because the forewings possess detached, short marginal intercalary veins along the outer margins, Ulmer (1920) placed his genus in the family Ephemerellidae. Lestage (1925) considered *Melanemerella* to be a primitive genus compared to other Ephemerellidae, and that it was closely related to *Teloganodes* from southeast Asia. Demoulin (1955) discussed the status of *Melanemerella* and established a new subfamily for it in the family Tricorythidae. No evidence for the reclassification was given by Demoulin. Allen (1965) included Demoulin's subfamily Melanemerellinae in the family Ephemerellidae, where it has remained since (McCafferty and Edmunds 1979).

As part of our revisionary research on the pannote mayflies of the world, we obtained the single specimen of *Melanemerella* held by the Vienna Museum. We had become suspicious of the placement of this taxon in Ephemerellidae or Tricorythidae, because in the Pannota, only the family Leptohyphidae has been generally known in the Neotropics. Also, larvae collected in Colombia by one of us (WPM) and presumed for some time to represent the unassociated larval stage of *Melanemerella* is now known to belong to the little known genus *Haplohyphes* (family Leptohyphidae). Our suspicion about the familial classification of *Melanemerella* was born out by the analysis of characters associated with the specimen of *M. brasiliana,* including adult vestiges of larval characters known to be of importance in higher classification. Below we present a redescription and revised higher classification of the genus and species.

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Melanemerella brasiliana Ulmer, 1920

Female Adult (pinned). Body length 8 mm; forewing length 11 mm; forewing width 4 mm; hindwing length 2 mm. Body coloration generally grayish black to black; wings dark gray, except outer margin of forewings slightly translucent. Head without cephalic projections or vestiges of such. Compound eyes separated more than 6 times width of median ocellus. Thorax (Figs. 1,2) with mesonotum lacking deep transverse suture; mesoscutellum short and not tapered posteriorly; metascutellum poorly developed but fully exposed dorsally (Fig. 2). Forewing (Fig. 3) with 1-3 short, detached intercalaries in each marginal interspace; cubital area with numerous crossveins and asymmetrical in right wing (see Ulmer 1920, Fig. 32) and left wing (Fig. 3); long but detached ICuA subparallel with CuA; CuP strongly curved toward hind margin. Hindwings proportionately small (see Fig. 4 scaled to Fig. 3); costal projection submedial in position, angulate but not sharply pointed (Fig. 5). Legs with five tarsal segments but segment 1 partially fused with tibia (Figs. 6,7); each claw pair with at least one claw strongly hooked (opposite claw not clear from available dry fore- and midclaw of specimen). Foretibiae slightly longer than forefemora (Fig. 6). Abdomen (Fig. 2) with segments 1-5 distinctly shorter than distal segments. Terga 1-5 with evident gill-socket vestiges (indentations) at posterolateral extremities; hind margins of all terga smooth, without projections or tubercles, or vestiges of such. Sterna 2-6 with small anterolateral semicircular areas of thinner integument; sternum 9 deeply emarginate apically (Fig. 8). Median terminal filament well developed.

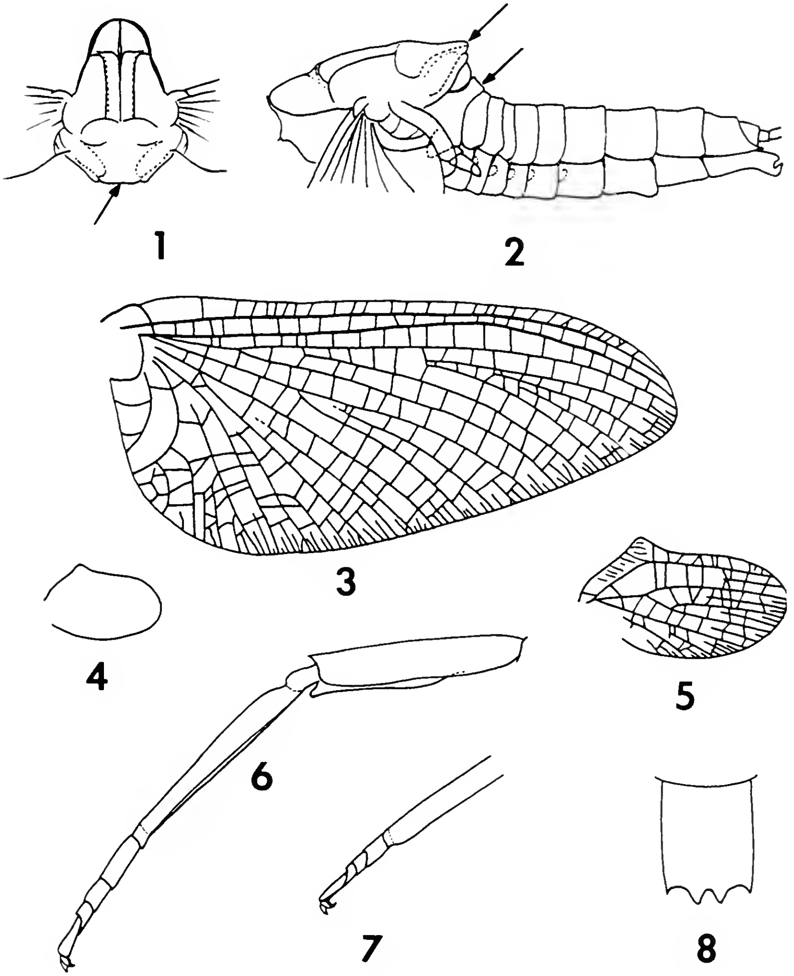
Egg. Observable eggs (remaining attached to abdominal sternum 7) lack polar caps.

Material examined. HOLOTYPE female adult (dry, pinned). Blue label: Espirito-Santo, Brasil, ex coll. Fruhstorffer. Yellow label: Coll. Nat. Mus. Wien. Pale yellow label: *Melanemerella* brasiliana Ulm., in handwriting. Right hindwing paper mounted on pin.

CLASSIFICATION

Critical evidence for removing *Melanemerella* from the Pannota (see McCafferty 1991) is seen in the shortness and untapered nature of the mesoscutellum and the full dorsal exposure of the metathorax, both of which are typical of adult schistonote mayflies, not pannote mayflies [Figs. 1,2; also see McCafferty and Edmunds (1979), Figs. 4-7]. In fact, *Melanemerella* does not fit Ephemerellidae (or Tricorythidae) in any notable aspects, except for having short detached intercalaries in the forewings, which are typical of Holarctic and Oriental ephemerellids. However, such intercalaries occur in at least some genera of several families including both schistonote and pannote mayflies, *e.g.*, Baetiscidae, Baetidae, Ephemerellidae, Ephemeridae, Potamanthidae, and Tricorythidae. Wang *et al.* (1995) showed this character to be subject to homoplasy in Ephemeroptera.

The presence of gill socket remnants on the posterolateral extremities of abdominal segments 1 and 2 of *Melanemerella* is also critical to our conclusion, because all ephemerellids (with the exception of the distinctive subfamily Teloganodinae in Africa and Australasia) lack gills on segment 2. Also, although small filamentous gills may be present on the first abdominal segment of pannotes, including Ephemerellidae and Tricorythidae, they are not oriented at the posterolateral extremity of segment 1 and would not leave an adult vestige in



Figs. 1-8. *Melanemerella brasiliana*, female adult. 1. Mesonotum (pointer to mesoscutellum margin). 2. Body in part, lateral (pointers to mesoscutellum and metascutellum). 3. Left forewing. 4. left hindwing (scaled to Fig. 3.). 5. Left hindwing (enlarged and detailed). 6. Foreleg. 7. Midleg. 8. 9th Sternum.

the position or of the relatively large size that is present in *Melanemerella*. Finally, the presence of one or two polar caps on the eggs of typical Ephemerellidae (with the exception of *Eurylophella*) and Tricorythidae (Koss and Edmunds 1974, McCafferty and Wang 1994) and the absence of polar caps in *Melanemerella* additionally reinforce our conclusions about removing *Melanemerella* from its former familial classifications.

Many characters suggest to us that *Melanemerella* may belong to the family Leptophlebiidae (infraorder Lanceolata) (see McCafferty 1991). The schistonote type of thorax, the forewing ICuA that is nearly parallel to CuA and attached to CuA only by crossveins, the tarsal segment 1 that is fused or partially fused with the tibia, the sculptured apical margin of the female abdominal sternum 9, the three developed caudal filaments, and the lack of polar caps in the eggs agree with the general characterization of Leptophlebiidae. Some of the above character states occur in various other families of Ephemeroptera, but the greatest number of matches with the characters states of *Melanemerella* are with Leptophlebiidae. Nevertheless, if indeed *Melanemerella* is a leptophlebiid, as we suggest, then it is an unusual one, but not entirely a unique one, as shown in the following.

From the examination of gill socket vestiges in the adult of *Melanemerella*, it is obvious that the larva has five or six pairs of abdominal gills, occurring on segments 1-5 or 1-6. We cannot be sure if gills exist on segment 6 because there is only a slight possible indication of a vestigial socket there. We are, however, confident that there is no gill present on the seventh abdominal segment of the larva. Although the presence of gills on abdominal segments 1-7 is a characteristic most typical of Leptophlebiidae, the South American genus *Massartella* (see Ulmer 1943, Pescador and Peters 1990) has gills on abdominal segments 1-6.

Also, although crossvenation in the cubital area of the forewing of *Melanemerella* is atypical of Leptophlebiidae, there are instances where crossvenation is well developed in this wing area in leptophlebiids. For example, it is well developed in the South American *Massartella alegrettae* Ulmer (Ulmer 1943, Fig. 38, male adult). In addition, sexual dimorphism occurs in certain Leptophlebiidae with respect to this character, *e.g.*, in the New Caledonian *Peloracantha titan* Peters and Peters, where the venation in the cubital area is poorly developed in the male, but well developed in the female (Peters and Peters 1979-80, Figs. 16-19). Because of this, it is possible that the unknown male of *Melanemerella* may have cubital crossvenation more typical of most leptophlebiids.

Concerning the dark coloration of the female adult of *Melanemerella*, a similar situation is found in *Massartella alegrettae* (Pescador and Peters 1990, Fig. 16). Finally, one male adult of *Massartella fruhstorfferi* Ulmer (= *M. brieni* Lestage) was collected at the same locality where *Melanemerella* was taken, by the same collector (see Ulmer 1943).

It is possible that *Melanemerella brasiliana* is an unusual leptophlebiid. Moreover, it may be related to the also unusual leptophlebiid genus *Massartella*, or, less plausibly, it may even be a species of *Massartella*. The provisional placement in the Leptophlebiidae will only be verified or refuted by the eventual study of the as yet unassociated larval stage of *Melanemerella*. Leptophlebiidae remains difficult to key out, in its entirety, from all other families on a world level in either the adult or larval stage. The inclusion of *Melanemerella* does not change this situation. It is also possible that *Melanemerella* belongs to a new family of mayflies, but again the larva would be needed to establish such.

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We thank Dr. Ulrike Aspöck of the Vienna Museum for kindly loaning us the type of *M. brasiliana*. This paper has been assigned Purdue Agricultural Research Program Journal Number 14844.

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NEW INFORMATION ON THE NEW WORLD *PHYSOCEPHALA* (DIPTERA: CONOPIDAE)[1]

Sidney Camras[2]

ABSTRACT: Examination of some types and additional material has resulted in some new synonymy. One new name is proposed: *P. wulpi* for *P. testacea*, which is preoccupied. Two new species are described: *P. bennetti* from Trinidad and *P. sabroskyi* from the Bahamas. A new key to species is presented.

Accumulation of material since my 1957 paper, reveals a large amount of variation in many species, as well as the frequent occurrence of intermediates. Intermediates are to be expected if we accept evolution; and some of these may be hybrids. This paper should be considered within context of my earlier paper (1957) in order to avoid a considerable amount of duplication.

Physocephala soror Kröber

Physocephala soror Kröber (1915a:143).

Remarks.— Several specimens have now been seen including a syntype (USNM). This species is similar to *P. inhabilis* Walker and *P. bipunctata* (Macquart). It should not be confused with *Conops soror* Kröber (1915b: 131) which is a synonym of *Physocephala inhabilis* (Walker) (1849:672).

Physocephala sororcula Williston

Physocephala sororcula Williston (1892: 83).

Remarks.— This species was previously considered a synonym of *P. furcillata* (Williston). Williston did not describe the halter which has black on the knob. A syntype (BMNH) was studied.

Physocephala marginata (Say)

Remarks.— Specimens have now been seen from Mexico, including typically dark specimens from Quintana Roo and Sinaloa (EMUS). There are intermediates toward *P. inhabilis* (Walker), a species that is also typically very dark, but has a very distinct wide pleural pollinose stripe. Intermediates also occur with *P. sagittaria* (Say) and *P. texana* (Williston).

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Physocephala sagittaria (Say)

Remarks.— Specimens have now been seen from Mexico. These are not as dark as northern USA specimens and are probably a southern cline (*P. castanoptera* Loew). Specimens have been found with a small hyaline area in the discal cell of one wing, and the discal cell of the other wing entirely dark. These have been seen from Alpine, Texas; Las Cruces, New Mexico; and San Rafael, Vera Cruz.

Reexamination of the holotype of *Conops dimidiata* Walker (BMNH) again confirms the synonymy with *P. sagittaria* (Say).

Physocephala wulpi, NEW NAME

Conops testaceus Wulp (1883: 13).

Remarks.—This name is preoccupied by *Conops testaceus* Macquart (1843, 9); India: Bengal and Pondichery. Typically this species is very rufous with no black on the mesonotum. Intermediates with *P. cayennensis* (Macquart) occur. The holotype of *C. testaceus* Wulp (ZMAN) was examined.

Physocephala cayennensis (Macquart)

Remarks. — There is a male specimen in (MNHN), #1711, not labelled as the type but apparently the specimen considered as the holotype by Séguy (Camras, 1957: 215). This species typically is very dark with black on the mesonotum.

Study of the holotype of *Conops piciventris* Wulp (ZMAN) confirms its conspecificity and synonymy with this species.

Physocephala bennetti, NEW SPECIES

Head: Frons black, extending through the face to the black cheek. Vertex yellowish brown. Frontal orbital margin brown and narrow, becoming wider and yellow at the facial orbital margin. Facial keel black becoming wider below; distinct from the yellow facial grooves. Occiput black, narrow orbital margin yellow pollinose, extending into the cheek. Antenna and arista black, dark brown ventrally at first flagellomere. Process of second aristal segment flat and wide, nearly as long as the third aristal segment. Scape about 3x as long as wide. Pedicel 3 1/2 x as long as scape. First flagellomere 1 1/2x length of scape.

Thorax: Dark brown with indistinct dark stripes on dorsum, and indistinct light yellow pollinose areas. Similar pollinose pleural stripe which is more distinct below. Legs dark brown with indistinct black ring near base of metafemur. Yellow pollinose areas on coxae and femora. Wing black anteriorly to fifth vein. Hyaline apically in discal cell and in a small area of first posterior cell. Halter yellow.

Abdomen: Dark brown, first tergite black. Black dorsally on second tergite with yellow pollinose margin at base and apex. Light yellow pollinose on apical tergites. Theca of moderate (average) length. Length 23 mm.

Type material.— HOLOTYPE ♀: Trinidad: Curipe, June 1965, F.D.B(ennett). Dead bee, *Xylocopa submordax*, found May 12. Emerged June 11. (CNC). PARATYPES: ♀, (Trinidad): Coll. Balandra, April 17, 1965, F.D. Bennett. Ex. *Xylocopa frontalis* -on ground below nest (CNC). Similar to holotype. Dark ring of metafemur distinct. ♀, (Trinidad): Aug. 1964. Ex. dead *Xylocopa submordax.* Pupal case on pin. (CNC). Similar to holotype but some yellow on lower face. ♀, (Trinidad): Curepa, July 1965, F.D. Bennett. Ex. adult of *Xylocopa submordax* (CNC). Similar to holotype but some yellow on face extending narrowly up on the frons, somewhat teneral.

Remarks.— This species is related to *P. cayennensis* (Macquart) having the black facial keel and yellow halter. It keys to *P. sericeus* (Olivier) in the 1957 key, but does not agree with Olivier's description.

Physocephala sabroskyi, NEW SPECIES

Head: Frons and face including grooves yellow. Narrow "T" pattern on frons, cheek and occiput black. Vertex brown. Antenna rufous, darker on pedicel mainly due to the black hairs. Pedicel 2.5x length of the scape, the first flagellomere a little longer than the scape. Proboscis black, rufous at base, 1.5x length of head.

Thorax: Black. Scutellum, humerus, and adjacent margins brown. Distinct gold pollinose pleural stripe connected to gold pollinose on humerus and adjacent areas. Gold pollinose on scutellum, adjacent mesonotum and upper margin of postnotum. Legs rufous with gold pollinose areas, black on coxae, claws and pulvillae. Halter yellow, black at base. Wing pattern rufous, extending to fifth vein, paler in costar cell. Black apically at first posterior cell (R_5) and submarginal cell (R_3). Discal cell hyaline in apical half.

Abdomen: Black, most of second tergite, base and apex of third tergite, and genitalia rufous. Gold pollinose apically on all the segments.

Length: 11 mm.

Type material.— HOLOTYPE ♂: Bahamas: Andros, 5 mi. S. Pt. Simon, W. Coast, 18 Mch., O.L. Cartwright. Smithsonian-H.J. Bowen Expedition, Andros I., Bahamas. 1966 (USNM).

Remarks.— This very distinctive species is easily recognized by the rufous wing pattern with black apically. Although the only other species in this genus with such a wing are from Argentina and Chile, this pattern is found in several West Indian *Physoconops.*

Etymology.— This species is named in honor of Dr. Curtis W. Sabrosky, in appreciation of all his help during my earlier work on Conopidae.

Physocephala venusta Parsons

Remarks.— Originally described from one female from Haiti, I have now examined a male and a female from the Dominican Republic: Cabo Rojo, km. 25 Alcoa Road, dry premontane forest, 18.I.1989, S.A. Marshall (DEBU). The male is similar to the female, the abdomen beyond the second tergite being mainly dark rufous. The black cheek is yellow in the center. The entirely dark discal cell suggests affinity to *P. sagittaria.*

Physocephala aurifrons (Walker)

Conops flavifrons Walker (1849: 672) [preoccupied by *Conops flavifrons* Meigen, 1824].
Conops aurifrons Walker (1849: 1158) [replacement name].
Physocephala vespiformis Kröber (1915a: 135). [new synonymy].
Physocephala brasiliensis Kröber (1915a: 136). [new synonymy].

The holotype of *P. aurifrons* (BMNH) was examined. It is a female from Pará, Brazil. The name *C. aurifrons* was given under "errata" to replace *C. flavifrons* but no reason was given. Presumably it was because *C. flavifrons* was preoccupied.

The type agrees with Walker's description except that when he described "front of head yellow" he was referring only to the face. The frons of this species is black.

The position of *P. flavifrons* in the 1957 key was based on a misidentified specimen from N. Luzon (BMNH).

The holotype of *P. vespiformis* (ZMHB) was examined, and R. Contreras-Lichtenberg sent a drawing of the wing of the holotype of *P. brasiliensis* showing that the wing pattern extends through the fifth vein, thus filling the second basal cell. The discal cell is hyaline apically.

The male of this species differs from the male of *P. lugubris* (formerly *P. nigrifacies)* as follows: the apex of the abdomen is more acutely pointed; the halter is yellow with black on knob; the facial grooves are mainly yellow in distinct contrast to the black face; the head is more rounded, and the size is usually larger. The female differs additionally by having the face yellow. The only males examined are two from Trinidad (CNC), one of which has the face entirely black and in the other it is partly yellow.

Physocephala carbonaria (Bigot)

Conops carbonarius Bigot (1887: 42).

Remarks. — This species is very similar to *P. aurifrons* but is more shiny, less pollinose. The male abdomen is rounded, thus differentiating *P. aurifrons* and *P. lugubris.* This species was previously considered to be a synonym of *P. nigrifacies* (Bigot). The two syntypes of *P. carbonaria* (male and female) and Williston's specimens (1892: 81) are all from Mexico (BMNH) and were examined for this study. A male and female from Costa Rica (CMNH) were also studied.

Physocephala thecala Camras

Remarks. — Originally described from a single female from Santa Catarina, Brazil. There are four males from Argentina (Tucumán and Catamarca, USNM) that are referred here. They are less robust than the type female but this may be due to geographical variation. The male abdomen is similar to *P. unicolor* Kröber but there are no posterior pollinose margins on the tergites. The apex of the abdomen of these males is bluntly pointed (as in *P. unicolor)* in two specimens; but in two this structure is rounded. This difference in the shape of the apex of the abdomen is unusual within a species, and shows that any character can be variable.

Physocephala nervosa Kröber

Physocephala nervosa Kröber (1915a: 145)
Physocephala pulchripennis Kröber (1927:132) [new synonymy].

Remarks.— The difference in wing pattern in the keys is not correct. In the original description of *P. pulchripennis,* the wing pattern is black apically.

Physocephala bicolor Kröber

Remarks.— The yellow faced female is now considered normal for this species as in the case of *P. aurifrons* and *P. carbonaria.* In all the other species examined the face is similar in both sexes. The head is missing in the female from Chapada in the USNM.

Physocephala picipes Kröber

Remarks.— The holotype female (NHMW) was studied. I have for comparison one female in my collection (ex. Pearson Collection) and one female from the BMNH, both from Nova Teutonia, Brazil. The type has some foreign material on the frons making it difficult to see the pattern but it seems to have a large dark "T" pattern. The specimen from the BMNH has yellow above the antenna this showing considerable variation in the color of the frons. My specimen, which is similar to the holotype, has more black on the frons with some yellow from the face extending onto the frons. Laterally black from the frons extends down to the face. The first flagellomere is relatively long and as a result the curvature resembling that of a *Tabanas* inverted is present, as described by Kröber. This curvature is the result of retraction of the soft underside, and occurs in other species; but because the first flagellomere is short in the other species it is not as conspicuous.

The arista and the sixth tergite are distinctive and characteristic of this species. The apical segment of the arista is cylindrical and blunt at the apex. In other species including the very similar *P. unicolor* it tapers and is pointed at the tip. The sixth tergite is relatively narrow (short), almost half the usual length. The halter, which is yellow, has a black mark at the junction of the knob and the stem.

Physocephala unicolor Kröber

Physocephala unicolor Kröber (1915a: 145).
Physocephala fairchildi Camras (1957: 216) [new synonymy].

Remarks. — The holotype of *P. unicolor* (ZMHB) was studied. In some views there is much more yellow on the halter than described. The abdomen has some dermestid damage and distortion so that it resembles a female, but it is a male. The apical tergite is bluntly pointed, about as long as wide.

There are two additional specimens from Entre Rios, Argentina (BMNH).

Physocephala lugubris (Macquart)

Conops lugubris Macquart (1835: 26).
Conops nigrifacies Bigot (1887: 40) [new synonymy].

Remarks.— Examination of the holotype (MNHN, #1715), reveals this synonymy. This could hardly be determined from the brief original description. This is not the same as the species described by Macquart (1843: 16) with the name *Conops lugubris,* which is a synonym of *P. tibialis* Say. That holotype, according to Kröber (1939: 541) is in the BMNH.

There is a male specimen (MNHN, #1712) under the name *P. lugubris,* not labeled as the type, which agrees with *P. tibialis.*

Physocephala ephippium (Macquart)

Conops ephippium Macquart (1843: 11).

Remarks.— Described from "Amerique meridionale." There are three specimens (MNHN, #527), as originally recorded but the locality is marked as Egypt. They agree with the original description but I believe they are P. *antiqua* (Wiedemann) which occurs in Egypt.

The first posterior cell is abruptly black on the basal half and the first basal cell is hyaline. This pattern is common in Old World species but has not been seen in any species from the New World.

Physocephala flaviceps (Macquart)

Conops flaviceps Macquart (1843: 15).

Remarks.— Described from "De l'Amerique septentrionale." The holotype was in Macquart's personal collection (Lille, France), and Matile believes that it no longer exists. From the description the wing band terminates abruptly (at the second vein). It would therefore be an Old World species, whether or not there was black in the first posterior cell.

Physocephala punctum (Bigot)

Conops punctum Bigot (1887: 45).
Physocephala punctum (Bigot) [Camras (1957: 217)].

Remarks.— One male and two females (BMNH) not labelled as types. The first posterior cell is black on the basal half and the first basal cell is hyaline. This is an Old World species. See note under *P. ephippium.*

Key to the New World *Physocephala*

1	Frons mainly or entirely dark	2
1'	Frons mainly or entirely pale	15
2	Face black, continuous with black frons and cheek	3
2'	Face yellow or reddish, or partly black	8
3	Head thin, nearly half as long as high. Facial grooves partly dark. Male abdomen pointed	4
3'	Head normal, much more than half as long as high. Facial grooves mainly pale. Male abdomen rounded or pointed	5
4	Halter black. Coxae mainly black	*P. lugubris*
4'	Halter black and yellow. Coxae dark yellow	*P. brunnipes*
5	Thorax rufous (male)	*P. bicolor*
5'	Thorax dark	6
6	Thorax partly brown, facial keel black	*P. bennetti*
6'	Thorax black, facial keel yellow (male)	7
7	Apex of abdomen rounded	*P. carbonaria*
7'	Apex of abdomen pointed	*P. aurifrons*
8	Discal cell entirely dark. Thorax mainly reddish	*P. floridana*
8'	Discal cell partly hyaline. Thorax black or rufous	9
9	Face partly black	10
9'	Face entirely yellow or rufous	12
10	Halter yellow with black mark at base of knob. Sixth tergite of female very short	*P. picipes*
10'	Halter black and yellow. Sixth tergite of female normal	11
11	Facial keel black	*P. bennetti*
11'	Facial keel yellow (males)	*P. aurifrons*
12	Cheek reddish, same as face	*P. spheniformis*
12'	Cheek black	13
13	Thorax rufous (female)	*P. bicolor*
13'	Thorax black	14
14	Abdomen shiny, less pollinose. Sixth tergite relatively short (female)	*P. carbonaria*
14'	Abdomen relatively dull, more pollinose. Sixth tergite relatively long	*P. aurifrons*
15	Cheek uniformly dark	16
15'	Cheek paler in middle	29
16	Wing pattern mainly rufous, dark apically	17
16'	Wing pattern dark, may be pale at base	19
17	Facial keel black. Halter black at knob	*P. nervosa*
17'	Facial keel yellow. Halter yellow	18
18	No pollinose pleural stripe	*P. segethi*
18'	Distinct gold pollinose pleural stripe	*P. sabroskyi*
19	Halter partly black	20
19'	Halter yellow except at base	24
20	Facial keel black	21
20'	Facial keel yellow	22

21 Face mainly black. Halter with small black area at junction of knob and stem .... *P. picipes*
21' Face yellow. Halter black on knob and on part of stem .... *P. unicolor*
22 Mainly rufous species (females) .... *P. bicolor*
22' Mainly black species 23
23 Tergites with pollinose apical margins. Theca short .... *P. sorocula*
23' Tergites without pollinose apical margins. Theca very long .... *P. thecala*
24 Facial grooves black. Discal cell dark 25
24' Facial grooves pale. Discal cell mainly hyaline 26
25 Black "T' of frons wide. Thorax partly reddish (SE USA) .... *P. floridana*
25' Black "T' of frons narrow. Thorax black (E N.Am.) .... *P. tibialis*
26 Facial keel black. Dark species .... *P. cayennensis*
26' Facial keel yellow 27
27 Cheeks black. Dark species (N.Am., Mex.) .... *P. furcillata*
27' Cheeks reddish. Rufous species 28
28 Scape 3-4x as long as wide. Rufous species (N.Am., Mex.) .... *P. texana*
28' Scape 2x as long as wide. Reddish species (N.Am.) .... *P. burgessi*
29 Knob of halter black or dark brown 30
29' Knob of halter yellow, may be pale rufous or brownish 31
30 Rufous species. No pleural stripe .... *P. rufthorax*
30' Dark species. Pollinose pleural stripe .... *P. bipunctata*
31 Facial grooves dark 32
31' Facial grooves pale 34
32 Discal cell entirely dark (N.Am., Mex.) .... *P. sagittaria*
32' Discal cell mainly hyaline 33
33 Pollinose pleural stripe distinct and wide above .... *P. inhabilis*
33' Pollinose pleural stripe less distinct, narrow above (N.Am., Mex.) .... *P. marginata*
34 Facial keel dark 35
34' Facial keel pale 36
35 Mesonotum entirely or mainly rufous .... *P. wulpi*
35' Mesonotum entirely or mainly black .... *P. cayennensis*
36 Mainly blackish species 37
36' Mainly reddish or brownish species 38
37 Abdomen black .... *P. inhabilis*
37' Abdomen dark reddish apically .... *P. venusta*
38 Rufous species. Black on mesonotum distinct (N.Am., Mex.) .... *P. texana*
38' Brownish species with diffuse black areas on mesonotum .... *P. soror*

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NOTES ON THE SPITTLEBUG GENUS *ECTEMNONOTUM* (HOMOPTERA: CERCOPIDAE)[1]

Ai-Ping Liang[2]

ABSTRACT: *Cosmoscarta nigra* Atkinson is transferred to the genus *Ectemnonotum* Schmidt. *E. strangulatum* Lallemand & Synave is synonymised with *E. fruhstorferi* (Jacobi) and *E. distanti* var. *rubrovittatum* Schmidt with *E. distanti* (Butler). *E. fruhstorferi* and *E. nigra* are reported from China and China and Laos, respectively, for the first time. Metcalf & Horton's (1934) record of *E. bivittatum* from China is rejected. Four lectotypes are designated. Syntypes of one Jacobi species found in the Natural History Museum, London, and four Schmidt species in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., are reported.

While accumulating information on the spittlebug fauna of the Oriental region a number of taxonomic discrepancies in the genus *Ectemnonotum* were noted which require amendments. In this paper, I transfer one species previously recognised in *Cosmoscarta* to *Ectemnonotum*, propose two new synonyms, select four lectotypes, and provide new distributional data for *E. fruhstorferi* (Jacobi) and *E. nigra* (Atkinson). Metcalf & Horton's (1934) record of *E. bivittatum* from China is rejected. Syntypes of one Jacobi species recently found in the Natural History Museum, London, and five Schmidt species in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., are also reported.

The specimens studied in the course of this work are deposited in the following institutions whose names are abbreviated in the text as follows:

BMNH – The Natural History Museum, London, UK; BPBM – Bernice P. Bishop Museum, Honolulu, Hawaii, USA; IZAS – Institute of Zoology, Academia Sinica, Beijing, China; MNHN – Muséum National d'Histoire Naturelle, Paris, France; MNHU – Museum für Naturkunde der Humboldt-Universität, Berlin, Germany; MVNH – Museum of Victoria Natural History, Victoria, Australia; NCSU – Department of Entomology Insect Collection, North Carolina State University, Raleigh, N.C., USA; SMTD – Staatliches Museum für Tierkunde, Dresden, Germany; TMNH – Tianjin Museum of Natural History, Tianjin, China; and USNM – [US National Museum] National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA.

Ectemnonotum nigra (Atkinson) NEW COMBINATION

Cosmoscarta nigra Atkinson, 1889: 335; Distant, 1908: 155; Lallemand, 1912: 135; Metcalf, 1961: 470. LECTOTYPE ♂, SIKKIM (BMNH), here designated [examined].

Gynopygoplax nigra (Atkinson); Lallemand & Synave, 1961: 34.

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Taxonomic note: Atkinson (1889) described *nigra* in *Cosmoscarta* Stål; Lallemand & Synave (1961), in their revision of world Cercopinae, transferred this species into *Gynopygoplax* Schmidt. I am here transferring *nigra* to *Ectemnonotum* Schmidt on the basis of the male genitalia.

This species was originally recorded by Atkinson (1889) from Sikkim. I here provide new locality records in China and Laos.

Distribution: Sikkim, China (Yunnan Province), Laos.

Specimens examined: Lectotype ♂, *Cosmoscarta nigra* Atkinson 1889, by present designation, Sikkim, '92-6', Atkinson Coll. (BMNH).

CHINA, YUNNAN PROVINCE: 1♂, nr. Cheli, 600 m, 22.iv.1957 (D. Panfilov); 1♂, 1♀, Cheli, Shihuiyao, 700 m, 26.iv.1957 (D. Panfilov); 1♀, Xishuangbanna, Mengla, 620-650 m, 4.v.1959 (S.F. Li) (all in IZAS). LAOS: 3♂, Luang-Prabang à Theng, 1888 (Pavie) (MNHN).

Ectemnonotum fruhstorferi (Jacobi)

Cosmoscarta fruhstorferi Jacobi, 1902: 23; 1905: 441, pl. 21, figs. 8, 8a. LECTOTYPE ♂, VIETNAM (SMTD), here designated [examined].

Ectemnonotum fruhstorferi (Jacobi); Schmidt, 1909: 297, 308.

Ectemnonotum strangulatum Lallemand & Synave, 1961: 83, 86, pl. 10, fig. 22. Holotype ♂, Laos (BMNH). [Examined by M.D. Webb on author's behalf.]. **New synonymy.**

Taxonomic note: *Cosmoscarta fruhstorferi* was described by Jacobi (1902) from an unspecified number of specimens from Tonkin, northern Vietnam. I have examined four male syntypes of *fruhstorferi* in SMTD and MNHU. One male syntype was also found in BMNH. Lallemand & Synave (1961) recorded *fruhstorferi* as *strangulatum* from Laos. I here provide new locality records for this species in China.

Distribution: Vietnam (Tonkin), Laos, China (Yunnan Province).

Specimens examined: Lectotype ♂, *Cosmoscarta fruhstorferi* Jacobi 1902, by present designation, [VIETNAM]: Central-Tonkin, Chien Hoa, Aug.-Sept., H. Fruhstorfer; Coll. A. JACOBI 1912-3; A. Jacobi, Typus; *fruhstorferi* Jac. (SMTD). Holotype ♂, *Ectemnonotum strangulatum* Lallemand & Synave 1961, LAOS: Pakneun, 24.ix.1918 (R. Salvaza) (BMNH). 1♂ paralectotype of *Cosmoscarta fruhstorferi* Jacobi 1902, same data as lectotype (SMTD); 2♂ paralectotypes of *Cosmoscarta fruhstorferi* Jacobi 1902, Tonkin (2♂ in MNHU; 1♂ in BMNH).

CHINA, YUNNAN PROVINCE: 3♂, Hekou, 80-200 m, 10.vi.1956 (K.R. Huang *et al.*); 1♂, same locality and altitude, but 12.vi.1956 (D. Panfilov); 9♂, Hekou, Xiaonanxi, 200 m, 8-12.vi.1956 (K.R. Huang *et al.*); 2♂, Xishuangbanna, Damenglong, 650 m, 6,14.vii.1958 (Y.R. Zhang); 1♀, Xishuangbanna, Mengla, 620-650 m, 13.xi.1958 (S.Y. Wang); 4♂, same locality and altitude, but 8,10,13.vii.1959 (S.F. Li); 3♂, 1♀, same locality and altitude, but 7.xi.1958 and 8,10.vii.1959 (F.J. Pu); 3♂, 2♀, same locality and altitude, but 19.xi.1958 and 12.vii.1959 (Y.R. Zhang); 6♂, same locality and altitude, but 7-9.vii & 28.viii.1959 (F.C. Zhang) (all in IZAS); 1♂, same locality, but 20.ix.1979 (S.L. Liu) (TMNH); 2♂, Xishuangbanna, Menglun, 650 m, 26,27.vii.1959 (F.J. Pu); 2♂, same locality and altitude, but 31.viii.1959 (F.C. Zhang); 6♂, same locality and altitude, but 22,23,25.vii & 3.viii.1959 (Y.R. Zhang); 11♂ & 1 specimen (without abdomen), same locality and altitude, but 22.vii-1.viii.1959 (S.F. Li); 2♂, 1♀, Xishuangbanna, Mengzhe, 870-1200 m, 5-8. ix. 1958 (F.J. Pu); 1♂, same locality and altitude, but 6.ix.1958 (S.Y. Wang); 2♂, Xishuangbanna, Xiaomengyang, 850 m, 12.vii & 10.x.1959 (L.C. Zang); 1♀, same locality and altitude, but 3.ix. 1957 (S.Y. Wang); 1♂, Xishuangbanna, Yunjinghong, 650 m, 19.vi.1958 (Y.R. Zhang) (all in IZAS). LAOS: 1♂, Tonpheng, 14.ix.1965 (native collector) (BPBM). VIETNAM: 1♂, Tonkin, Hoa-Binh (A. de Cooman) (IZAS).

Ectemnonotum distanti (Butler)

Cosmoscarta distanti Butler, 1874b: 672.
Ectemnonotum distanti (Butler); Schmidt, 1909: 307.
Ectemnonotum distanti var. *rubrovittatum* Schmidt, 1909: 297, 323; Metcalf, 1961: 497.
LECTOTYPE ♀, SUMATRA (MNHU), here designated [examined]. **New Synonymy.**
Ectemnonotum distanti var. *sanguineovittatum* [sic] Schmidt, 1909: 308.

Taxonomic note: Two spellings, *rubrovittatum* and *sanguineovittatum*, were used in Schmidt's (1909) original description of the new variety of *Ectemnonotum distanti*. Metcalf (1961) accepted *rubrovittatum* in his catalogue of world Cercopidae. Here, Metcalf (1961) is followed as first reviser and *rubrovittatum* is used.

Distribution: Indonesia (Sumatra).

Specimens examined: Lectotype ♀. *Ectemnonotum distanti* var. *rubrovittatum* Schmidt 1909, by present designation, Sumatra, excell. v. Studt G.; Type; *E. distanti* var. *rubrovittatum* Schmidt ♀ Edm. Schmidt determ. 1908 (MNHU).

SUMATRA: 3♂, 3♀, Westkuste, no date (F. Faber) (*Cosmoscarta distanti* Butl., Jacobi det.) (MNHU; IZAS).

Ectemnonotum bivittatum (LePeletier & Serville)

Cercopis bivittata LePeletier & Serville, 1825: 605.
Cercopis flavifascia Walker, 1851: 654.
Cosmoscarta bivittatum (LePeletier & Serville); Butler, 1874a: 256.
Ectemnonotum bivittatum (LePeletier & Serville); Schmidt, 1909: 303; Metcalf & Horton, 1934: 396, pl. 40, figs. 77, 82.

Taxonomic note: Metcalf & Horton (1934) in their Cercopoidea of China doubtly recorded *Ectemnonotum bivittatum* from China; they stated that "This species has been recorded from Java and Sumatra. We have a series from China without a definite locality, whether these were introduced into China or whether the label is an error, we have no way of telling." This Chinese record was later accepted by Wu (1935: 160) and Metcalf (1961: 494) in their catalogue of Chinese insects and catalogue of world Cercopidae, respectively. I have recently examined the specimens of *E. bivittatum* studied by Metcalf & Horton in NCSU. Their identifications are correct. Six specimens, each of which has Metcalf's identification label, were found; but they do not have any collecting labels. I don't know why Metcalf and Horton (1934) believed that these specimens were collected from China. I also found five additional, unidentified specimens of *E. bivittatum* from Java in NCSU without Metcalf's identification labels. All specimens of the two groups proved to be the same species. It appears that the 6 "Chinese" specimens which Metcalf & Horton studied were probably from Java. No specimens of *E. bivittatum* have ever been reported by other investigators from China so it appears that the species does not occur in China.

Distribution: Indonesia (Borneo, Java, Sumatra) and Malaysia (Malacca, Sarawak).

Specimens examined: 2♂, 4♀, no data, *Ectemnonotum bivittatum* A. & S., Det. Z.P. Metcalf (NCSU). [INDONESIA]: 1♂, Java, Malang; 1♂, Java, Malang, '507'; 2♀, Java, Soekaboemi, Le Moult; 1♀, Java, Soekaboemi (all in NCSU); 1♂, 1♀, Bintang (Rottger), Cat. No 5719; 2♂, Nord-Borneo (Rolle V.); 15♂, 7♀, Java, Kawi-Geb., 1219 m [4000 ft], no date (Thieme V.); 1♀, Java, Palabuan-Ratu (Axel Preyer S.G.); 1♀, Java, Tengger-Geb. (Fruhstorfer S.); 1♂, 1♀, Java, ?Hgg, Cat. No. 5718; 1♀, Ober-Langkat, Deli, 1894 (M. U de S.); 1♀, Sumatra (Excell. V. Stut. G.) (MNHU; IZAS). [MALAYSIA]: 1♂, Mallaca (Künstler) (MNHU); 1♀, Sarawak (Wallace) (*Cercopis flavifascia*) (VMNH).

Ectemnonotum rugosum Schmidt

Ectemnonotum rugosum Schmidt, 1909: 313; Lallemand, 1912: 142; Metcalf, 1961: 500; Lallemand & Synave, 1961: 86. LECTOTYPE ♂, SUMATRA (MNHU), here designated [examined].

Taxonomic note: This species was described from three males and three females from Sumatra. One female syntype recently found in the USNM is here designated as paralectotype.

Distribution: Indonesia (Sumatra).

Specimens examined: Lectotype ♂, by present designation, SUMATRA: Soekaranda, Dr. H. Dohrn S.; Type; *Ectemnonotum rugosum* Schmidt ♂ Edm. Schmidt determ. 1909 (MNHU); 1♀ paralectotype, same data as lectotype (USNM).

Ectemnonotum cochleatum Schmidt

Ectemnonotum cochleatum Schmidt, 1909: 301, 318, 324.

Taxonomic note: This species was described from two males and two females from Sumatra. One female syntype recently found in the USNM is reported here.

Distribution: Indonesia (Sumatra).

Specimen examined: 1♀ Syntype, Sumatra, Soekaranda Dr. H. Dohrn S.; Type; *Ectemnonotum cochleatum* Schmidt ♀ Edm. Schmidt determ. 1909 (USNM).

Ectemnonotum dohrni Schmidt

Ectemnonotum dohrni Schmidt, 1909: 298, 304, 323.

Taxonomic note: This species was described from two males and one female from Sumatra. One male syntype recently found in the USNM is reported here.

Distribution: Indonesia (Sumatra).

Specimen examined: 1♂ Syntype, Soekaranda Januar 1894 Dohrn; Type; *Ectemnonotum dohrni* Schmidt ♂ Edm. Schmidt determ. 1909 (USNM).

Ectemnonotum excellens Schmidt

Ectemnonotum excellens Schmidt, 1909: 311.

Taxonomic note: *Ectemnonotum excellens* Schmidt was described from seven males and five females from Sumatra. One female syntype recently found in the USNM is reported here.

Distribution: Indonesia (Sumatra).

Specimens examined: 1♀ Syntype, Sumatra Soekaranda Dr. H. Dohrn S.; Type; *Ectemnonotum ex[c]ellus* [sic] Schmidt ♀ Edm. Schmidt determ. 1909 (USNM).

SUMATRA: 1♂, no definite locality (Excels. V. Studt G.); 1♂, no definite locality (Rolle Y.); 1♂, 1♀, Deli (Martin, G.); 2♂, Ober Langkat, Deli, 1894 (M. U de S.); 1♂, 3♀, West Ruste (V. Faber) (MNHU; IZAS).

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SCIENTIFIC NOTE

FIRST REPORT OF *CHAULIOGNATHUS* (COLEOPTERA: CANTHARIDAE) LARVAE IN EXCAVATED SHOOTS OF *PINUS SYLVESTRIS*[1,2]

R.D. Waltz[3], T. McCay-Buis[3]

While performing regulatory inspections of Scots Pine *(Pinus sylvestris* L.) Christmas trees in Hancock County, Indiana, several larvae of *Chauliognathus* Hentz (Coleoptera: Cantharidae) were observed and collected from within shoots that had been previously excavated by larvae of *Eucosma* Hübner and *Rhyacionia* Hübner (Lepidoptera: Tortricidae) or *Dioryctria* Zeller (Lepidoptera: Pyralidae). The Scots Pine Christmas trees had been brought to the attention of one of us (TMB) based on concerns by the landowner regarding a September infestation by "worms" in Christmas trees that were ready to be marketed. Such a late-season infestation by "worms" is unusual because this time period is well beyond the normal range of larval activity for shoot-boring moths in that part of Indiana. In all cases, the only "worms" encountered were larvae of an unknown *Chauliognathus* sp. All Scots Pine Christmas trees, where larvae were collected, were approximately 7-10 years in age, and 6-10 feet in height.

Chauliognathus is a common genus of North American Cantharidae including eighteen nominal species (White 1983), two of which, *C. marginatus* F. and *C. pennsylvanicus* DeGeer, have been reported from Indiana (Blatchley 1910). Review of the *Chauliognathus* collection held at Purdue University confirmed the above two species as the only species presently known from Indiana. Species of larval *Chauliognathus* can not be readily discriminated from one another at this time (see Böving and Craighead 1931, Peterson 1951, and LeSage 1991 for general characters).

Larvae of *Chauliognathus*, widely reported as predatory on many different soft-bodied arthropods, are generally reported in duff, forest litter, and under loose bark (Peterson 1951, Arnett 1973, Carroll 1987, LeSage 1991). The collection of *Chauliognathus* larvae within excavated shoots of *P. sylvestris* has not been previously reported in the literature, although at least some members of the Malthinini have been known to inhabit pine branches (Arnett 1973). No larvae of shoot-boring moths or other insects were observed at the time larvae of *Chauliognathus* were found within pine shoots. *Chauliognathus* larvae and those of several different shoot-boring moths of pine are nearly equal in diameter, which leads us to believe that random, accidental wandering within pine shoots is unlikely. Future field observations may demonstrate that *Chauliognathus* is an opportunistic predator on species of some shoot-boring moths, possibly utilizing search strategies similar to other burrow-predating cantharids (Schultz 1994).

Voucher specimens of *Chauliognathus* larvae from Scots Pine are deposited in the Entomological Research Collection of Purdue University, West Lafayette, IN.

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[2] We thank Al Wheeler, Jr., Pennsylvania Department of Agriculture, and Cliff Sadof, Purdue University, for comments on an early draft of this note.

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BOOKS RECEIVED AND BRIEFLY NOTED

BIOLOGICAL CONTROL. R.G. Van Driesche and T.S. Bellows, Jr. 1996. Chapman & Hall. 539 pp.

The stated intent of these authors is to provide a well-integrated, broadly-based text of appropriate length and degree of technical detail for teaching a one semester upper level course in biological control. The authors have attempted to focus on principles and concepts rather than on biological control of particular taxa or biological control by particular kinds of natural enemies. Only biological control of plant pathogens is addressed separately. The text has been written to encourage training of a new generation of biological control scientists committed to the understanding of biological control and to its safe use to solve pest problems.

THE BEETLES OF THE WORLD. VOL. 20. CICINDELIDAE 4. THE NEARCTIC REGION. Karl Werner. 1994. Sciences Nat., Vemette, France. 196 pp. 27 pl. Text in German, English, and French.

This is the second of two volumes on the Nearctic Cicindelidae. The first volume was reviewed in Entomol. News, Vol. 105, No. 1, January & February, 1994. This new volume completes the genus *Cicindela* as generally followed in the United States. As stated in the earlier review, most specimen photographs are outstanding and well illustrate obvious characters but several are off color (ex: *C. blanda, C. nevadica tubensis, C. macra fluviatilis).* Also, again, more complete descriptive information is needed, especially where identification details can not possibly be adequately shown in dorsal habitus photographs (ex: *C. lemniscata* and *C. l. rebaptista).* Notwithstanding these comments, this volume, as the former one, is a very beautiful book that one would be proud to own and display but, again, better suited for a coffee table than a taxonomist's library.

H.P.B.

When submitting papers, all authors are requested to (1) provide the names of two qualified individuals who have critically reviewed the manuscript *before* it is submitted and (2) suggest the names and addresses of two qualified authorities in the subject field to whom the manuscript may be referred by the editor for final review. All papers are submitted to recognized authorities for final review before acceptance.

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(Continued on inside of back cover)

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A NEW GENUS, *HECALOCORICA*, AND A NEW SPECIES OF HECALINE LEAFHOPPER FROM COSTA RICA (HOMOPTERA: CICADELLIDAE)[1]

M. W. Nielson[2]

ABSTRACT: A new genus and new species, (*Hecalocorica bidentata*), from Costa Rica is described and illustrated. Notes on related Neotropical genera are also given.

Linnavuori (1957) revised the subfamily Hecalinae for the Neotropical region, giving keys and redescriptions of five genera (*Cerillus* Oman, *Egenus* Oman, *Tenucephalus* Delong, *Spangbergiella* Signoret, *Bonamus* Oman), and their attendant species. In his revision of the Ethiopian Deltocephalinae, Linnavuori (1975a) reduced Hecalinae to a tribal level, citing several principal characters that allied the group within the Deltocephalinae. He also established a new genus, *Neohecalus*, for two Nearctic species that were previously assigned to *Hecalus*, a widespread group in the New and Old World. In a companion paper, Linnavuori (1975b) removed *Cerillus* from the tribe Hecalini and erected a new tribe, Cerillini, to accommodate the genus. Linnavuori and DeLong (1978) reviewed the tribe for Mexico and the United States including the genera *Hecalus* Stal, *Hecullus* Oman, *Memnonia* Ball, *Neohecalus*, *Dicyphonia* Ball, *Spangbergiella*, and described a new genus, *Jiutepeca*.

In this paper, a new genus, *Hecalocorica,* is described and illustrated from Costa Rica. Unlike other genera in the tribe, the ocelli are on the crown margin about 1/3 the distance from the eyes to the apex of the crown. The aedeagal processes are ventral whereas in other groups it is apical or subapical. The plate, venation in the forewing, body configuration and size are typical of *Spangbergiella*, to which it is likely most closely related.

Hecalocorica, NEW GENUS

Type-species, *Hecalocorica bidentata*, n. sp.

Large, elongate species. Similar in general habitus to *Spangbergiella* but with ocelli removed about 1/3 distance from eyes to apex of crown; male genitalia distinctive. General color greenish to stramineous.

Head large, slightly wider than pronotum, anterior margin rounded; eyes small; crown produced, shorter than pronotum, shallowly depressed, anterior submargin with depressed line between ocelli, margin somewhat foliaceous in lateral view; ocelli visible from above, about 1/3 distance from eyes to apex of crown; pronotum large, broad, inflated, lateral margins parallel, surface with transverse striations; scutellum large (Figs 1, 2); face depressed along anterior submargin;

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clypeus broad anteriorly, lateral frontal sutures reaching ocelli; gena large, curved below eyes; clypellus long (Fig 3); forewing long, membranous, two claval veins, three apical cells, outer anteapical cell open distally, central anteapical cell closed, inner anteapical cell open basally (Fig. 4); hind femoral setal formula 2:2:1.

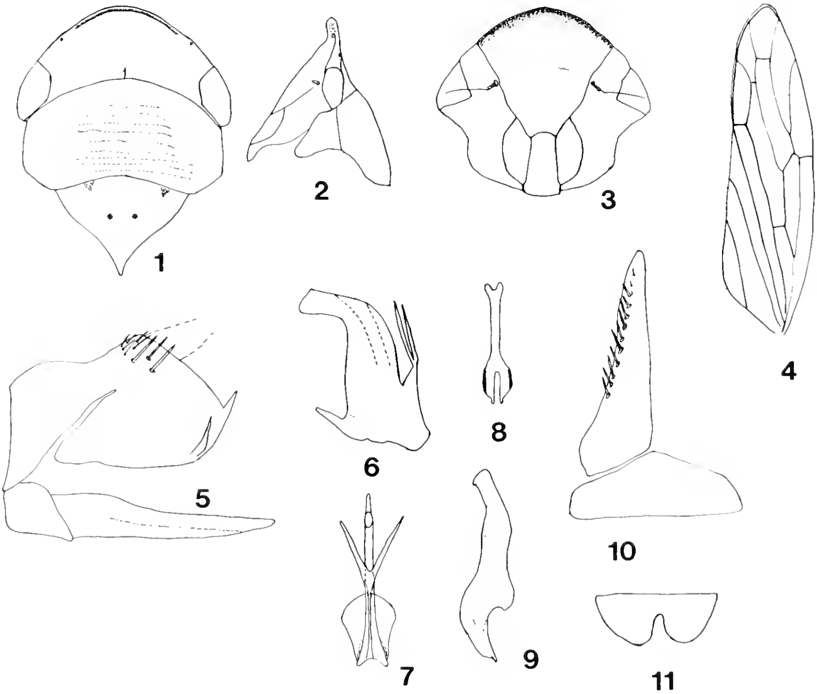
Male. Genitalia symmetrical; male pygofer elongate, armed on caudal margin; aedeagus flat, with ventral processes; connective long, narrowlyY-shaped; style with short apophysis; valve broadly triangulate; plate triangular elongate, macrosetae uniseriate.

Hecalorcorica bidentata, NEW SPECIES

Figs. 1-11

Length: male 9.50 mm., female 12.30 mm.

Male: Pygofer about twice as long as broad, with 2 stout caudal spines, macrosetae on middle of dorsal margin (Fig. 5); aedeagus in lateral view very broad, shaft compressed laterally, apex narrowed and curved dorsally, with pair of long spines ventrally, gonopore large, subapical (Fig. 6), ventral spines diverging in ventral view (Fig. 7); connective elongate, narrowly Y-shaped Fig. 8);



Figs. 1-11. *Hecalocorica bidentata*, n. sp. 1. Head, pronotum & scutellum, dorsal view. 2. Head & pronotum, lateral view. 3. Face, ventral view. 4. Forewing, dorsal view. 5. Male pygofer, valve & plate, lateral view. 6. Aedeagus, lateral view. 7. Same, ventral view. 8. Connective, dorsal view. 9. Style, ventral view. 10. Valve & plate, ventral view. 11. Female seventh segment, ventral view.

plate, lateral view. 6. Aedeagus, lateral view. 7. Same, ventral view. 8. Connective, dorsal view. 9. Style, ventral view. 10. Valve & plate, ventral view. 11. Female seventh segment, ventral view.

style long, apophysis short, rounded apically with small projection laterally (Fig. 9); valve broad, short, triangulate (Fig. 10); plate long, triangulate, macrosetae on lateral margin, uniseriate (Fig. 10).

Female. Seventh segment short, caudal margin bilobed (Fig. 11).

Holotype male: COSTA RICA: San Jose, Cerro de la Muerte, pass on Highway #1, km. 88, 6.V.1995, Baumann & Houseman (UCR). Allotype female, same data as holotype (UCR).

Remarks: Two immature specimens (4 & 5 instar), same data as type specimens, were examined and are deposited in the UCR collection.

This species is rare and occurs in high elevations above 2800 m. It is the largest in size of the New World Hecalini.

ACKNOWLEDGMENTS

I thank Richard Baumann, Monte L. Bean Museum, Brigham Young University for loan of specimens, Paul Freytag, University of Kentucky, Lexington and Ray Gill, California Department of Food and Agriculture, Sacramento for reviewing the paper. Type specimens are deposited in the collection of the University of Costa Rica, San Jose (UCR).

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AIDS FOR FIELD IDENTIFICATION OF PITCHER PLANT MOTHS OF THE GENUS *EXYRA* (LEPIDOPTERA: NOCTUIDAE)[1]

Debbie Rymal Folkerts[2], George W. Folkerts[3]

ABSTRACT: Three species of *Exyra* live in the pitchers of carnivorous pitcher plants of the genus *Sarracenia*. *Exyra semicrocea* inhabits all species of *Sarracenia*, whereas *E. fax* is restricted to *S. purpurea*, and *E. ridingsii* is restricted to *S. flava*. All three species can be identified in the field, using macroscopic characters of the adult and larval stages, and by characteristics of feeding and life history. Each species occurs throughout the ranges of their host plants except that *E. semicrocea* does not occur in the northern portion of the range of *S. purpurea*.

The noctuid moths of the genus *Exyra* Grote are herbivores on the tissues of carnivorous pitcher plants of the genus *Sarracenia* (Sarraceniaceae). Three nominal species are recognized, *E. fax* (Grote), *E. ridingsii* (Riley), and *E. semicrocea* (Guenée). During our work with these species over the past twenty years, we have received many requests for identification, life history data, and conservation information. We therefore present the following material to assist other workers who may be interested in the group. We also attempt to clear up some confusion and inaccuracies present in the literature.

Two of the *Exyra* species, *E. fax* and *E. ridingsii*, are host specific (Jones 1935). The former occurs in association with *S. purpurea* and the latter with *S. flava*. *Exyra semicrocea* may be associated with any of the species, although it is less common in *S. psittacina* and *S. purpurea* than in the other species, and is not known to occur north of southeastern Virginia, where *S. purpurea* is the only pitcher plant species. Apparently, the ability of *E. semicrocea* to use *S. purpurea* as a host depends on the presence of other pitcher plant species to which it is better adapted. In general, the ranges of the various species coincide with the ranges of their host plants. (Detailed descriptions of the ranges are provided below.)

Among the moth species, *E. ridingsii* and *E. semicrocea* are very similar in many ways and appear to be a sister pair. They can easily be confused in the field. *Exyra fax*, called *E. rolandiana* Grote in much of the literature in the past century (see Lafontaine and Poole 1991), however, is very different from the other two species and morphologically may be more primitive, although Jones

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(1921) thought that the adult color pattern of the other two species was primitive. If *E. fax* is primitive, the genus would be assumed to have evolved when an ancestral noctuid began to use *S. purpurea* as a host plant.

Exyra semicrocea seems to be, in both morphology and behavior, the most variable of the three species. The epithets *hubbardiana* Dyar (1904) and *immaculata* Benjamin (Benjamin 1922, McDunnough 1938) were applied to color variants. Hodges (1983) listed these names as synonyms of *E. semicrocea.* We do not feel that these forms deserve taxonomic recognition because the variation appears to be continuous. Nor are they geographic variants as indicated by Forbes (1954). We have found all types at the same locality in the southeastern U. S., as did Benjamin (1922).

The life history of all three species is similar. Eggs are laid on the inner walls of the pitchers, just below the orifice. Larvae feed on tissues of the host plant, most commonly on the leaf tissue. In the spring, when the pitcher plants flower, larvae may occasionally be found feeding in the flower buds or flowers, and occasionally in very early fruits just after the petals have fallen. The latter condition occurs most commonly when weather conditions, or burning during the previous year, result in flowers being present for several days before new pitchers mature. *Exyra* larvae do not feed on or cause damage to the developing fruit in its later stages. The caterpillar commonly encountered in pitcher plant fruits is that of the olethreutine tortricid, *Endothenia hebesana* (= *E. daeckeana*) (Jones 1908, Hilton 1982, Folkerts 1992).

Feeding by larval *Exyra* spp. usually occurs within a protective, enclosed chamber created by larval activity. Interior tissues of the leaves are eaten, leaving the outer epidermis intact; tops of pitchers are closed by silken sheets or by wilting above a feeding groove that encircles the leaf; any holes present in leaves are webbed over with silk; drainage holes are often cut in pitchers, below the feeding chamber.

Pupation takes place within pitchers. Pupae are either suspended by silk or found within accumulated frass at the bottom of pitchers. Drainage holes are often made before pupation. Adults occur in the pitchers clinging to the inner walls. They are among the few insects that can successfully crawl on the inner surface of a pitcher. Rymal (1980) studied some of the adaptations of *E. semicrocea* for this unique type of locomotion. Adults may be seen flying at dusk and are sometimes taken at light, although they are not as attracted to light as are many moths (Benjamin 1922). Most of these are males, females seeming to stay in or near the pitchers. Mating occurs in the pitchers (Rymal 1980).

Rymal and Folkerts (1982) discussed the significance of pitcher plant insects, including *Exyra* spp., in the conservation of the plants. However, little has been written about the conservation status of the insects. All species of *Exyra* are declining in abundance, although none currently appear threatened with extinction. The major factor causing decline is destruction and alteration of pitcher plant habitats (Folkerts 1977, 1982, 1990, 1991). The major loss of diversity among the moths may be related to the extinction of *Exyra* populations associated with disjunct *Sarracenia* populations, notably *S. oreophila*, *S. rubra* subsp. *alabamensis* and *S. rubra* subsp. *jonesi.* Additionally, we have noticed a significant decline in southern populations of *E. fax* in the past two decades. Although definitive data are difficult to obtain, we feel that two introduced species, the imported red fire ant (*Solenopsis richteri* Forel) and the nine banded armadillo (*Dasypus novemcinctus* L.) may be involved. Larvae of *E. fax* are relatively easy for fire ants to locate because the pitchers of *S. purpurea* are decumbent and short. We have seen columns of fire ants removing prey from pitchers in which the water had dried down. Armadillos are common in pitcher plant habitats throughout much of the southeast. Pitchers of *S. purpurea* damaged by armadillo chewing are frequently encountered. Pitchers of other species are also sometimes torn by armadillos, seemingly in attempts to locate sarcophagid larvae that inhabit the prey mass.

Although adults and larvae of all three species vary, identification is relatively easy if several characters are examined. The features we use in the following keys and descriptions are those readily seen by the naked eye and a few easily visible with a hand lens. For those who wish additional features, the genitalia of both sexes of all three species have been pictured by Lafontaine and Poole (1991). Color pictures of adults may be found in Holland (1920) and in Lafontaine and Poole (1991), who depicted some of the variations. Black and white photographs of adults of all species, showing much of the variation, may be found in Jones (1921). Lafontaine and Poole (1991) pictured the larva of *E. fax.* Jones (1907, 1921) provided sketches of all larval instars and pupae of all species. He also included photographs of the eggs but not at a size that allows the distinguishing features to be seen.

Key to adults of the species of *Exyra*

1. Prothoracic notum covered with orange to maroon scales; fore wings with ivory, orange and maroon mottling on a black background or with wavy, horizontal bars of ivory, orange and black, varying to entirely grayish black, sometimes with an orange distal fringe; hind wings entirely grey to black; found in *Sarracenia purpurea* almost exclusively, adults occasionally in *S. flava* .... *Exyra fax* (formerly called *E. rolandiana*).

1'. Prothoracic notum covered with black scales; fore wings patterned with areas of ivory and areas of black, or entirely ivory to light yellow; hind wings entirely black, entirely ivory, or black and ivory .... 2.

2. Basal half of fore wings entirely ivory to light yellow; distal half entirely black or black with one wavy-edged ivory band; hind wings entirely grey to black; with wings at rest, most appear to have three distinct colored areas (black pronotum, light base of the forewings, black distal portions of forewings); occasionally fore and hind wings entirely ivory to light yellow; found in all *Sarracenia* species .... *Exyra semicrocea.*

2'. Basal half of fore wings ivory to light yellow with one wavy edged, black transverse band; distal half black with at least one wavy-edged ivory bar; occasionally black bands are widened and fused such that forewings are nearly black with traces of ivory; hind wings with wavy, horizontal black and ivory bars, varying to almost entirely black; with wings at rest, appear to have alternating horizontal bands of black and ivory; found exclusively in *S. flava* .... *Exyra ridingsii.*

Key to the larvae of the species of *Exyra*

Note: There seems to be no precisely appropriate term for the laterally projecting unsclerotized lobes present on the thorax and abdomen in larvae of two of the species. Although Jones (1921), the most notable student of the genus, called them lappets, a reviewer pointed out that this term is usually reserved for more flattened projections that function to disguise the outline of resting larvae. "Pinaculum" was used by Lafontaine and Poole (1991), but refers to a sclerotized area around the base of one or more setae (Stehr 1987). "Chalaza" and "scolus" might be applicable but also refer to sclerotized structures (Stehr 1987). Rather than coin a new term, we follow the usage of Jones (1921), Forbes (1954) and others and use "lappet," although we acknowledge the possible ambiguity.

1. Laterally projecting lappets (conical projections from the lateral portions of segments) on mesothoracic, metathoracic and first four abdominal segments; integument from red to brown with white or whitish intersegmental areas .... 2.

1'. Laterally projecting lappets absent; integument red to reddish brown with whitish intersegmental areas....................................... *Exyra fax* (formerly called *E. rolandiana*).

2. Abdominal lappets blunt apically, entirely covered with minute black hairs, a long terminal hair (L1) projecting from each; thoracic lappets pointed, less than half the length of the abdominal lappets, covered with shorter hairs; integument bright red with white intersegmental areas, occasionally varying to a duller brownish red with dull white intersegmental areas; head capsule marked with wavy black bands on an ivory background .... *Exyra semicrocea*

2'. Thoracic and abdominal lappets sharply pointed, with long terminal hairs (L_1), partially covered by minute hairs between which the smooth integument can be easily seen (appearing almost smooth in gross aspect); thoracic lappets nearly as large as abdominal lappets, metathoracic lappets more than half the length of the first abdominal lappets; integument varying from bright red and white to reddish brown with brownish white intersegmental areas; head capsule marked with wavy, dark-brown bands on a brown background................................. *Exyra ridingsii*

Key to feeding sign
and other evidence of *Exyra* activity in pitcher plants

(Although identification of the species of *Exyra* is sometimes difficult without specimens, it is often possible, using several characters, to distinguish the signs of *E. semicrocea* feeding from that of the other two species when sign is found in *S. flava* or *S. purpurea*.)

1. In *S. flava*; evidence of 1st instar larvae feeding in the vertical groove of the pitcher throat in the form of silk and frass capsule covering the larvae or remaining in pitcher throat after larvae have departed; pupae or pupal exuviae in smooth, oval chambers within the frass near the bottom of pitchers; most damaged pitchers closed by a silken sheet near the orifice, or up to several centimeters below, several silken sheets often present in same pitcher; usually only immature pitchers closed by wilting; drainage holes usually present in pitchers with pupae, but rarely present in pitchers occupied by larvae .... *Exyra ridingsii*

1'. In any *Sarracenia* species; no evidence of 1st instar larvae feeding in pitcher throat; pupae or pupal exuviae suspended by silk above the frass, only occasionally within the frass; damaged pitchers closed by wilting or by silken sheets near the orifice; drainage holes may be present in pitchers with pupae or larvae. 2

2. In *S. purpurea*; drainage holes nearly always present near the base of occupied pitchers; pitcher orifice often covered with a sheet of silk that frequently contains frass; usually only one encircling feeding groove present . . . . *Exyra fax*

2'. In any *Sarracenia* species; drainage holes usually present only in pitchers containing pupae; sheets of silk covering pitcher orifices only occasionally contain frass; several encircling feeding grooves often present . . . . *Exyra semicrocea*

ADDITIONAL NOTES

Exyra fax

Eggs are dull, yellowish-white, and laid separately, several per pitcher, on the interior walls. Usually this species overwinters as 3rd instar larvae in small amounts of frass in narrow bottom portions of dry pitchers. Overwintering pitchers are closed, usually by wilting and silk, and have drainage holes. Pupae are suspended from a sheet of silk within pitchers that are usually closed by silk or wilting. Occasionally pupation occurs within frass. In the southeastern U. S., adults occasionally rest in pitchers of *S. flava.*

We have found no evidence that the larvae "tie the top of the pitcher closed with silk" as indicated by Lafontaine and Poole (1991). Although hibernacula usually do not contain water, overwintering larvae can withstand freezing temperatures and can survive being frozen in ice. Jones (1921) hypothesized that the reddish coloration of the adult was an adaptation for crypsis on the often reddish-purple pitchers.

The period of activity of this species begins in late March at sites along the Gulf Coast. Several generations per year occur in the southerly areas of the range. In the more northerly portions of the range, activity may not begin until late June and only one generation may occur in a season (Brower and Brower 1970).

Exyra ridingsii

Eggs are dusty white, laid separately, one to several per pitcher, on the interior walls, one to a few centimeters below the orifice. Jones (1921) stated that the eggs were cryptic when pitchers were encrusted with dried nectar. This species may overwinter as 2nd, 3rd or 4th instar larvae in the lower portions of senesced pitchers. Larvae may become active during warm winter periods but rarely feed because green tissue is seldom present in the senesced pitchers of *S. flava.* Pupae of this species may be distinguished by a conspicuous anterior protuberance, which was figured by Jones (1921).

Activity begins in late March or early April at sites in northern Florida. In northerly portions of the range in North Carolina and Virginia, adults may not be seen until early May. At all sites, two or more generations may occur per year.

Exyra semicrocea

Eggs are dull, yellowish white, laid separately, one to several per pitcher, on the interior walls, one to a few centimeters below the orifice. First instar larvae almost always girdle pitchers with a feeding groove. This species overwinters as 2nd, 3rd or 4th instar larvae, usually near the bottoms of pitchers. Larvae may become active and feed during warm winter periods. Migration to a new, undamaged pitcher usually takes place before pupation.

This species exhibits considerable variation in its behavioral patterns. Jones (1921) stated that it altered its behavior to suit each particular host plant. However, we have found essentially all variations in behavior in populations within a single host species, *S. leucophylla.* We have not observed the tough, thick, button-like wad of silk and chewed fragments that Jones (1921) reported this species to use in closing pitchers of *S. psittacina.* We have found larvae of this species feeding on *S. psittacina* during the winter when the leaves of other host species present were partially or completely senescent.

Forbes stated, of the genus, that color variation in the moths was related to the flower color of the host species. This is not true, since yellow morphs of *E. semicrocea* feed on both red- and yellow-flowered *Sarracenia* species. Jones (1907) felt that moths of this species were not as variable as *E. ridingsii.* We, like Lafontaine and Poole (1991), find it to be the most variable of the genus.

Activity begins in mid March at sites in central Florida where the moth uses *Sarracenia minor* as a host plant. In northerly areas of the range, activity may not begin until mid May.

DISTRIBUTION AND ABUNDANCE

No complete range maps for the species have been published. The maps and range information in Lafontaine and Poole (1991) only represent the localities of examined material and are, for the most part, incomplete.

Exyra fax (Figure 1a)

Range: Throughout the range of the host plant, *S. purpurea*, as far as is known. From northeastern British Columbia, across Canada to Labrador, south throughout the boreal peatland area to Minnesota and northeastern Illinois east to Pennsylvania, south along the Atlantic Coastal Plain, extending into the mountains of the Carolinas, to east central Georgia (most of Georgia lacks the host plant), from southwestern Georgia west though southern Alabama and the Florida Panhandle and historically to eastern Louisiana (no populations of the host plant are currently known to exist in Louisiana).

Abundance: In the northerly portions of the range, the moth is present in the majority of host plant populations. However, in the southern portion of the range, where *S. purpurea* occurs sympatrically and often syntopically with other *Sarracenia* species, *E. fax* is not abundant, many populations of the host plant not harboring the species. This may be the result of competition with *E. semicrocea.*

Exyra ridingsii (Figure lb)

Range: Throughout the range of the host plant, *S. flava.* From southeastern Virginia south along the Atlantic Coastal Plain to northern peninsular Florida, west through the Florida Panhandle to southwestern Alabama. A disjunct population in the mountains of the Carolinas.

Abundance: Relatively abundant throughout its range, but absent from many host plant populations where *S. flava* is syntopic with other species of *Sarracenia.* Populations of this species have been known to be displaced by populations of *E. semicrocea, i.e.,* sites which once harbored only *E. ridingsii* species now support only *E. semicrocea.*

Exyra semicrocea (Figure 1c)

Range: Throughout the ranges of all *Sarracenia* species except in northern areas where *S. purpurea* is the only host species present. From southeastern Virginia south along the Atlantic Coastal Plain to central peninsular Florida (where *S. minor* is the only host plant), west to southeastern Louisiana. Disjunct in western Louisiana and east-central Texas (where *S. alata* is the only host plant). Disjunct populations in central Alabama, northeastern Alabama, north-central Georgia and adjacent North Carolina, and the mountains of the Carolinas (these in disjunct populations of *S. oreophila*, *S. rubra alabamensis* and *S. rubra jonesi).* The locality depicted by Lafontaine and Poole (1991) on the Mississippi River in the vicinity of Baton Rouge, Louisiana, is almost certainly incorrect. Pitcher plants of the genus *Sarracenia* do not occur on the alluvial soils of the Mississippi River floodplain. Thus, the absence of a host plant precludes the existence of an *Exyra* population in the area.

Abundance: Usually present in higher inherent abundance than the other *Exyra* species. At many sites in the southeastern U. S. where host plants of the other species occur, this is the only species present. It seems to attain very high population levels in *S. leucophylla* and *S. alata.* It is not as commonly encountered in *S. psittacina* and *S. purpurea* as in the other host species. Populations of this species are known to have been displaced from *S. flava* by *E. ridingsii.*

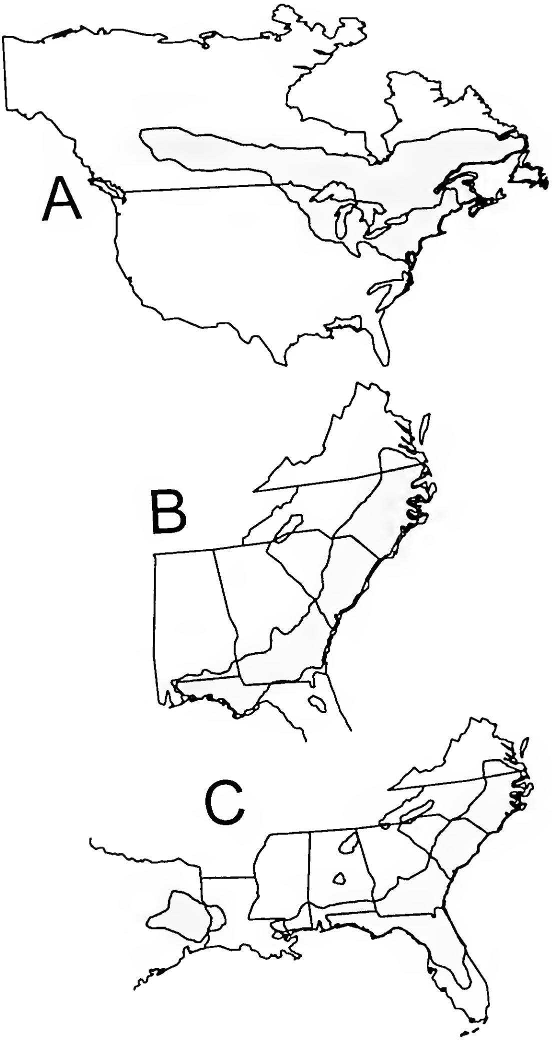

Fig. 1. Geographic ranges of *Exyra* species. A. *E. fax*. B. *E. ridingsii*. C. *E. semicrocea*.

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OCCURRENCE OF ALDERFLY LARVAE (MEGALOPTERA) IN A WEST VIRGINIA POPULATION OF THE PURPLE PITCHER PLANT, *SARRACENIA PURPUREA* L. (SARRACENIACEAE)[1]

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ABSTRACT: Eight alderfly (Sialidae) larvae were identified in the contents of 99 leaves collected May 14-15, 1994, from a population of the purple pitcher plant, *Sarracenia purpurea*, from Big Run Bog, Tucker County, West Virginia. Five of the larvae were surrounded by mycelia mats. The fungus belonged to the water mold genus, *Saprolegnia* (Saprolegniaceae). Adult alderflies collected from the same locality in June were determined to be *Sialis joppa*. The occurrence of alderfly larvae in pitcher plants is unusual, and probably related to flooding of the habitat.

Alderflies (Sialidae) are a small family of aquatic insects with approximately 23 North American species (Evans, 1984). The predacious aquatic larvae can be abundant in streams, rivers and ponds. Larvae migrate from the water and pupate on dry ground several yards from the water. Adult insects are generally found in the same areas as the immatures. They are usually inactive, resting in the vegetation near their larval habitats. In West Virginia, four species of alderflies have been reported (Tartar *et al.,* 1973; 1978) .

While studying a population of purple pitcher plants, *Sarracenia purpurea L.,* in West Virginia, the contents trapped at the base of several leaves were analyzed by transferring the materials into separate petri dishes. One of the leaves contained a larva approximately 1.0 cm long, which was later identified as belonging to the genus *Sialis* (Sialidae). A study was initiated to determine whether sialid larvae are common to this population of pitcher plants.

This study is significant because it adds to our knowledge of the biology of pitcher plants. Although a variety of species of arthropods are known to be regular inhabitants of these unusual carnivorous plants, it is not clear whether sialid larvae are prey, occasional associates or regular inhabitants.

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METHODS

The *S. purpurea* population is located in Big Run Bog located at 39° 07' N latitude and 79° 35' W longitude, Tucker County, West Virginia at an elevation of 980 m above sea level. The bog occupies approximately 20-25 ha in the Monongahela National Forest (Wieder *et al.* 1981). Big Run Bog (also known as Olson Bog) is dominated by *Sphagnum* and *Polytrichum* which together cover 85% of the surface (Wieder *et al.* 1981). *Sarracenia purpurea* was introduced to this bog in 1946 (Strausbaugh and Core, 1970) and is well established today.

On May 18, 1994 four mature plants were collected for leaf analysis. Individual plants were scooped up by hand, placed in plastic pans with water, covered and transported back to the laboratory at Blackwater Falls State Park. Three additional plants were collected June 14-15, 1994.

During the two visits to the bog in 1994, adult insects were collected using both a sweep net and a beating sheet. In early spring of the next year (March 30, 1995), aquatic specimens were collected using an aquatic insect net from the shallow water in the same vicinity where the pitcher plants had been collected previously. Specimens were preserved in 70% ethanol.

Individual leaves were analyzed after removal from the main cluster by cutting the base with a razor blade. Liquid contents of each leaf were poured into a watch glass. The leaf was then slit lengthwise and folded open. The solid contents at the base of the leaf were removed with a spatula and placed in a vial containing 70% ethanol. Ninety-nine leaves were processed from the May 20, 1994 collections and an additional forty-seven leaves from the June 14, 1994 collections. Each sample was examined under low magnification and alderfly larvae were removed and placed in separate vials.

RESULTS

A total of eight alderfly larvae were identified in the contents of the leaves. All larvae were recovered from the May collections; none was recovered from the June collections. Each of the plants sampled in May had at least one larvae in a leaf sample. Microscopic examination revealed dense mycelial growths attached to the membranous areas of the larvae. The fungus was identified as a species of *Saprolegnia,* a true water mold (Saprolegniaceae) (Coker, 1923).

Although no adult alderflies were collected in May from the sweep net or beating sheet samples, several were collected in June including one adult male. The specimen was identified as *Sialis joppa* Ross. Four species of alderflies have been recorded in West Virginia including *S. joppa* (Tartar *et al.,* 1978).

DISCUSSION

Pitcher plants are usually associated with bogs or swamps and are rather unusual because they exhibit passive carnivory. A number of reports document that *S. purpurea* capture a broad spectrum of insect species as well as other arthropods (Rymal and Folkerts, 1982; Bradshaw and Creelman, 1984). Species found in the pitcher plant may be classified as inhabitants, prey, pitcher plant herbivores or occasional associates. Purplish/red nectar guides lead attracted insects up the brightly colored leaves to the lip where some of them fall into the water-filled reservoir below (Joel, 1986). Pitcher plants rely on a diverse community of bacteria, protozoa and insect larvae for decomposition of trapped prey and absorption of nutrients (Addicott, 1974).

Alderfly larvae have previously been recovered from pitcher plants. Mather (1981) recovered S. *joppa* larvae from a population of S. *purpurea* in New Jersey, one in late April and the other May 30. The collection dates for our material coincide well with the New Jersey collections. No fungal growth on the specimens was reported by Mather. There also was no indication of the number of plants sampled.

The presence of eight sialid larvae in 99 leaf content samples shows that sialid larvae are relatively common insects found in this population of pitcher plants. Since the same species has now been found in two widely dispersed pitcher plant populations, it may be inferred that they are not rare in pitcher plants. Whether sialid larvae are prey is not clear. Five of the larvae exhibited dense growths of *Saprolegnia i*ndicating the specimens were dead when collected. It is not known whether the other two larvae were alive or dead at the time of collection.

Alderflies are generally associated with both lotic and lentic habitats. Mather (1981) suggested that the larvae may have entered the pitcher plant in search of pupation sites. We suggest that in early spring the water level in the bog is higher due to both snow melt and rain. During that time sialid larvae distribute throughout the bog, some moving into pitcher plant leaves where a rich source of dead insects and live Diptera larvae can provide nourishment. As the water level recedes, the sialid larvae become stranded in the leaves. In March, 1995, we attempted to test this hypothesis by collecting aquatic insects from the shallow water in the vicinity of where previous pitcher plant collections had been made. No sialid larvae were recovered.

Miles *et al.*, (1975) reported that a related pitcher plant species, *Sarracenia flava,* produces a number of natural products including two amines, an unusual enol diacetal monoterpene, sarracenin, and coniine, one of the poisonous alkaloids found in hemlock *(Conium maculatum).* The two amines are responsible for paralyzing insects after they become entrapped in the pitcher.

It is possible that coniine, sarracenin, or other toxic amines are present in *S. purpurea.* These or related compounds may immobilize or kill sialid larvae that enter the pitcher plants. The dead insects may subsequently be invaded by a species of *Saprolegnia* which decomposes the larvae, providing nutrients for the plant.

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SCIENTIFIC NOTE

FOUNDING QUEEN OF THE RED IMPORTED FIRE ANT *(SOLENOPSIS INVICTA)* (HYMENOPTERA: FORMICIDAE) OBSERVED IN CARNIVOROUS PLANT[1]

James T. Vogt[2]

The white-topped pitcher plant, *Sarracenia leucophylla* Raf. (Sarraceniaceae), occurs from southeastern Georgia through the Florida panhandle and southern Alabama to southeastern Mississippi (Folkerts 1990). Several insect species are associated with this and other species of pitcher plants in the southeastern U.S., as prey, pollinators, pitcher inhabitants, herbivores and casual associates (Rymal and Folkerts 1982). Of particular interest are pitcher inhabitants, which have evolved means of avoiding capture by carnivorous pitcher plants and can utilize the tubular leaves for shelter and/or feed on the entrapped prey or leaf tissue. Among the more intriguing pitcher inhabitants are arthropods which use the pitcher as a nesting site. For example, the wasp *Isodontia mexicana* (Saussure) (Hymenoptera, Sphecidae) commonly nests in pitcher plants (Rymal and Folkerts 1982). The nests, containing paralyzed prey and wasp larvae, are heavily preyed upon by red imported fire ants (Rymal and Folkerts 1982) which are common in southeastern bogs. In one instance a small colony of acrobatic ants *(Crematogaster,* subgenus *Acrocoelia* Mayr) numbering ca. 80-100 workers was observed in a pitcher *(S. flava* L.) in a Florida bog (T. Paige Carithers, pers. comm.). *Solenopsis* spp. and other ant species can be important prey items for some species of pitcher plants (Folkerts 1992).

On October 20, 1995, while assisting T. Paige Carithers with arthropod sampling at a pitcher plant bog in Baldwin Co., Alabama, I observed a single red imported fire ant queen in the pitcher of a white-topped pitcher plant. The pitcher, approximately 30-40 cm in height, was filled to within ca. 10-15 cm of the top with caterpillar (Noctuidae: *Exyra* sp.) frass and the accumulated debris of several captured and partially digested or decomposed insects. The red imported fire ant queen was seen atop the debris when the hood of the pitcher was pulled back. Upon closer examination and dissection of the pitcher it was noted that the queen had a clutch of eggs (ca. 20-40) which appeared alive and healthy. The eggs were in the immediate vicinity of the queen.

To my knowledge, this is the first record of the red imported fire ant using a pitcher plant, or any carnivorous plant, as an ectopic nest. The occurrence of an apparently newly mated founding queen in a white-topped pitcher plant raises some interesting questions. It is not known how the queen got there. She may have landed in the pitcher by chance following a mating flight, or, finding that conditions in the bog were too wet following the rain that typically precedes mating flights (Rhoades and Davis 1967, Markin *et al.* 1971), she may have climbed the pitcher and been captured while searching for a suitable place to raise her first brood. However the queen entered the plant, it is evident that the tubular leaf of the carnivorous white-topped pitcher plant provides a habitat suitable for the initial stages of colony founding by red imported fire ant queens, at least when the pitcher contains enough debris to prevent the drowning of the queen and her eggs. Survival of the first brood (minims) and ultimately the colony are matters for speculation. Accumulated debris in the pitcher could possibly serve as food for a developing colony as long as the pitcher did not fill with water during rain. Further observations are planned to detect the frequency of this occurrence.

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ANTHRENUS MUSEORUM (COLEOPTERA: DERMESTIDAE), AN EGG PREDATOR OF *LYMANTRIA DISPAR* (LEPIDOPTERA: LYMANTRIIDAE) IN CONNECTICUT AND A REVIEW OF DERMESTIDS AS GYPSY MOTH EGG PREDATORS[1]

Paul W. Schaefer[2], R. S. Beal, Jr.[3]

ABSTRACT: Larvae of *Anthrenus museorum* were collected in egg masses of *Lymantria dispar* in Tolland Co.,Connecticut, in March 1982. Field evidence and subsequent laboratory rearing confirmed predation on viable moth eggs. In Japan and South Korea, several new collection records and a possible new species of *Trogoderma* from Japan are reported. The first recovery of *Cryptorhopalum ruficorne* in Delaware is included. Dermestids in the role as predators on gypsy moth eggs worldwide are compiled in a table and briefly reviewed. Any impact appears to be directly density dependent and at high moth populations the impact may be significant. This form of egg predation has not been thoroughly studied.

Dermestid beetles (Coleoptera: Dermestidae) are known principally as pests of stored products, carpets, dried animal tissues (e.g. skins, furs, feathers, insect collections), and a wide variety of other organic matter (Griswold 1941; Hinton 1945). A catalogue of the Dermestidae of the world, including distributions, was compiled by Mroczkowski (1968).

The association of dermestid beetles with gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae), eggs was recognized long ago (Forbush & Fernald 1896; Burgess 1899) but the significance and impact of this association remain elusive. There have been many anecdotal accounts of finding larval dermestids feeding in gypsy moth egg clusters but little has been done to clarify the impact of this predation, with the possible exception of the study by Nonveiller (1959). Usually larvae are found to have hollowed out a portion of an egg mass. Few have determined to what extent this form of egg predation has contributed to gypsy moth egg mortality. In the process of tunneling within an egg mass, disruption of the protective setae covering the egg mass occurs. It has been suggested that this is important since it enhances parasitism by egg parasitoids, e.g., *Ooencyrtus kuvanae* (Howard) (Hymenoptera: Encyrtidae) and *Anastatus japonicus* Ashm. (Hymenoptera: Eupelmidae), by making more eggs in a cluster accessible to these parasitoids (Mason & Ticehurst 1984). Under field conditions, Nonveiller (1959) concluded that dermestids had a significant impact on gypsy moth egg survival under outbreak conditions, sometimes ac-

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counting for up to 50% mortality of viable eggs; many dermestids were also found in old egg clusters where they were clearly feeding as necrophagans and not predators. At lower population levels the impact is greatly diminished (Nonveiller 1959). It appears that mortality of the gypsy moth egg stage due to dermestid predation is directly density dependent; this has yet to be experimentally confirmed.

FIELD COLLECTION

North America: The senior author collected a number of dermestid larvae in egg masses of gypsy moth at Willington, Tolland Co., Connecticut, on March 16, 1982. Egg masses with dermestid larvae were found under the eaves and roof overhang on a building adjacent to gypsy moth infested forests. At least one predatory larva was found in a gypsy moth egg mass on a *Quercus rubra* L. trunk adjacent to the building. As egg masses were scraped off the building, tunneling and apparent destruction of viable eggs were evident. Collected dermestid larvae were returned to the laboratory and allowed to complete development in the presence of the remains of the field collected egg masses or on laboratory reared eggs. In total, 14 adult dermestids were reared from the Willington material.

These adults, subsequently identified as *Anthrenus museorum* (L.)[4] (Coleoptera: Dermestidae), were introduced into pint paper cartons and provided with laboratory reared gypsy moth egg masses. During exposure to fresh gypsy moth egg masses, viable eggs were deposited; subsequently a new generation of dermestids was reared exclusively on gypsy moth eggs. Development of the laboratory reared generation occurred at ambient laboratory room temperatures (ca. 18-26° C.) and emergence of the adults occurred in March, 1983. Thus partial development of the parental generation and complete development of the progeny occurred within one year. This record of *A. museorum* as a predator on viable gypsy moth eggs in Connecticut is the first North American record. It is also the first confirmed occurrence of the species in Connecticut, previous authors often mistaking *A. castaneae* Melsheimer for this species.

Gypsy moth egg masses collected in Newark, Delaware, on April 4, 1983, were isolated in pint paper cartons. The following month, three adults of the dermestid *Cryptorhopalum ruficorne* LeConte emerged, a first record of this association in Delaware, although *C. ruficorne* was reported as a predator of gypsy moth eggs in nearby states (Mason & Ticehurst 1984; Beal 1985).

Japan and South Korea: During the collection of gypsy moth egg masses in our previously reported study (1975-78) of egg parasitism (Schaefer *et al.* 1988), a collection of dermestids was obtained concurrently. Dermestid larvae were isolated and reared on available field collected gypsy moth eggs. Emerging adults were killed, pinned and labeled. Although some of those records

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[4] First identified in 1983 by J. M. Kingsolver, USDA, SEL, Beltsville, MD (now retired).

were published previously (Schaefer, 1980; 1981), all of our dermestid records are included in Table 1.

Deposition of Specimens: A synoptic collection of available dermestid material is deposited in the U. S. National Museum, Wash. D.C., The Carnegie Museum, Pittsburgh, Penna., and in the Gillette Entomological Museum at Colorado State University.

BRIEF REVIEW OF DERMESTIDS AS GYPSY MOTH EGG PREDATORS

In North America, there are relatively few references to the presence of Dermestidae in gypsy moth egg masses (Table 1). Burgess (1899) reported finding *A. verbasci* (L.) larvae feeding on gypsy moth egg masses in Massachusetts in October, and that adults appeared the following May. Hoebeke *et al.* (1985) illustrated and provided a key to identify eastern North American species of *Anthrenus,* including both *A. verbasci* and *A. museorum,* and Griswold (1941) studied the biology of *A. verbasci* in detail. Campbell (1967) stated that unidentified dermestid larvae were occasionally seen preying on gypsy moth eggs in northeastern New York. In central Pennsylvania, Brown and Cameron (1982) listed larvae of *Dermestes lardarius* L. as a predator associated with gypsy moth eggs. Also in Pennsylvania and in West Virginia, larvae of C. *ruficorne* were found attacking gypsy moth eggs (Mason & Ticehurst 1984) and, as mentioned above, P.W.S. confirmed C. *ruficorne* in this same role in Delaware. All these North American records and all other known records worldwide are included in Table 1, which is an updated version of the basic table of predators first compiled by Brown and Cameron (1982).

In other areas of the world, especially in Eurasia, there are considerably more records of dermestid associations with gypsy moth eggs. The most common genera are *Anthrenus, Attagenus, Dermestes, Megatoma* and *Trogoderma.* Of apparent lesser frequency are species in the genera *Globicornus, Ctesias,* and *Zhantievus.* Nonveiller (1959) found six new dermestid species feeding in gypsy moth egg masses and of these, *Megatoma pici* was the most abundant. Interestingly, Nonveiller found that larvae of *M. pici* were fairly mobile and larvae would readily move between different egg masses. All of these dermestid beetles appear highly opportunistic; no doubt any insect egg mass similar to those produced by gypsy moths will be suitable for attack. For example, in India, *Lymantria obfuscata* (L.), often referred to as the Indian gypsy moth, has the same egg laying behavior. Its eggs are reportedly attacked by *"Anthrenus sp.* prob. *museorum",* and an *Orphinus* sp. (Dharmadhikari *et al.* 1985). Howard (1897) and Burgess (1899) record dermestids also attacking eggs of white-marked tussock moth, *Orgyia leucostigma* (J. E. Smith) (Lymantriidae), which are deposited in a hardened foam-like material.

Table 1: World list of Dermestidae reported as predators (or apparent predators) of gypsy moth eggs, *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae).

Species (Alphabetically listed)	Location	Reference/Collector/Year[a]
	EUROPE AND ASIA	
Anthrenus museorum (L.)	Japan	Schaefer 1980
	South Korea	Schaefer (1976)
	Japan (Kyushu & Honshu)	Schaefer (1976)
verbasci (L.)	European SSR	Karnozhikii 1957
	Japan (Kyushu & Honshu)	Schaefer (1976)
	Japan	Schaefer 1980
	Ukraine	Kotenko 1982
Attagenus unicolor unicolor Brahm (?) (recorded as *A. piceus* Olivier)	Russia	Nonveiller 1959
unicolor japonicus Reitter	Japan (Kyushu)	Schaefer (1976)
sp.	Japan	Schaefer 1980
	Europe	Thompson & Simmonds 1964[b]
Ctesias serra F.	Yugoslavia	Nonveiller 1959
Dermestes ater De Geer	Europe	Forbush & Fernald 1896
	Azerbaijan	Aliev *et al.* 1974
bicolor F.	Ukraine	Kotenko 1982
erichsoni Ganglbauer	Yugoslavia	Nonveiller 1959
	Bulgaria	Schedl 1936; Karnozhikii 1957; Nonveiller 1959 Stefanov & Keremidchiev 1961[b]
	Romania	Pirvescu 1978; Teodorescu 1980
	Russia	Shapiro 1956; Vorontsov 1950 Nonveiller 1959
	Ukraine	Kotenko 1982
	Russia Far East	Kolomiets 1987
lardarius L.	France	Picard 1921; Nonveiller 1959
	Bulgaria	Schedl 1936; Karnozhikii 1957; Nonveiller 1959; Stefanov & Keremidchiev 1961
	Italy	Prota 1966
	Azerbaijan	Aliev *et al.* 1974
	Europe	Burgess & Crossman 1929[b]
	Russia	Shapiro 1956; Vorontsov 1950 Nonveiller 1959
	Ukraine	Kotenko 1982
	Italy (Sardinia)	Luciano & Prota 1983
undulatus Brahm	Russia	Shapiro 1956; Vorontsov 1950; Nonveiller 1959
	Ukraine	Kotenko 1982
sp.	Japan	Schaefer 1980
spp.	Yugoslavia	Nonveiller 1959
	Ukraine	Zelinskaya 1981

Globicornus nigripes F.	Yugoslavia	Nonveiller 1959
Megatoma conpersa Solskij	Russia Far East	Kolomiets 1987
pici Kalik	Yugoslavia	Nonveiller 1959[b]; 1976
pubescens Zetterstedt	Yugoslavia	Nonveiller 1959
undata L.	Yugoslavia	Nonveiller 1959
	Romania	Pirvescu 1978
Orphinus sp.	Japan	Schaefer (1976)
Trogoderma sp.	Ukraine	Kotenko 1982
varium (Matsumura & Yokoyama)	Japan (Kyushu & Shikoku)	Schaefer (1976)
sp. possibly undescribed[c]	Japan (Shikoku)	Schaefer (1976)
Unidentified	Japan	Howard 1910

AFRICA

Anthrenus verbasci (L.)	Morocco	DeLepiney 1930[b]
vladimiri Menier & Villemant	Morocco	Menier & Villemant 1993
Dermestes lardarius L.	No. Africa	Thompson & Simmonds 1964[b]
Trogoderma versicolor Creitz	Morocco	DeLepiney 1927[b], 1929, 1930[b], 1933 Nonvieller 1959
versicolor var. *meridionale* Kraatz	Morocco	Hérard & Fraval 1980
sp.	Morocco	DeLepiney 1927[b]
Zhantievus lymantriae Beal	Morocco	Beal 1992

NORTH AMERICA

Anthrenus museorum (L.)	Connecticut	Schaefer (1982)[d]
verbasci (L.)	Massachusetts	Burgess 1899; Howard 1910
Cryptorhopalum ruficorne LeConte	Pennsylvania & West Virginia	Mason & Ticehurst 1984; Beal 1985
	Delaware	Schaefer (1983)[e]
Dermestes lardarius L.	North America	Griffiths 1976[f]
	Pennsylvania	Brown & Cameron 1982
Trogoderma prob. *ornatum* (Say) (listed as *T. tarsale* Melsheimer)	Massachusetts	Howard 1910
Unidentified	New York	Campbell 1967[b]

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[a] Years given in parentheses are years of specimen collection. Specimens collected by the senior author in the 1970's were identified by Sadanari Hisamatsu (1977) and/or by John M. Kingsolver (1979). Years not in parentheses refer to date of publication; see Literature Cited.

[b] Cited in Griffiths 1976.

[c] D. G. H. Halstead, *in litt.*

[d] Identified by J. M. Kingsolver (1983) and confirmed by R.S.B., Jr. (1995).

[e] Identified by J. M. Kingsolver (1984), examined by R.S.B., Jr. (1985).

[f] Listed in Griffiths' (1976) table but text does not substantiate a North American record associated with egg masses, however a record coming from a pupal mass is recorded.

We believe that, in time, many other associations will become known as other species of opportunistic dermestids are found to take advantage of the nutritional resources and protected niches represented by individual masses containing hundreds of gypsy moth eggs. This will be especially true as the invading gypsy moth in North America moves into new geographical areas and comes in contact with other dermestid species for the first time.

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DISTRIBUTION, IDENTIFICATION AND RATE OF SPREAD OF *NOCTUA PRONUBA* (LEPIDOPTERA: NOCTUIDAE) IN THE NORTHEASTERN UNITED STATES[1]

Steven Passoa[2], Craig S. Hollingsworth[3]

ABSTRACT : The distribution and spread of *Noctua pronuba* in the eastern United States is reviewed using data collected until the end of the 1994 season. Diagnostic features of the genitalia in both sexes are discussed and illustrated. The rate of spread of *N. pronuba* in the eastern United States averaged approximately 80 miles per year from 1985-1994.

Noctua (= *Triphaena, Rhyacia*) *pronuba* (L.) is a medium-sized moth (wingspan 50-60 mm) with polymorphic pale gray to brown forewings and black-bordered bright yellow hind wings. Because of variability in the forewing pattern, several color forms have been named (see Warren 1914; Wright 1987). The life cycle of *N. pronuba* is well documented, and therefore, good illustrations exist for both the adult (Warren 1914; Alford 1984; Wright 1987; Hill 1987) and immature stages (Döring 1955; Anciloto and Grollo 1970; Neil and Specht 1987; Alford 1984; Aizpurúa 1985; Sannino *et al.* 1988). Information on the systematics and biology of this species can be obtained in Fibiger (1993), Poole (1989), Carter (1984), and Zhang (1994). Although *N. pronuba* has no official common name recognized by the Entomological Society of America, it is often called the large yellow underwing in European literature (Zhang, 1994).

The biology of *N. pronuba* was summarized by Alford (1984), Fibiger (1993), Hill (1987), and Carter (1984). Approximately 1000-2000 eggs are laid from June to October on the leaf undersides or tips of the host plant. Larvae hatch in 10-13 days (Carter 1984) and are polymorphic with green or brown color forms (Neil and Specht 1987). The hosts of *N. pronuba* include grass (*Poa annua* L.), herbaceous and greenhouse plants (*Viola odorata* L., *Primula, Rumex, Polygonum, Atriplex, Myosotis, Taraxacum officinale* Weber, chrysanthemum, *Freesia,* carnations, *Gladiolus*), and crops (tomatoes, potatoes, carrots, beets, cabbage, grapes, various Brassicaceae) (Ancilotto and Grollo 1970; Hoebeke and Wheeler 1983; Zhang, 1994). More rarely, shrubs (*Ribes*) and trees are attacked (Browne 1968; Edland 1978). Although larvae are sometimes abundant, significant damage to agroecosystems is sporadic. Outbreaks have been reported in cole crops, lettuce (Hill 1987), strawberry (Alford 1984) and forest

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nurseries (Carter 1984). Neil and Specht (1987) predicted damage to hayfields because *N. pronuba* is common on grass. Typical of many cutworms in the subfamily Noctuinae (= Agrotinae), feeding occurs near the crown and roots of the host. Larvae overwinter and pupate in the soil during May and June (Carter 1984). Although the flight period can extend through October, adult numbers peak from June through August. This may include a month-long reproductive diapause. Usually one generation occurs annually, but three to four are reported in Israel (Hill 1987). Both sexes of *N. pronuba* are attracted to lights (Wright 1987), sugar baits, and flowers (Fibiger 1993).

The large yellow underwing is native to the Palearctic Region. Recently it was introduced to North America where the first capture was at Halifax, Nova Scotia, in 1979 (Neil 1981). It is now distributed throughout the Atlantic Provinces of Canada west to Ontario (Morton 1994) and the United States, originally at the Maine border (Wright 1987). The purpose of this paper is to update the distribution, diagnosis, and rate of spread of *N. pronuba* in the United States. This will alert regulatory agencies to the presence of a newly introduced potential pest and will provide yet another case study to document pathways used by introduced insects to enter North America.

MATERIALS AND METHODS

We contacted two organizations, the United States Department of Agriculture's (USDA) Cooperative Agricultural Pest Survey (CAPS) program and the Lepidopterists' Society, to solicit collection records for *N. pronuba.* Members of the CAPS program within the northeastern United States were issued color photographs and information on how to distinguish *N. pronuba* from other similar Noctuidae, especially *Noctua comes* (Hübner), to ensure accurate screening of light trap samples for this species (Passoa 1992). The database maintained by the CAPS program, the National Agricultural Pest Information System (NAPIS), does not address pest distributions outside of the United States; thus, records from Canada were not included in this paper. Data not published in peer-reviewed journals (Passoa 1992, Winter 1993) were verified by contacting the collector.

The senior author examined at least one specimen from each state reported in this paper, but many county records sent in by members of the Lepidopterists' Society were accepted on faith. Determination of our study organism was based on a voucher specimen from Maine identified by Dr. R. W. Poole (Systematic Entomology Laboratory, Washington, D. C.) and deposited in the United States National Museum of Natural History.

RESULTS

The following distribution records represent all *N. pronuba* data seen by the authors up to 1995 and include only adults collected mostly at light traps. Unless otherwise indicated by a number in parenthesis, one moth was captured at each locality.

CONNECTICUT: Hartford Co.: 11-VII-1994, C. Maier. **New Haven Co.,** 30-IX-1994, C. Maier. **Tolland Co.:** 21-VIII-1993, J. Trouern-Trend. **MAINE: Cumberland Co.:** Cape Elizabeth, 27-VIII-1990(3), 16-VII-1991, J. Dill. **Knox Co.:** Matinicus Island, VIII-1985, VIII-1986, A. E. Brower; 21-VI-1985, 17-VIII-1985, 1986, 1987, D. Mairs; Vinalhaven, 1987, D. Mairs. **Waldo Co.:** Isleboro, 19-VIII-1988, 8 to 10-IX-1992 (2), W. Winter. **Washington Co.:** Steuben, 23-VII-1987, 19-VII-1988, 11 to 17-VIII-1989 (2), 29-VII-1990, 14 to 28-VIII-1990 (3), 1 to 16-VIII-1991 (4), M. Roberts; Meddybemps, 1986, D. Mairs; Stillwater, 27-VIII-1990, J. Dill (4). **MARYLAND: Anne Arundel Co.:** Annapolis, 13-IX-1993, Maryland Dept. Agr. blacklight survey. **Baltimore Co.:** 17-VIII-1994, Maryland Dept. Agr. blacklight survey. **Dorchester Co.:** Rhodesdale. 19-VI-1994, Maryland Dept. Agr. blacklight survey. **Harford Co.:** 2-VIII-1994, Maryland Dept. Agr. blacklight survey. **Howard Co.:** Glen Elg, 18-VIII-1992, D. Crouch. **Saint Mary's Co.:** 27-VIII-1994, Maryland Dept. Agr. blacklight survey. **Washington Co.:** 17-VIII-1994, Maryland Dept. Agr. blacklight survey. **MASSACHUSETTS: Barnstable Co.:** Truro, 2-VII-1989, 27-VIII-1989, M. Mello; North Truro, 30-VI-1989, M. Mello; Fox Run Circle, 23 to 26-VI-1990, B. Williams (5). **Bristol Co.:** South Dartmouth, 28 to 29-VI-1992 (2). **Middlesex Co.:** Chelmsford, 24 to 26-VIII-1992, G. Holt (2); Holliston, 29-VIII-1991, 20-VII-1992, 11 to 25-VIII-1992 (5), 5 to 7-IX-1992 (3), D. Willis. **Norfolk Co.:** Dedham, 24-VIII-1991, 6-IX-1991, 11-VI-1992, 17 to 20-VII-1992 (2), 3 to 28-VIII-1992 (18), 19-IX-1992, 21 to 26-VI-1993 (4), 29-VIII-1993, 19 to 22-VIII-1993 (9), 23 to 31-VIII-1993 (33), 1-IX-1993, numerous captures from 6 to 10-VI-1994 to 3-X-1994 with a peak of 110 specimens on 25 to 29-VIII, D. Winter. **Plymouth Co.:** Myles Standish State Forest, 27-VIII-1991, 1-VIII-1992, 1-VII-1993, M. Mello. **NEW YORK: Washington Co.:** Cambridge, 25-VII-1992, H. Romack. **Yates Co.:** Bellona, 3 to 10-VIII-1992, J. Knodel (2); 6 to 28-VI-1994, J. Knodel (2). **Ulster Co.:** near Newpalz, 13-VI-1994, S. Adams. **NEW HAMPSHIRE: Coos Co.:** Whitefield, 25-VII-1990, W. Kiel. **Hillsborough Co.:** no other data. **Rockingham Co.:** no other data. **Strafford Co.:** no other data. **VERMONT: Chittenden Co.:** Burlington, 30-VIII-1991; 6-VI to 9-VIII-1992 (9), J. Grehan; Colchester: 16-VIII- 1991, J. Grehan: no collection date, J. Hedbor, South Burlington, 8-IX-1989, collector unknown. **Franklin Co.:** Franklin Bog, 14-VIII-1992, J. Grehan. **Grand Isle Co.:** South Hero, 26-VIII-1992 (4), J. Hedbor; 11-IX-1993, J. Grehan. **Washington Co.:** Waterbury, 25-VII-1992, J. Grehan.

Negative data. A report of *N. pronuba* in Tacoma,Washington,was negative. The specimen examined by the senior author represented *Noctua comes.*

The NAPIS database contained the following negative data from blacklight traps: Minnesota Department of Agriculture surveyed 15 counties but did not capture any *N. pronuba* in 1994; Maryland Department of Agriculture reported one positive and 21 negative counties for *N. pronuba* in 1993; by 1994, 23 counties were surveyed in Maryland but only two were positive; and the New York Agricultural Experiment Station (Geneva) did not find *N. pronuba* in either Clinton, Essex or Ontario counties in 1994.

DIAGNOSIS

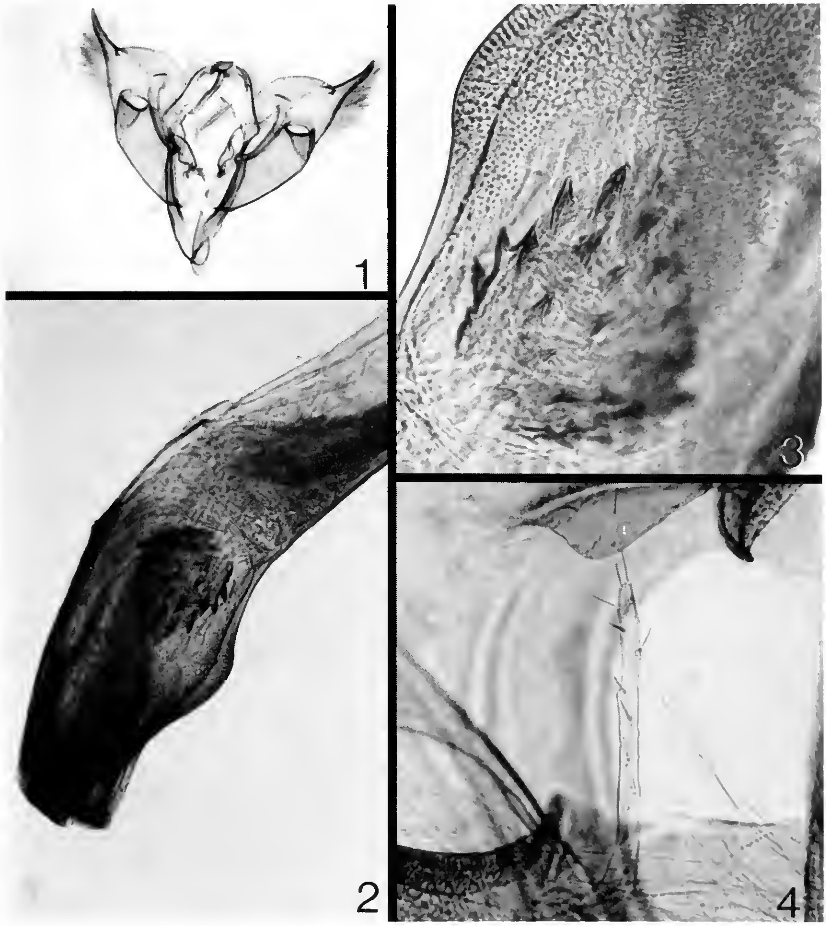
Although *N. pronuba is* frequently identified by the characteristic yellow hindwing with a black border, it may sometimes be confused with the smaller *N. comes* (see Results). The presence of a black hindwing discal dot usually, but not always, will distinguish *N. comes. Noctua pronuba* lacks the dot in all color forms except one (Fibiger 1993). The male genitalia of both species are very different. According to Neil (1984), the valve of *N. comes* is long, thin, and has a knoblike process. There is no knoblike process in *N. pronuba,* and the valve shape is much wider (Fig. 1). Pierce (1909) illustrated the male genitalia of *N. pronuba,* except for the aedeagus. The cornuti of *N. comes* consist of two series of spines that differ in size (Neil 1984), in contrast to *N. pronuba,* where the cornuti are clumped in a cluster of approximately equal size (Figs. 2, 3). Unlike *N. comes* (Neil 1984), an ampulla (a thin rodlike structure) is present on the valve of *N. pronuba* (Fig. 4).

Female genitalia can also distinguish *N. comes* from *N. pronuba.* The most obvious difference is the lack of sclerotized bands in the corpus bursae of *N. comes* (Neil 1984); these are present in *N. pronuba* (Figs. 5, 6, 7). Pierce (1952) illustrated the female genitalia of *N. pronuba* with a v-shaped genital plate. Actually, the area anterior to the ostium has a medial indentation (Fig. 8). The texture of the corpus bursae of *N. comes* has only a small area of wrinkled cuticle (Neil 1984) whereas this texture is widespread on the same structure in *N. pronuba* (Fig. 9).

DISCUSSION

One obvious need of regulatory entomology is an ability to predict the geographical range of introduced insects. Two main methods have emerged. The Office of Technology Assessment Report (1993:86-87) graphed the cumulative number of states where a target organism was collected during a given year. For *N. pronuba,* based on United States data, a similar graph is shown in Figure 11. Initially, the range remained constant during 1985-1988, and *N. pronuba* was known only from Maine. From 1989-1993, when the CAPS survey was most active, the rate of spread (slope) was 4 (7-3) states in 4 years (1993-1989), or about one state per year. This pattern is similar to other introduced insects (*e.g.,* gypsy moth, *Lymantria dispar* L.). From 1870-1900, there was little spread and only a few states were infested (Office of Technology Assessment Report 1993: 87). The highest rate of gypsy moth movement was from 1970-1990, almost 100 years after the initial introduction, where the known infestation jumped from 10 to 20 states in 20 years, or about .5 states/year (Office of Technology Assessment Report 1993: 87). This is similar in magnitude to the figure for *N. pronuba* given above.

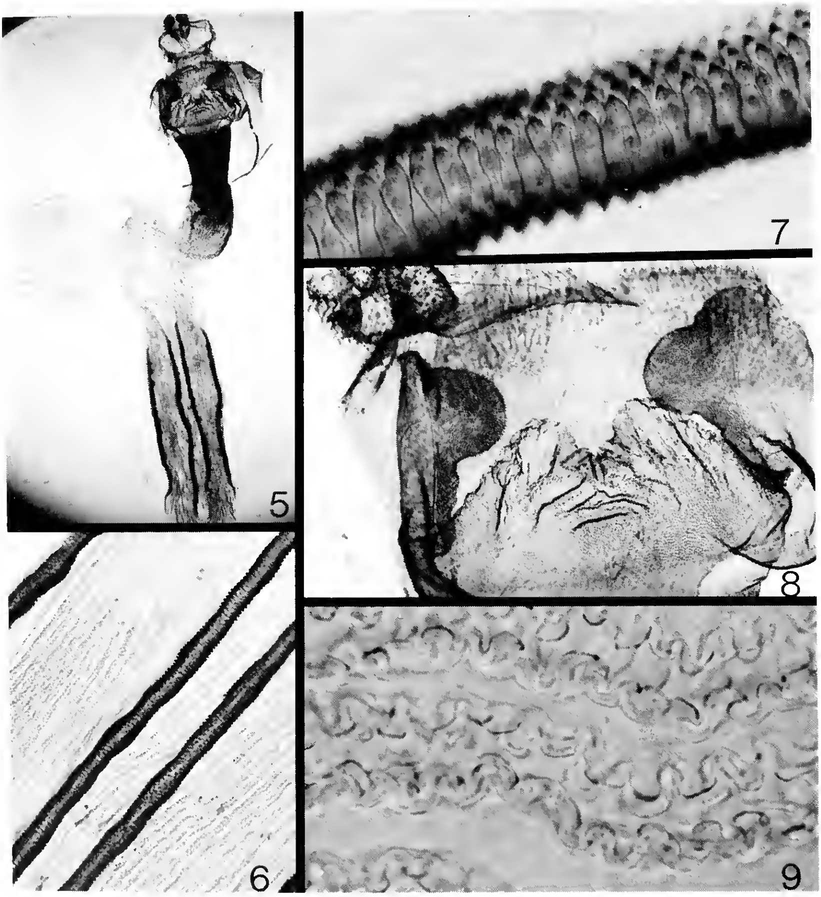
Another method used by Liebhold *et al.* (1995), Neron and LeGault (1992), and Ferguson (in press) documents the rate of spread of an introduced pest in terms of distance traveled/year. These figures were calculated by dividing the distance of the farthest expansion by the time a target organism used to reach that point. For *N. pronuba* in eastern North America, this figure is approximately 800 miles/10 years, or 80 miles/year, which compares to 55 km (= 35 miles)/year calculated by Neron and LeGault (1992) for *N. pronuba* in Canada.



Figures 1-4. Male genitalia of *Noctua pronuba*. 1, ventral view with valves spread (10 x). 2, aedeagus, lateral view (40x). 3, cornuti of aedeagus (100x). 4, ampulla (160x).

Several factors have probably contributed to the spread of the large yellow underwing in North America including wind (Specht and Mairs 1986), migratory habits of the adults, and wide host range of the larvae (Neron and LeGault 1992).

A comparison of the gypsy moth with *N. pronuba* is especially interesting in light of differences between the two species. Although the spread of the gypsy moth may have been assisted by humans (Liebhold *et al.* 1995), the maximum rate of spread for this species is only 13 miles/year(Liebhold *et al.* 1995). Be-



Figures 5-9. Female genitalia of *Noctua pronuba*. 5, ventral view (10 x). 6, sclerotized bands on corpus bursae (l00x). 7, enlargement of sclerotized band (400x). 8, ostium bursae, ventral view (40x). 9, texture of corpus bursae between sclerotized bands (400x).

cause *N. pronuba* lays eggs in houses (Carter 1984), but not on vehicles, humans probably will not play a role in the movement of this species. Adults of *N. pronuba* are migratory (Fibiger 1993); females of the European strain of the gypsy moth do not fly (Schaefer 1988). Efforts were made to control the spread of the gypsy moth (Office of Technology Assessment Report 1993); no control action was taken for *N. pronuba* by the USDA Animal and Plant Health Inspection Service. Perhaps 13 to 100 miles are opposite ends of an extreme where an extensive quarantine leads to a slow spread in the case of the gypsy moth and uncontrolled migration of *N. pronuba* leads to rapid colonization.

Clearly, the two methods have many problems and caveats, perhaps this is the reason why published reports rarely try to present such data. In the case of all distributional studies, there is an "entomologist-area effect", which implies

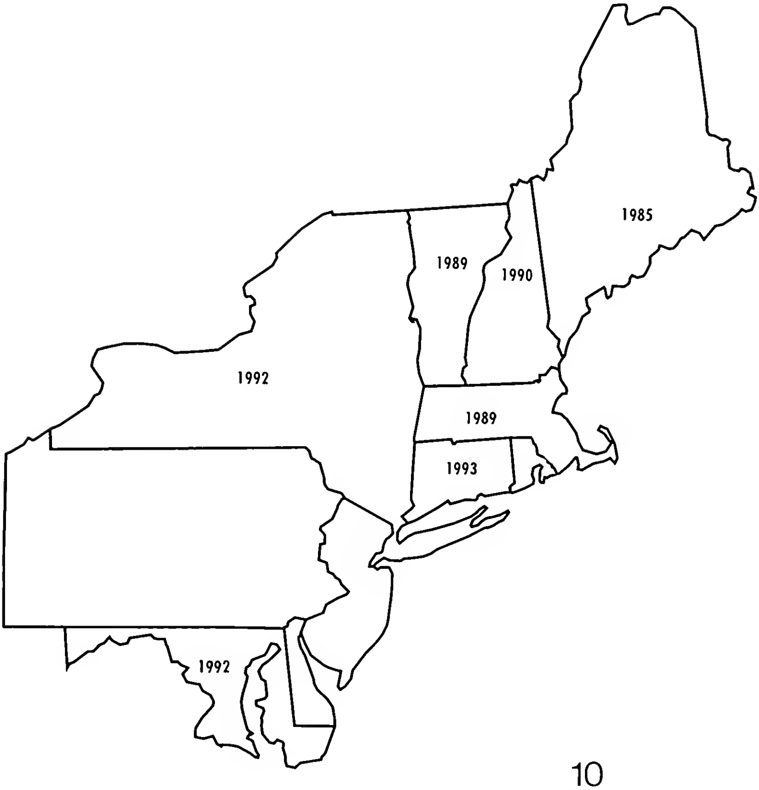


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Figure 10. Years of first capture of *Noctua pronuba* in the northeastern United States.

that records can only occur where researchers are actively collecting data. A figure for the number of states colonized/year is misleading because states vary so much in size. Distance measures are more accurate but mean less from a political standpoint because most quarantine decisions are made on a county, state or regional basis. If an insect crosses the county line, the whole county can be quarantined, which "extends" the distribution of the pest far beyond where it actually colonized. However, data on introduced insects are most reliable when the insect is easily recognized and the sampling area is well-collected. This is the case for *N. pronuba* in the eastern United States, where most states contain lepidopterists capable of recognizing the large yellow underwing, and many individuals operate a light trap on a regular basis.

In summary, quantitative measures of introduced insect distributions need to be developed and reported, especially because the rate of spread is highly variable between species. If we can not trust our positive introduced insect records because of a lack of regionwide negative data, this would seem to justify a need for the continued support of domestic surveys such as the CAPS program.

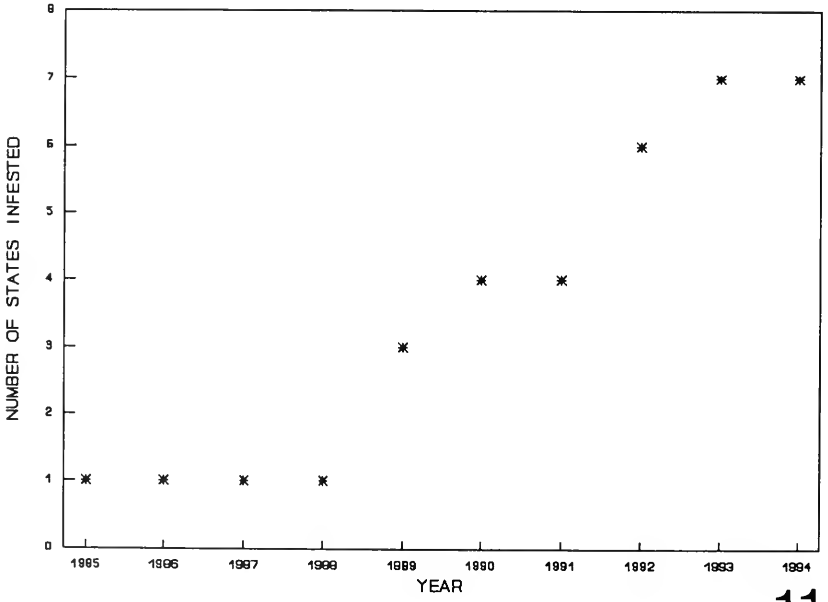

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Figure 11. Rate of spread of *Noctua pronuba* by cumulative number of states infested in the eastern United States per year.

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PARENTAL CARE IN *ERIXESTUS WINNEMANA* (HYMENOPTERA: PTEROMALIDAE), AN EGG PARASITE OF *CALLIGRAPHA* (COLEOPTERA: CHRYSOMELIDAE)[1]

Robert F.W. Schroder, Anne M. Sidor, Michael M. Athanas[2]

ABSTRACT: Parental care is very rare among parasitic Hymenoptera. We report the first evidence of parental care in *Erixestus winnemana* (Hymenoptera: Pteromalidae), a native pteromalid egg parasite of *Calligrapha*, (Coleoptera: Chrysomelidae), in the United States. *Erixestus winnemana* protects her eggs from other parasites and hyperparasite *Apostocetus* sp. (Hymenoptera: Eulophidae).This behavior is also exhibited on Colorado potato beetle, *Leptinotarsa decemlineata*, eggs.

Erixestus winnemana Crawford is an egg parasite of *Calligrapha* in the United States. Our interest in *Erixestus* was to determine its potential as a biocontrol agent for the Colorado potato beetle, *Leptinotarsa decemlineata* (Say); *Calligrapha* and *Leptinotarsa* belong to the same subtribe, Doryphorina, in tribe Chrysomelini, and therefore may be hosts for the same parasites. On July 6, 1992 we collected egg masses of *C. spiraceae* (Say) from ninebark, *Physocarpus opulifolius* (L.), a woody shrub found along stream banks near Flintstone, Washington County, MD. Here we observed *E. winnemana* exhibiting parental care on one of the egg masses.

In this paper, we report the first evidence of parental care in *E. winnemana* parasitizing *C. spiraceae. Erixestus winnemana* exhibited the same behavior on *C. multipunctata* (Say), *C. philadelphica* (L.), and *L. decemlineata* eggs in the laboratory. We also describe the behavior of *Erixestus* against the hyperparasite, *Aprostocetus* sp.

MATERIALS AND METHODS

The beetles, parasites and hyperparasite were all reared at 24°C, at 50-60% RH and 16L : 8D photoperiod in our laboratory. *Calligrapha multipunctata* was collected in Johnson County, Arkansas and reared in the laboratory on black willow, *Salix nigra* Marsh. *Calligrapha philadelphica* was collected near Flintstone, Washington County, MD and reared on red willow *Cornus amomum* Mill. in the laboratory. *Calligrapha spiraceae* was also collected near Flintstone and reared on ninebark in the laboratory. *Leptinotarsa decemlineata* egg masses were obtained from a laboratory colony of the beetle. *Erixestus* were reared in wide-mouth 3.8 liter glass jars streaked with honey and 5% honey water. Labo-

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ratory reared *Calligrapha* egg masses were placed in the jar and exposed to parasites for 24 hrs. They were removed and incubated until the parasites emerged in 10-13 days. Egg masses collected in the field were incubated in the laboratory for the emergence of parasites and hyperparasites. The hyperparasite, *Aprostocetus*, was reared in the laboratory by exposing it to parasitized *Calligrapha* eggs for 24 hours in a petri dish.

Behavioral observations were conducted in the following manner. An egg mass from a particular species of beetle was placed in a small petri dish with an *Erixestus* female until she parasitized several eggs, at which time a female hyperparasite or other *E. winnemana* females were added and observations on their behavior were made. In addition, 2-3 females were placed in a small petri dish with multiple egg masses to observe the behavioral response to more than one egg mass. All observations were made directly through a microscope or recorded on VCR tape and viewed later.

RESULTS

The general parental care behavior pattern of *E. winnemana* observed on egg masses of the three *Calligrapha* species and on *L. decemlineata* was as follows. When the *Erixestus* female is first placed in a petri dish, she searches for an egg mass and begins drumming it with her antennae (Fig. 1-a). Several seconds later she proceeds to insert momentarily her ovipositor approximately 1/3 of its length, withdraws it and feeds on the exuding yoke (Fig. 1-b). She then inserts her ovipositor again for several seconds, but this time to its full length. At this point she becomes very protective of the egg mass, which she will guard until her young emerge (ca. 10-13 days) (Fig. 1-c). She may continue to oviposit in other eggs in the mass, but she does not willingly leave it for another egg mass. When other females approach the mass she makes herself look bigger by extending her wings, and lashing out at the intruder (Fig. 1-d). She responds in the same way if approached by an inanimate object such as a brush. If the intruder does not retreat, a fight ensues for several seconds (Fig. 1-e). At this point, she either wins and the intruder leaves or she is injured/killed. If she survives, she grooms herself and flexes her body by rising up and down on the egg mass (Fig. 1-f). If she loses, the egg mass is abandoned and the new female takes over. The old female will then move to another mass that has not been parasitized or fight for the possession of it.

The parasite's response to hyperparasites is the same as previously described. *Aprostocetus* sp. is more patient and persistent in its attempt to get on the egg mass. It will very slowly circle around the mass, make a few attempts to get on the egg mass, and if the female is resting or in the process of ovipositing, the hyperparasite will quickly mount the egg mass and immediately oviposit. But when the female is again aware of the hyperparasite, she chases it off the mass.

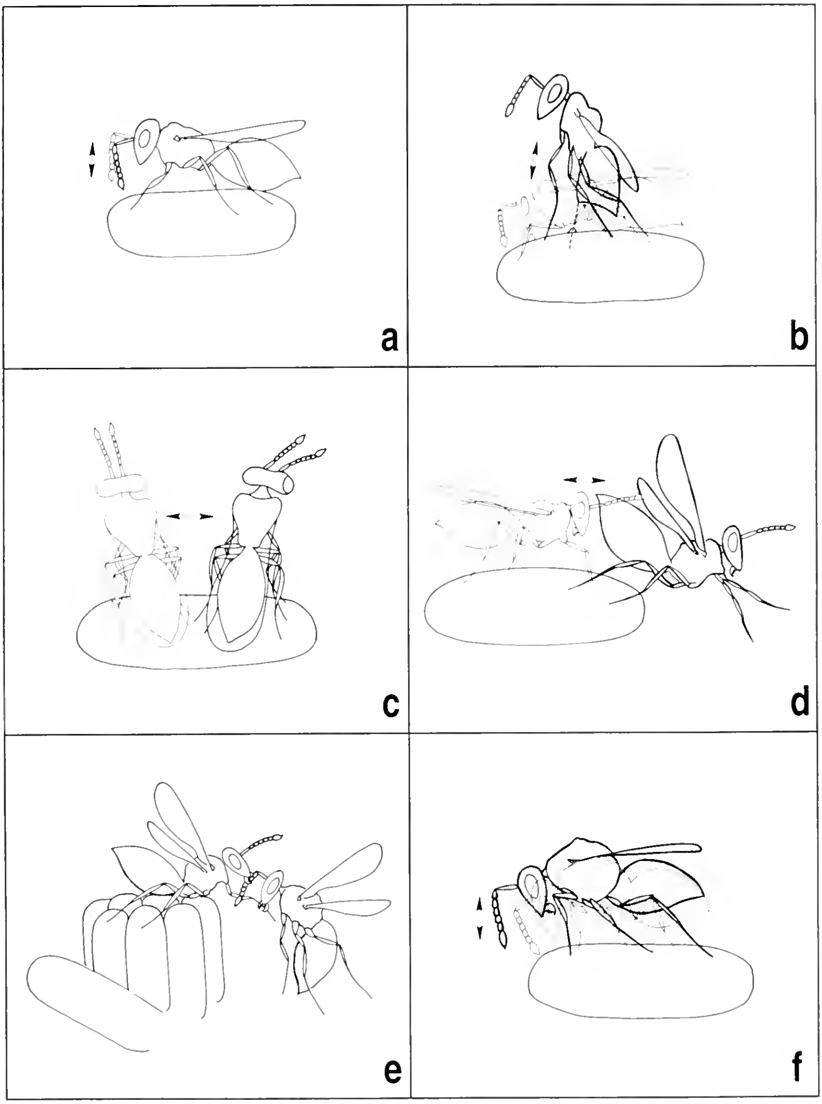

Fig. 1. Schematic of parental care behavior patterns of *Erixestus winnemana* Crawford, on eggs of *Calligrapha* and *Leptinotarsa decemlineata*. (a) Drumming egg with antennae. (b) Partial insertion of ovipositor. (c) Oviposition and beginning of guarding the egg mass. (d) Protection of egg mass. (e) Combating behavior. (f) Grooming and flexing on egg.

DISCUSSION

Parental care in insects ranges from passive egg guarding to complex grooming, feeding, protective, and nesting behaviors. Tallamy and Wood (1986) categorize parental care into 3 primary behaviors: 1) physical protection of offspring from danger, 2) protecting resources vital to offspring; and/or 3) facilitating offspring feeding. In our study, *E. winnemana* physically protected the parasitized egg mass from hyperparasitism, and competition by other parasites.

According to Tallamy and Wood (1986), the costs of parental care include: 1) the defense of offspring, at the risk of physical injury or death; 2) offspring clustered in one spot may be more attractive to parasites and predators than isolated ones, and 3) the evolutionary decision to invest more time in a few progeny versus minimal amount of time on many. The costs of parental care for *E. winnemana* are very similar to those mentioned by Tallamy. For instance, in the laboratory we demonstrated that the female protects her offspring from hyperparasitism and superparasitism of the host eggs, protection that can result in the female's death. Also, the female makes the decision to remain on the egg mass she has parasitized until the eggs hatch or she loses possession of it. Here again, she invests more time to protect a few offspring versus moving on to oviposit in other scattered egg masses. In nature, *E. winnemana* oviposits her eggs in a mass averaging 2-7 eggs/mass on the underside of leaves. These egg masses are sparsely scattered on ninebark shrubs found along the stream banks. We did not observe more than one parasite on an egg mass in nature. Daviault (1941) reported on *E. winnemana* as an egg parasite of *C. bigsbyana* and *C. scalaris,* but did not mention parental care in his discussion of the biology of the parasite.

Parental care is very rare among hymenopterous parasites. Most parasites usually oviposit on/in or near a suitable host and then leave without paying any further attention to their progeny. However, there are a few species where the female protects her progeny until they mature. There is only one known instance in the Ichneumonoidea, where the braconid, *Cedria paradoxa,* attacks the larvae of the pyralid moth, *Hapalia machaeralis,* in India (Beeson & Chatterjee 1935). In this case, a single braconid female parasitizes one caterpillar and guards the offspring from the egg to adult stages or until her death. Several bethylid species also exhibit parental care, when the female remains with her progeny, defending them against predation, hyper-, super- and multiple parasitism (Gordh & Hawkins (1981), Doutt (1973), Bridwell (1919), Kuhne & Becker (1974), Gerling (1979), and Hardy & Blackburn (1991). Here we have demonstrated a new form of subsocial behavior in parasitic Hymenoptera, specifically in the pteromalids.

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PROCLOEON VIRIDOCULARIS (EPHEMEROPTERA: BAETIDAE) FROM MICHIGAN AND PENNSYLVANIA, NEW RANGE EXTENSIONS WITH COMMENTS ON THE SPECIES[1]

R.D. Waltz[2], James B. Munro[3]

ABSTRACT: *Procloeon viridocularis* is reported for the first time from both Michigan and Pennsylvania. These collections are also the first reports of this species outside the southeastern United States. Previously, this species was known only from Alabama, Florida, Georgia, Mississippi and South Carolina. The larva of *Procloeon viridocularis* is distinct, if not unique, among Nearctic *Procloeon* based on a combination of characters including elongate claws, simple gills, long, narrow maxillary palps, and terminal segment of the labial palps greatly expanded. The larvae are similar to larvae of the genus *Pseudocentroptiloides.* A synoptic comparison and contrast of the larvae of this species with *Pseudocentroptiloides is* provided.

While conducting ecological studies of mayfly drift and periodicity, two unusual larval exuviae of *Procloeon* Bengtsson were collected by one of us (JBM) from Blooming Grove Creek, Pike County, Pennsylvania, August 10, 1993. Independently, the senior author encountered two larvae of the same type from Michigan, Cheboygen Co., Lake Huron, Grassy Bay, near shore area, May 18, 1992, collected as part of ongoing studies of the National Biological Service, Great Lakes Science Center. The larvae and larval exuviae were characterized by elongate claws greater than one-half the length of their respective tarsi, greatly expanded terminal segments of the labial palps, and each maxilla bearing a narrow, much elongated (compared to the majority of *Procloeon* species) palp extending well beyond the galealacinea.

These larvae and larval exuviae were identified as *Procloeon viridocularis* (Berner) based on comparisons with published descriptions (Berner 1940) and comparisons with previously identified material in the senior author's collection from the southeastern United States. This species has been reported from Alabama, Florida, Georgia, and Mississippi (Berner and Pescador 1988) and South Carolina (Unzicker and Carlson 1982: p. 3.85). The discovery of *P. viridocularis* from the northernmost county of the lower peninsula of Michigan and from northeastern Pennsylvania greatly extends the known northern range of this species. It may eventually be found throughout much of the east (equal to northeast + southeast sensu McCafferty and Waltz 1990).

This widespread, but apparently uncommon, species was originally described

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in *Centroptilum* Eaton as both larvae and adults by Berner (1940) and later transferred to *Procloeon* (McCafferty and Waltz 1990). Some workers have brought to the attention of the senior author the phenotypic similarities of the larva of *P. viridocularis* with *Pseudocentroptiloides* Jacob, noting especially the claw, gill, and labial palp characters as being very similar. However, *P. viridocularis* lacks the identifying synapomorphies which would place it in *Pseudocentroptiloides,* including lack of a v-shaped notch at the anterior margin of the labrum, lack of a characteristically modified maxilla, and lack of shortened glossae and paraglossae (see Waltz and McCafferty 1989). The larva of *Procloeon viridocularis* is distinctive, if not unique, among North American *Procloeon* in possessing elongate claws which exceed one-half the length of their respective tarsi, possessing greatly expanded terminal segments of the labial palps, combined with the possession of maxillae with an elongate, two-segmented palp which extends well beyond the apex of the galealacinea. Like other *Procloeon* species, larvae of this species possess caudal filaments with lateral setae present to the tips of the filaments, and have the mandible incisors united beyond half way from the base on at least one mandible.

Berner and Pescador (1988) provided an excellent account of the habitats of *P. viridocularis* in the southeastern United States. In the southeast, larvae of this species apparently prefer sandy bottomed streams with moderate current where they may be found in still pockets behind rocks or at the base of rooted plants.

The collection site for *P. viridocularis* in Michigan was uncharacterized other than as a near shore site in Lake Huron.

The site from which the Pennsylvania material is taken is located in Blooming Grove Creek, a clean, clear-water, third order stream. This dominantly free stone stream is generally characterized by substrate boulders with a low degree of embeddedness. Pools and riffles provide a variety of alternative microhabitats. The stream is fed by swamp water outflows maintaining a pH of around 6.14 (Ersbak 1993). Low alkalinity 4.9 mg/l ($CaCO_3$), low total hardness 18.8 mg/l($CaCO_3$), and average temperatures of 20° C ranging from a low of 1.9°C in February to a high of 23.0°C in September (Ersbak 1993) summarize the physical and chemical parameters of the site.

The habitat described above appears to differ somewhat from that described for this species by Berner and Pescador (1988). However, one rather large pool, with sandy substrate located approximately seven meters upstream from the sampling site, matched closely the characteristics of the southeastern habitat for this species described by Berner and Pescador (1988). The pool did not exceed 30 cm in depth and was bordered by an emergent bur reed, *Sparganium chlorocarpum.* It is possible that this pool represents the habitat of this species in Pennsylvania, rather than the more generally distributed boulder type of habitat occurring throughout most of the stream.

ACKNOWLEDGMENTS

We thank the Blooming Grove Hunting and Fishing Club for allowing one of us (JBM) to study the stream site from which some of the specimens in this report were collected. We thank Pat Hudson, National Biological Service, Great Lakes Science Center, for providing the Michigan material cited in this report.

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SAMPLING TECHNIQUE FOR SOIL MACROARTHROPODS INHABITING FOREST FLOORS[1]

Pierre Paquin, Daniel Coderre[2]

ABSTRACT: Most soil fauna sampling techniques have been developed for microarthropods and are not suitable for sampling macroarthropods. This paper describes a better sampling methodology for the entire macroarthropods assemblage. A given sample area of 12.5cm by 25cm exempt from biases and obstacles is divided into three fractions (aerial, epigeic and endogeic). The collection of each fraction is adapted to the behavior of the soil fauna that it contains. Flying insects are first collected with a removable net attached to the top edge of the sampling mold, the litter is then gathered by hand, and finally the deeper organic layers are collected in a block. This method permits sampling of the soil by taking into consideration the vertical distribution of organisms. Samples stored as blocks of soil in polyethylene bags are sufficiently large and stable to insure the survival of organisms until extraction. This new methodology has certain advantages over traditional methods in that it allows a quantitative sampling of all soil organisms according to their vertical distribution.

Most sampling techniques for soil fauna have been developed by taking into consideration the microdistribution, small size and high density of microarthropods (especially Collembola and Acarina). These sampling parameters are not suitable for macroarthropods which are, in general, less numerous per unit area (Edwards 1967). The dimensions of the sample must therefore be proportional to the size of the organisms (Kaczmarek 1993), whereas the shape must attempt to maximize the representation of the soil under study. Indeed, the number of samples and the sample volume itself must attempt to compensate, through sufficient volume and number, the potentially contagious distribution of edaphic organisms (Górny and Grüm 1993, Huflejt and Karwowski 1993).

Good sampling must be representative of the environment under study (Kasprzak 1993) and avoid biases caused by nonhomogeneous features of the soil, which often harbor a particular fauna. Flogaïtis (1983) recommends that stumps, dead wood and proximity to trees should be avoided by keeping a constant minimal distance between these biases and the sample. Indeed, these distinctive features of the soil harbor their own characteristic fauna and are sources of contamination to be avoided during sampling. Stumps (Smith and Sears 1982), dead wood (Teskey 1976), animal excrement (Peck 1991), and fungi (Pielou and Verma 1968) are microhabitats to be avoided. Random sampling in an area exempt from biases and obstacles is thus recommended for the study of soil

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organisms. Górny and Grüm (1993) suggest a flexible rather than a rigid approach to sampling in respect of randomly chosen plots. Good judgement is therefore called upon when deciding whether to include or exclude habitat characteristics during sampling. For example, old cedar forest soils are associated with the presence of decomposing wood (Bergeron and Dubuc 1989). This distinctive feature should therefore be included in representative samples of such soils.

Geoffroy *et al.* (1981) and Zukowski (1993) mention that adult Diptera and Hymenoptera associated with the soil are rarely collected, even though these insects play an important role in the dynamics in soil assemblage at the larval stage or as parasitoids or parasites (Zukowski 1993). Traditional sampling techniques are not well suited for the characterization of highly mobile or flying macroarthropods associated with the soil.

We believe that the method described here is an improvement for the sampling and characterization of soil macroarthropods. It is the best possible compromise given the numerous constraints and variables associated with the collecting of soil organisms. The method has proven its superiority in an extensive forest soil ecology sampling program.

MATERIALS

The equipment includes: (1) An aluminum sampling mold 6mm thick and 20cm high, with a 12.5cm by 25cm sampling surface (Fig. 1). The mold's bottom edge is tapered to insure a good bite into the soil. (2) A removable Terylene net with an elastic band at its lower border (Fig. 1). This elastic border can be adjusted to the top edge of the sampling mold. It should be noted that the Terylene

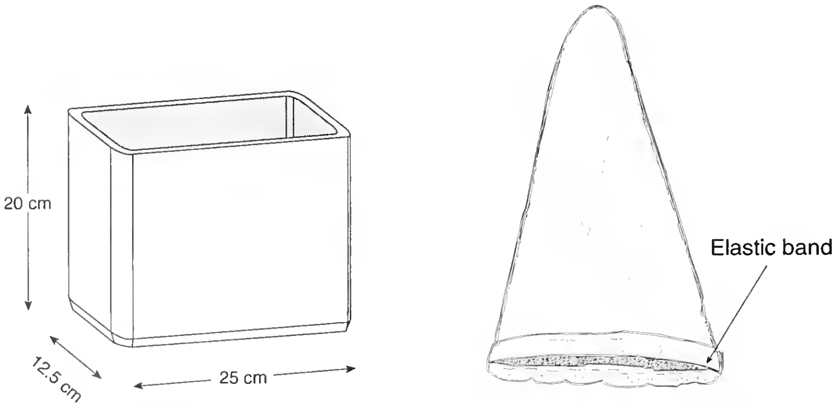

Figure 1. Sampling mold and removable net.

can be replaced by another material transparent enough to allow visual localization of the insects within the net. Terylene, however, is resistant to tearing and is not degraded by light, as is the case with other materials. (3) A wash flask filled with acetic alcohol. (4) Flexible tweezers. (5) Scintillation vials. Their advantage is that they are made of unbreakable plastic. One vial is required per soil sample. (6) A knife with a long blade. (7) A square shovel. (8) A 60cm by 90cm clean, white and smooth surface. A surface covered by melamine or Formica® is ideal. (9) Two-liter polyethylene bags. One bag per soil sample is required. (10) Ten-liter polyethylene bags. One bag per soil sample is required. (11) A measuring tape.

METHODOLOGY

This method was tested in boreal forests: including a deciduous forest (*Populus tremuloides* Michx.); a mixed forest (*Abies balsamea* (L.) Mill., *Picea glauca* (Moench) Voss and *Betula papyrifera* Marsh.); and a coniferous forest (*Thuya occidentalis* L. and *Abies balsamea* (L.) Mill.). These forests are situated in western Québec's clay belt, in the Duparquet Lake region (48°30' North, 79°15, West). See Bergeron *et al.* (1983) for a more detailed description of the vegetation and soils in this region.

Our technique is aimed at quantifying diversity and biomass at three macroarthropod groups: (1) flying adult insects associated with soils (Diptera and Hymenoptera), (2) fast-moving epigeic insects in the litter (larval and adult Staphylinidae, Carabidae, Arachnida, etc.) and (3) slower endogeic organisms found in the deeper organic fraction (Diptera larvae, etc.).

The collection of the three fractions (aerial, epigeic and endogeic) constituting a sample is carried out in eleven distinct steps: (1) Sampling plots are randomly chosen in areas exempt from biases and obstacles (as a function of included and excluded characteristics). Walking heavily is avoided since soil vibrations cause highly mobile insects to flee. (2) The sampling mold covered by the removable net is forcefully driven into the soil, so that the tapered edges of the mold penetrate the litter. (3) After one minute, the flying organisms can be found in the net. They rarely number more than one or two at a time. (4) A careful inspection allows one to locate and fix them using the wash flask filled with acetic alcohol. A single jet of alcohol through the net is enough to immobilize them. (5) After the insects are immobilized, the net is removed. Because of the surplus alcohol, the insects remain stuck on the inner surface of the net. With the flexible tweezers, the insects are transfered to the scintillation vials. This constitutes the aerial fraction of the sample. The vials must then be filled with acetic alcohol and labeled according to the sample to which they belong. (6) The litter (superficial layers composed of dead leaves, needles or twigs) contained within the mold is then delicately gathered by hand. This litter is transfered to two-liter polyethylene bags and constitutes the epigeic fraction of the sample. During the first steps of the procedure, because the mold is driven into the soil, litter organisms are prevented from escaping. (7) The knife is used to cut through the soil along the inner edges of the sampling mold. The square shovel can be used to break roots that the knife cannot cut. (8) The mold is then removed, after which the block of soil is lifted from the ground with the square shovel and placed on the Formica® board. (9) The organic layers are then separated from the mineral layers so as to transfer in one block the organic layers to the ten-liter polyethylene bags. This fraction constitutes the endogeic fraction of the sample. In luvisols or podzols, the separation of organic layers from mineral layers is easily accomplished. (10) The bags containing litter, as well as the blocks of organic layers, are placed in an ice chest until they can be brought to the laboratory. Care must be taken so that the blocks are placed as they were originally found in the ground, with the top part of the blocks facing up, to avoid disturbing the organisms they contain. (11) The thickness of the litter and of the organic layers are measured in the hole left after the samples are taken. These data will later serve to calculate the volume of each fraction.

The total duration of the entire procedure in the field is ten minutes per sample. In the laboratory, the contents of the scintillation vials are transfered to vials that can better prevent the alcohol from evaporating. The fractions contained in the polyethylene bags are stored in a refrigerator at 4°C until extraction.

DISCUSSION

We believe our methodology possesses many advantages over previously used techniques. (1) Our approach for the choice of sample plots in areas exempt from biases complements that of Flogaïtis (1983). The elimination of biases associated with nonhomogeneous distinctive features of the soil insures a greater representativity of the sample. The greater volume collected, in comparison with traditional soil core techniques (Vannier and Vidal 1965), results in only slightly less flexibility regarding the choice of plots.

(2) Compared with the average small surface areas of samples generally used in studies of soil fauna (Murphy 1958a, 1958b, Vannier and Vidal 1965, Vannier 1966), that used in our method (312.5cm^2) is 12.5 times larger. Because of its small size, traditional coring, aimed especially at Acarina and Collembola, does not permit a true evaluation of larger (and hence less numerous per unit surface) macroarthropods (Edwards 1967). Vannier and Alpern (1968), however, underline the fact that a sampling surface should correspond to a precise surface area. That proposed in our method corresponds to 1/32 m^2. Vannier and Vidal (1965) recommend that the number rather than the size of samples be increased; it is preferable to have many smaller samples instead of one large sample. In that perspective, we are specifying that the sample size

must respect the physical characteristics such as the distribution, the size and the number per unit area of the organisms under study.

(3) The size of the sample proposed in our technique approaches that used by Vannier and Alpern (1968), who adopted a 20cm by 10cm surface, and that by Flogaïtis (1983) with 25cm^2. However, a rectangular rather than a square shape was adopted because, for a given surface, a rectangular shape samples on a longer transect, which better distributes the sampling effort and tends to reduce the influence of a contagious distribution.

(4) Our technique was tested in three types of forest soils. It is also suitable for agricultural soils, as well as many other types of ecosystems. With respect to its adaptability to different soil types, its versatility is comparable to the traditional coring sampling techniques.

(5) The volume of the samples and the methodology described herein allow the collection of every type of soil organism: flying organisms, organisms in the litter and those from deeper layers, be they macro or microarthropods. Our technique is nonselective, with each collected fraction adapted to the behavior of the organisms that comprise that fraction. Collecting in three fractions allows a rapid determination of the vertical distribution of organisms relative to a precise surface or volume, without risk of contamination, since our approach eliminates migration of organisms from one soil layer to another due to the layers' being collected separately. In general, traditional coring does not take the vertical distribution of organisms into consideration. Vannier and Alpern (1968) propose a method, inspired by Murphy (1958a), to study the vertical distribution of organisms, but the small sampling area (20 cm^2) of this technique is not suitable for macroarthropods. Our method, in this sense, complements that of Flogaïtis (1983) for the separation of sublayers of the sample. No other method allows the collecting of flying insects. With our proposed methodology, it is possible to sample adult Diptera and Hymenoptera. Although collected in lesser numbers than by the use of the terrestrial emergence cages (Martin 1977), these specimens can facilitate the identification of immature stages found in the soil, yield information on the phenology of the species involved and provide the first step in associating parasitoids and parasites with their hosts.

(6) Within a global approach to edaphic communities, our technique leads to a large quantity of microarthropods (Acarina and Collembola) because of their small size and the high densities they can reach (Edwards 1967). A subsampling of these groups, once the specimens are extracted, is therefore recommended (Niedbala and Rajski 1993).

(7) The quantitative approach of this technique allows the association of the organisms collected with a precise unit of surface or volume. The organisms collected in the epigeic fraction are the same as those collected by the European sifting technique described by Smetana (1971). The sifting technique is qualitatively more efficient due to the large volume of litter it allows one to process

The quantitative measure is however, more precise with a fixed soil surface such as proposed by our technique.

(8) Our collecting technique insures that the specimens are well preserved. The organisms in the first fraction are placed in alcohol while in the field and so remain in a perfect condition. Those found in the litter are subjected to only a delicate pressure during the manual collecting, which insures their good condition. The organisms contained in the third fraction sustain only a minimal pressure during the cutting out of the block of soil. The large size of the samples results in there being little disturbance for the organisms (Murphy 1958b, Vanier and Alpern 1968). Traditional coring, because of the small size of the samples it yields, exerts a physical pressure (Vannier and Alpern 1968) that can damage fragile specimens.

(9) The technique of collecting soil samples in the shape of blocks was initially proposed by Murphy (1958b) but the aim of his proposition was to later sample the blocks by careful coring without pressure. Our technique leads to larvae samples and requires more time for extraction than the smaller traditional samples. Edward and Fletcher (1970) and Leinnas (1978) studied the effects of storage on small samples. These were determined negligible for delays of 28 to 29 days. Rapoport and Oros (1969) reported variable effects for a delay of 120 days. They also showed that the use of polyethylene bags (rather than other materials) minimizes biases due to storage. Samples collected with our technique (in the shape of blocks and stored at low temperatures in polyethylene bags) allow an equivalent duration of storage, and probably a longer one because of the large volume involved. These blocks create a temporary environment sufficiently large and stable to insure the survival of the organisms they contain. A low refrigerator temperature (4°C) minimizes organism activity. Maturation is negligible and reproduction of most macroarthropods requires an adult sexual phase impossible under such conditions. The low levels of activity by individuals and the large sample volume minimize predation during storage.

The proposed technique is aimed mainly at forest soil macroarthropods but is equally suitable for all edaphic organisms. Our method allows the collection of individuals belonging to the aerial, epigeic and endogeic fractions of the soil. This quantitative method also considers the vertical distribution of organisms. The method is simple, inexpensive, efficient and rapid. It lends itself to many types of biological studies such as inventories, environmental impact evaluations, parasitism, voltinism, microhabitat studies and the vertical distribution of the soil fauna.

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REVISION OF THE INTERTIDAL ALEOCHARINE GENUS TARPHIOTA (COLEOPTERA: STAPHYLINIDAE)[1, 2]

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ABSTRACT: A systematic revision of the genus *Tarphiota* is presented. *Tarphiota* Casey is redescribed. *Tarphiota fucicola* and *T. geniculata* are redescribed. *Tarphiota pallidipes* synonymized under *T. fucicola.* Lectotype and paralectotypes are designated for *T. pallidipes, T. debilicollis, T. hirsutula, T. iota, T. insolita, T. litorina,* and *T. seditiosa* from Casey's syntype series deposited in the NMNH. A key is provided for separation of the known species of *Tarphiota* and illustrations of diagnostic features are presented.

Members of the genus *Tarphiota* Casey are confined to the sandy beaches of Pacific North America. *Tarphiota* was first described and characterized by Casey in 1893. Mäklin (1852) described *Tachyusa fucicola* and *Homalota geniculata* from the coast of Alaska. *Tachyusa fucicola* was transferred to *Homalota* Mannerheim by Mäklin in 1853. Casey (1893) described the new genus and species *Tarphiota pallidipes* from the coast of California. He believed that the genus *Tarphiota* included *H. fucicola* and *H. geniculata.* Later, Casey also described six additional species from the Pacific coast of America. However, all six species were synonymized by Fenyes in 1920 and *T. pallidipes* is synonymized under *T. fucicola* in this paper.

Examination of the type series of *T. fucicola* (Mäklin) and *T. geniculata* (Mäklin) in the collections of the Finnish Museum of Natural History allowed me to revise this genus. In this paper, I redescribe *Tarphiota* Casey and the two valid species [*T. fucicola* (Mäklin), *T. geniculata* (Mäklin)], synonymize *Tarphiota pallidipes* Casey under *Tarphiota fucicola* (Mäklin), and designate lectotypes and paralectotypes from the syntype series of each described species in the collections of the NMNH.

Tarphiota Casey

Tarphiota Casey, 1893: 332, 1910: 74; Fenyes, 1920: 254; Bernhauer and Scheerpeltz, 1926: 596; Blackwelder, 1952: 374; Hatch, 1957: 145; Moore and Legner, 1975: 489, 1976: 535; Seevers, 1978: 132.

Diagnostic Combination. Among aleocharine genera with 4-5-5 tarsal formula, members of *Tarphiota* are recognized by the combination of: integument

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of head, pronotum, and elytra granulose due to a fine-meshed, raised reticulation; antennomeres (Fig. 1) 8-10 transverse; head without infraorbital carina; mandible (Fig. 4) with blunt apex; labium (Fig. 6) with narrow Y-shaped ligula; mentum with long v seta; separated mesocoxae; pointed mesosternal process; unmargined mesocoxal cavities; anterior and middle tibiae with a row of spines; elytra slightly sinuate apico-laterally, longer than pronotum; hind wings present; and internal circular sclerites present at base of metasternum.

Description. Small, length 2.0-3.1 mm. Body shape narrow, flattened and parallel-sided. Body color black or dark brown. Microsculpture of head, pronotum, and abdominal segments faintly polygonal. Integument of head, pronotum, and elytra granulose due to a fine-meshed, raised reticulation, more or less uniformly pubescent with short microsetae.

HEAD. Slightly deflexed, ≈1.2 times as wide as long. Eyes with microsetae between facets, ≈0.5 times as long as tempora. Neck absent but basal constriction present. Infraorbital carina absent. Microsetae relatively long, directed anteriorly, almost uniformly distributed. Integument granulose. Hexagonal microsculptures present. Tempora short. Submentum with several setae and punctures. Antenna (Fig. 1) with 11 antennomeres, slightly incrassate towards tip; antennomeres 2-3 each shorter than preceding, 4-7 gradually dilated, 8-10 transverse.

MOUTHPARTS. Labrum (Fig. 2) transverse, 9+9 major setae distinct, 3+3 additional setae present, sensillae present, punctures distributed anteriorly. Epipharynx (Fig. 3) with about 6-8 lateral pores on each side, numerous tiny pores, about 6-8 pores on apical region, about 35 pores on median region along with numerous indistinct pores. Mandibles (Fig. 4) asymmetrical, apex blunt and curved downward; right mandible with median tooth, absent from left mandible; serration absent from apex to median tooth, many punctures scattered ventrally and dorsally; prostheca well developed, membranous with fibrils. Maxilla (Fig. 5) with galea and lacinia elongate; galea with inner surface membranous, apex with long filiform setae, outer surface corneous, apex with numerous delicate branching fibrils which have a row of extremely delicate setae; lacinia more or less acute, internal surface with comb composed of a single row of 9 well separated spines followed more proximally by a small dense patch of setae, and a distinct row of numerous setae, a row of pores on dorsal surface; maxillary palpus, robust, with 4 articles, article 3 incrassate distally and longer than article 2, article 4 very slender, narrow distally with filamentous sensilla. Labial palpi (Fig. 6) with 3 articles, elongate, article 3 shorter than article 1 and longer than article 2, article 3 incrassate distally; ligula bifid, 2 tubercles on tip; a pair of medial setae, twin pores, median pores, distal pores, setal pores, real pores, basal pores present, and about 30-35 or 5 pseudopores present medially, 11-12 or 3 laterally. Prementum with a pair of comb-like hypoglossae. Mentum almost trapezoidal, slightly emarginate anteriorly, three main setae present on each side, v setae relatively long, several setae and punctures present.

THORAX. Pronotum ≈1.2-1.3 times as wide as long, basal and apical lines about equal in length, sides round; microsetae uniformly distributed; macrosetae absent; integument granulose, a row of distinct dark punctures on base. Pattern of pubescence with setae subparallel, those on the anterior half of pronotum directed anteriorly and those on posterior half directed posteriorly in a narrow median strip, lateral setae with anterior half directed antero-laterally and posterior half directed postero-laterally. Scutellum more or less octagonal. Hypomera feebly inflexed, entirely visible in lateral aspect. Mesocoxal cavities narrowly separated; mesosternal process acute. Metasternum longer than width of mesocoxa. Tarsal formula 4-5-5, internal circular sclerites present at base of metasternum; anterior and middle tibiae with distinct row of spines.

ELYTRA. ≈1.2-1.3 times as long as pronotum; very slightly sinuate apicolaterally, longer laterally than medially, carina present on anterior medial edge of elytra; microsetae numerous, uniformly distributed, directed more or less posteriorly; macrosetae absent; integument granulose. Hind wings present.

ABDOMEN. General shape broad at base, sides uniformly converging to broadly rounded apex. Tergites III-VIII with distinct macrosetae. Tergites III-VI moderately impressed at base, anterior margin of tergites III-VI deeply and broadly V-shaped. Tergite VIII with 4 or 7 pairs of macrosetae. Tergite X with seta numerous, 3-4 major setae distinct; posterior margin not well sclerotized.

AEDEAGUS. Median lobe (Figs. 7 and 10). Paramere (Figs. 8 and 11).

SPERMATHECA. (Figs. 9 and 12).

SECONDARY SEXUAL CHARACTERISTICS. Male tergite VIII slightly sinuate.

Type species. *Tarphiota pallidipes* Casey [= *T. fucicola* (Mäklin)]. Designated by Casey (1910).

Distribution. From Alaska to California.

Biology. Members of the genus *Tarphiota* inhabit the mid to upper littoral zone of fine-grained sandy beaches, which is covered by only one or two high tides each month and contains decaying seaweed. Nothing is known of larvae or development of any species of *Tarphiota.*

Remarks. Casey (1893) described a new genus *Tarphiota* for *T. pallidipes* and mentioned that members of *Tarphiota* resembled *Alianta* Thomson, but differed from members of this latter genus by having spinulose tibiae. Fenyes (1918) placed *Tarphiota* in the tribe Myrmedoniini (group Athetae) based on the 4-5-5 tarsal formula, antennae with 11 antennomeres, maxillary palpi with 4 articles, and labial palpi with 3 articles. The tribal name Myrmedoniini was later synonymized under the name of Athetini by Seevers (1978). Bernhauer and Scheerpeltz (1926) classified the genus based on Casey's description and Fenyes' placement. Moore and Legner (1976) still placed *Tarphiota* in the Myrmedoniini (= Athetini). Seevers (1978) placed *Tarphiota* in the tribe Athetini with *Pontomalota* Casey but noted that these intertidal genera were not necessarily related to each other and other members of Athetini. Ahn (in press) hypothesized that members of *Tarphiota* were closely related to members of *Pontomalota* and *Thinusa* Casey and that these genera might form a monophyletic group within the tribe Athetini.

Key to the species of the genus *Tarphiota*

1. Body length 2.9-3.1 mm; abdominal tergite VIII with 7 pairs of macrosetae; spermatheca with narrow tube (Fig. 9); paramere as in Fig. 8 .... *T. fucicola*

Body length 2.0-2.6 mm; abdominal tergite VIII with 4 pairs of macrosetae; spermatheca with broad tube (Fig. 12); paramere as in Fig. 11 .... *T. geniculata*

Tarphiota fucicola (Mäklin)

Tachyusa fucicola Mäklin, 1852: 306; Bland, 1865: 406.
Homalota fucicola (Mäklin), 1853: 182.
Tarphiota fucicola Casey, 1893: 333; Bernhauer and Scheerpeltz, 1926: 596; Hatch, 1957: 145; Moore and Legner, 1975: 489; Lohse and Smetana, 1985: 286.
Tarphiota debilicollis Casey, 1910: 75. synonymy by Fenyes 1920.
Tarphiota pallidipes Casey, 1893: 333; Fenyes, 1920: 254. NEW SYNONYM.

Description. Length 2.9-3.1 mm. Body color black, legs brown. Head ≈1.2 times as wide as long, integument granulose, microsculpture more ore less hexagonal. Labrum transverse. Epipharynx

(Fig. 3) with ≈8 lateral pores on each side. Labium (Fig. 6) with ≈12-13 medial pseudopores and ≈11-12 lateral pseudopores. Pronotum ≈1.3 times as wide as long, integument granulose; sides round. Mesosternal process narrow, acute. Elytra ≈1.3 times as long as pronotum, integument granulose. Abdominal tergites with microsetae more or less uniformly distributed, several macrosetae present.

Aedeagus. Median lobe as in Fig. 7. Paramere as in Fig. 8.

Spermatheca. Tube narrow (Fig. 9).

Type series. *Tachyusa fucicola* Mäklin, Lectotype designated by Lohse and Smetana in 1985.

Tarphiota debilicollis Casey: Lectotype, here designated, in the collection of the NMNH, with label as follows: "Casey bequest 1925; Lectotype, *Tarphiota debilicollis* Casey, Desig. K. J. Ahn, 1994".

Tarphiota pallidipes Casey: Lectotype, here designated, in the collection of the NMNH, with label as follows: "Casey bequest 1925; Lectotype, *Tarphiota pallidipes* Casey, Desig. K. J. Ahn, 1994". Paralectotypes, 8, same data as lectotype.

Material Examined. CANADA: British Columbia, Queen Charlotte Isl., LepasBay, Graham Island, 15 July 1988, J. S. Ashe, ex under rotting seaweed on beach (13, KSEM); Sidney (5, CAS); Victoria, Vanc., Hubbard & Schwarz (1, NMNH), Wickham (1, CAS). UNITED STATES: Alaska: Glacier Bay, Unalaska, Van Dyke, 5 July 1907 (8, CAS); Nazan Bay, Atka Aleutian Is., 31 July 1907, V. Dyke (6, CAS), 1 Aug. 1907 (8, CAS). California: Marin Co.: Point Reyes, North Beach, 15 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed (1, KSEM); Stinson Beach, 14 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed on beach (17, KSEM); San Francisco Co.: San Francisco, 1 May 1910, F. E. Blaisdell (1, CAS), 27 May 1908 (1, CAS), 24 Nov. 1907 (1, CAS), 24 Nov. 1918, E. P. Van Duzee (1, CAS); Long Beach, 28 Oct. 1916, J. O. Martin (4, CAS); San Mateo Co.: Pacific Beach, 16 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed on sand beach (4, KSEM); Montara Beach, 16 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed on sand beach (32, KSEM); Pomponio St. Beach, 5 June 1991, K. J. Ahn, ex under seaweed (6, KSEM); Halfmoon Bay St. Beach, 16 May, K. J. Ahn & J. S. Ashe, ex under seaweed on sand beach (6, KSEM); Moss Beach, 12 May 1910, F. E. Blaisdell (2, CAS), May 1910 (1, CAS); Santa Cruz Co.: Aptos, 19 Nov. 1932, F. E. Blaisdell (2, CAS); Humboldt Co.: Prairie Creek Redwoods St. Park, Gold Bluff Beach, 24 July 1975, V. F. Lee (1, CAS); Monterey Co.: Zmudowski St. Beach, 20 May 1991, K. J. Ahn, ex under seaweed (3, KSEM); Salinas River St. Beach, 20 May 1991, K. J. Ahn, ex under seaweed (43, KSEM); Carmel, 8 Sept. 1920, F. E. Blaisdell (4, CAS), 24 March 1919, E. P. Van Duzee (4, CAS); San Luis Obispo Co.: Cayucos St. Beach, 22 May 1991, K. J. Ahn, ex under seaweed (1, KSEM); Santa Barbara Co.: Santa Barbara, Hubbard & Schwarz (1, NMNH); Pt. Sal St. Beach, 3 June 1991, K. J. Ahn, ex under seaweed (2, KSEM); San Miguel Isl., 20 June 1910, V. W. Owen (2, CAS); Los Angeles Co.: Los Angeles, April, Chittenden (1, NMNH), Aug. (2, NMNH), July (1, NMNH), 17 June 1937 (2, NMNH), 11 March 1934 (1, NMNH); Santa Monica, March, A. Fenyes (2, CAS); Redondo, March, A. Fenyes (4, CAS), 4 June 1904, A. Fenyes (1, CAS); San Diego Co.: San Diego, 20 Aug. 1917, J. O. Martin (1, CAS); Port Watsonville, Cal, 26 Nov. 1932, F. E. Blaisdell (3, CAS); Cal, Hubbard & Schwarz (1, NMNH); Cal (4, NMNH); Del Monte, 7 June 1904, A. Fenyes (2, CAS).

Distribution. From Alaska to California.

Synonymy. I have examined Casey's syntypes of *Tarphiota pallidipes*. I could not find sufficient characters to separate *Tarphiota pallidipes* from *T.*

fucicola. Leg coloration, which was previously used to distinguish *T. pallidipes* from *T. fucicola* by Casey (1893), is not a reliable distinguishing characteristic.

Tarphiota geniculata (Mäklin)

Homalota geniculata Mäklin, 1852: 308; Bland, 1865: 404.
Tarphiota geniculata (Mäklin), 1893: 334; Bernhauer and Scheerpeltz, 1926: 596; Hatch, 1957: 145; Moore and Legner, 1975: 489; Lohse and Smetana, 1985: 291.
Tarphiota hirsutula Casey, 1910: 75. synonymy by Fenyes 1920.
Tarphiota iota Casey, 1910: 76. synonymy by Fenyes 1920.
Tarphiota insolita Casey, 1910: 76. synonymy by Fenyes 1920.
Tarphiota litorina Casey, 1910: 75. synonymy by Fenyes 1920.
Tarphiota seditiosa Casey, 1910: 76. synonymy by Fenyes 1920.

Description: Length 2.0-2.6 mm. Body color entirely black. Head ≈1.2 times as wide as long, integument granulose, microsculpture more or less hexagonal. Labrum very transverse. Epipharynx with ≈6 lateral pores on each side. Labium with ≈5 medial pseudopores and ≈3 lateral pseudopores. Pronotum ≈1.2 times as wide as long, integument granulose; apical line straight, basal line very slightly sinuate, sides round. Mesosternal process acute. Elytra ≈1.2 times as long as pronotum, integument granulose. Abdominal tergites with microsetae more or less uniformly distributed, macrosetae not distinct.

Aedeagus. Median lobe as in Fig. 10. Paramere as in Fig. 11.

Spermatheca. Tube broad (Fig. 12).

Type series. *Homalota geniculata* Mäklin, Lectotype designated by Lohse and Smetana in 1985.

Tarphiota hirsutula Casey: Lectotype, here designated, in the collection of the NMNH, with label as follows: "Cal, Casey bequest 1925; Lectotype, *Tarphiota hirsutula* Casey, Desig. K. J. Ahn, 1995".

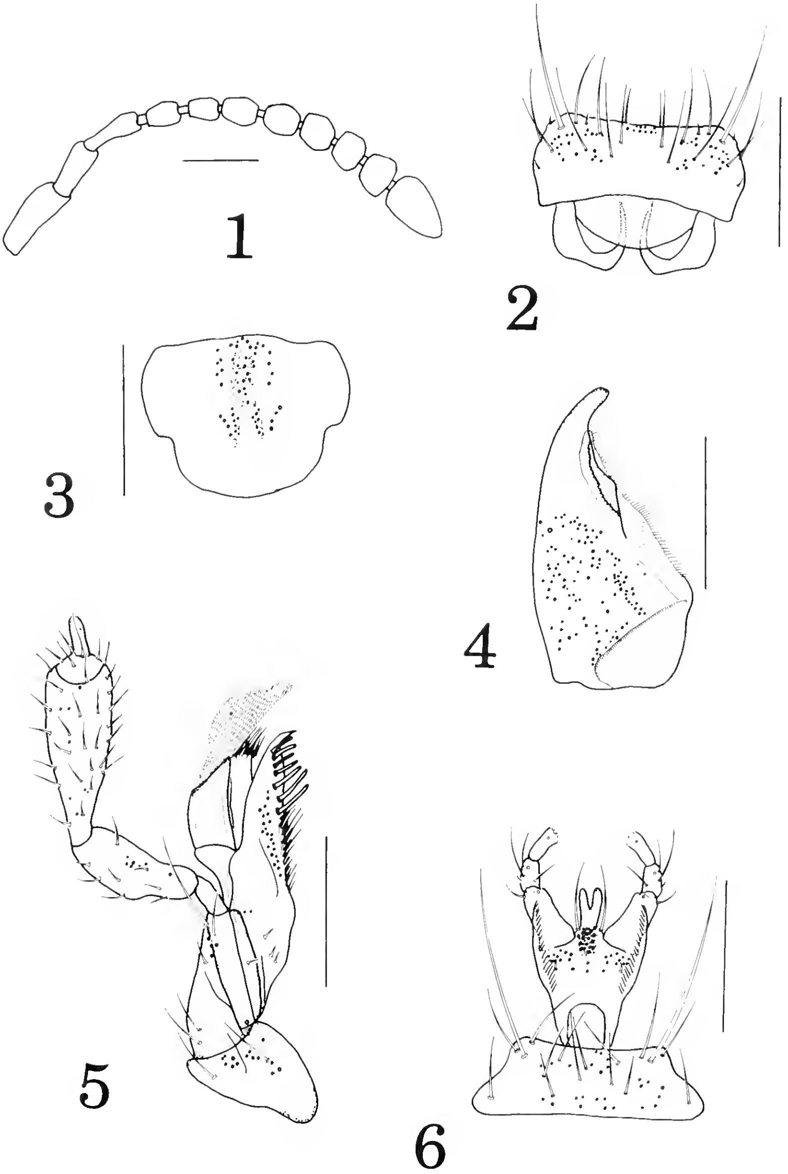
Tarphiota iota Casey: Lectotype, here designated, in the collection of the NMNH, with label as follows: "Cal, Casey bequest 1925; Lectotype, *Tarphiota iota* Casey, Desig. K. J. Ahn, 1995". Paralectotype, 1, same data as lectotype.

Tarphiota insolita Casey: Lectotype, here designated, in the collection of the NMNH, with label as follows: "Casey bequest 1925; Lectotype, *Tarphiota insolita* Casey, Desig. K. J. Ahn, 1995".

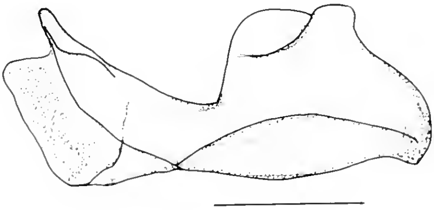
Tarphiota litorina Casey: Lectotype, here designated, in the collection of the NMNH, with label as follows: "Cal, Casey bequest 1925; Lectotype, *Tarphiota litorina* Casey, Desig. K. J. Ahn, 1995". Paralectotypes, 2, same data as lectotype.

Tarphiota seditiosa Casey: Lectotype, here designated, in the collection of the NMNH, with label as follows: "Casey bequest 1925; Lectotype, *Tarphiota seditiosa* Casey, Desig. K J. Ahn, 1995". Paralectotype, 1, same data as lectotype.

Material Examined. CANADA: British Columbia, Queen Charlotte Isl., Lepas Bay, Graham Island, 15 July 1988, J. S. Ashe, ex under rotting seaweed on beach (35, KSEM); Massett, no date, Rev. Keen (2, CAS); Sidney, no date, A. Fenyes (1, CAS). UNITED STATES: Alaska: Nazan Bay,



Figs. 1-6. *T. fucicola* (Mäklin). 1, Antenna, dorsal aspect; 2, labrum, dorsal aspect; 3, epipharynx, dorsal aspect; 4, right mandible, ventral aspect; 5, maxilla, dorsal aspect. 6, labium, dorsal aspect. Scale, 0.1 mm.



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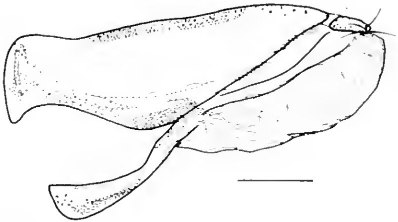

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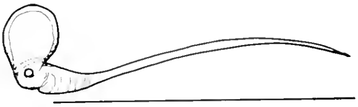

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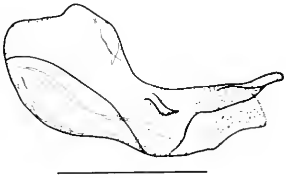

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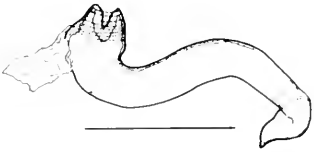

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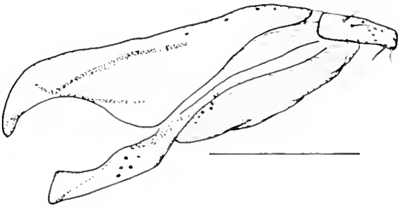

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Figs. 7-12. *T. fucicola* (Mäklin), 7-9 and *T. geniculata* (Mäklin), 10-12. 7, Median lobe, lateral aspect; 8, paramere, lateral aspect; 9, spermatheca, dorsal aspect; 10, median lobe, lateral aspect; 11, paramere, lateral aspect; 12, spermatheca, dorsal aspect. Scale, 0.1 mm.

Atka Aleutian Isl., 1 Aug. 1907, Van Dyke (3, CAS). Oregon: Lincoln Co.: 5.0mi. S. Waldport, 26 Aug. 1986, J. S. Ashe, ex running on wave swept shore (5, KSEM); 4.0mi. N. Yachts hwy 101, 27 Aug. 1986, J. S. Ashe, ex on sand beach (39, KSEM). California: Humboldt Co.: Prairie Creek Redwood St. Park, Gold Bluff Beach, 24 July 1975, V. F. Lee (6, CAS); Marin Co.: Bolinas Point, 1.6mi. due west of Bolinas, 16 June 1974, V. F. Lee (8, CAS), 20 April 1975 (7, CAS), 9 June 1974 (2, CAS); Bolinas Point, 2 June 1974, V. F. Lee (4, CAS); Stinson Beach, 14 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed on sand beach (2, KSEM); Point Reyes, North Beach, 14 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed (1, KSEM); Point Reyes, Nat. Seashore Wildcat Beach, 1 June 1975, V. F. Lee (2, CAS); San Francisco Co.: San Francisco, no date, F. E. Blaisdell (4, NMNH), Aug. (16, CAS), July (2, CAS), 9 Sept. 1909 (1, CAS), 27 May 1908 (1, CAS), 24 Nov. 1907 (4, CAS), May (1, CAS), 6 Aug., Wickham (4, CAS), 1 Aug. (2, CAS); San Mateo Co.: Halfmoon Bay St. Beach, 16 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed (10, KSEM); Montara Beach, 16 May 1991, K. J. Ahn & J. S. Ashe, ex under seaweed on sand beach (1, KSEM); Pomponio St. Beach, 5 June 1991, K. J. Ahn, ex under seaweed (12, KSEM); Monterey Co.: Asilomar St. Beach, 20 May 1991, K. J. Ahn, ex under seaweed (10, KSEM); Asilomar Beach, 31 March 1968, J. B. Evans, ex under wet seaweed (1, KSEM); Salinas River St. Beach, 20 May 1991, K. J. Ahn, ex under seaweed; Zmudowski St. Beach, 20 May 1991, K. J. Ahn, ex under seaweed (41, KSEM); Carmel, 24 March 1919, E. P. Van Duzee (1, CAS), 8 Sept. 1920, F. E. Blaisdell (8, CAS); San Luis Obispo Co.: Pismo St. Beach, 2 June 1991, K. J. Ahn, ex under seaweed on sand beach (4, KSEM); Cayucos St. Beach, 22 May 1991, K. J. Ahn, ex under seaweed (23, KSEM); Morro Strand St. Beach, 22 May 1991, K. J. Ahn, ex under seaweed (8, KSEM); Santa Barbara Co.: Santa Barbara, 16 June 1931, F. E. Blaisdell (1, CAS); Pt. Sal St. Beach, 3 June 1991, K. J. Ahn, ex under seaweed (42, KSEM); Carpinteria St. Beach, 23 May 1991, K. J. Ahn, ex under seaweed (4, KSEM);


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Figs. 13-14. 13, *Tarphiota fucicola* (Mäklin), habitus. Length: 3.0 mm; 14, *Tarphiota geniculata* (Mäklin), habitus. Length: 2.4 mm.

San Miguel Isl., 20 June 1910, V. W. Owen (2, CAS); Ventura Co.: San Buenaventura St. Beach, 23 May 1991, K. J. Ahn, ex under seaweed (5, KSEM); Los Angeles Co.: Long Beach, 28 Oct. 1916, J. O. Martin (3, CAS); Redondo, March, A. Fenyes (3, CAS), April (1, CAS), July (1, CAS); S. Pedro, Aug. (2, KSEM): Cal (3, NMNH); San Diego Co.: San Diego, Hubbard & Schwarz (1, NMNH), 20 Aug. 1917, J. O. Martin (8, CAS), 22 Nov. 1890, F. E. Blaisdell (5, CAS), 19 Jan. 1928 (4, CAS), no date (2, CAS), no date, Wickham (1, CAS); Silver Strand St. Beach, 28 May 1991, K. J. Ahn, ex under seaweed (8, KSEM); Del Monte, June, A. Fenyes (2, CAS); Casey bequest 1925 (6, NMNH).

Distribution. From Alaska to California.

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DESCRIPTION OF MATURE LARVA OF *OSMIA (ACANTHOSMIOIDES) NIGROBARBATA* (HYMENOPTERA: MEGACHILIDAE)[1]

F. Torres[2], S.F. Gayubo[2]

ABSTRACT: The mature larva of *Osmia* (*Acanthosmioides*) *nigrobarbata* is described and compared with the other described larvae in the genus. The antennal papillae and the maxillary and labial palpi are the fundamental morphological features which permit the characterisation of the species studied.

The holarctic genus *Osmia* Panzer comprises about 135 species in the Nearctic region, distributed from the Boreal zone to Costa Rica (Michener *et al.,* 1994). Nests are in preformed cavities or burrows in stems, wood or soil.

To date, the mature larvae of only four species have been described (McGinley, 1989) of which three are Palearctic and one Nearctic with two subspecies.

The larva here described is, therefore, the second known for a Nearctic species, and the first for its subgenus.

MATERIALS AND METHODS

A postdefecating larva preserved in alcohol, collected in 1966 by Rozen and Favreau in Arizona (3 miles north of Apache, Cochise County) U.S.A., has been studied.

The techniques employed for its treatment were those described by Michener (1953) and McGinley (1981), consisting of drawing the intact specimen with the aid of a camera lucida. The head capsule and the tegument were then cleared with a solution of hot potassium hydroxide (KOH), neutralising the caustic base in water and placing it in a well slide filled with glycerine.

The terminology used is that of Michener (1953) and Rozen (1994), and the following abbreviations are used in the description: d = diameter; h = height; l = length; w = width; m = mean.

Osmia (Acanthosmioides) nigrobarbata, Cockerell

Mature larva

Figures 1-10

BODY: Robust fusiform (l = 10mm; w at widest = 3.75mm), with greatest width at IV

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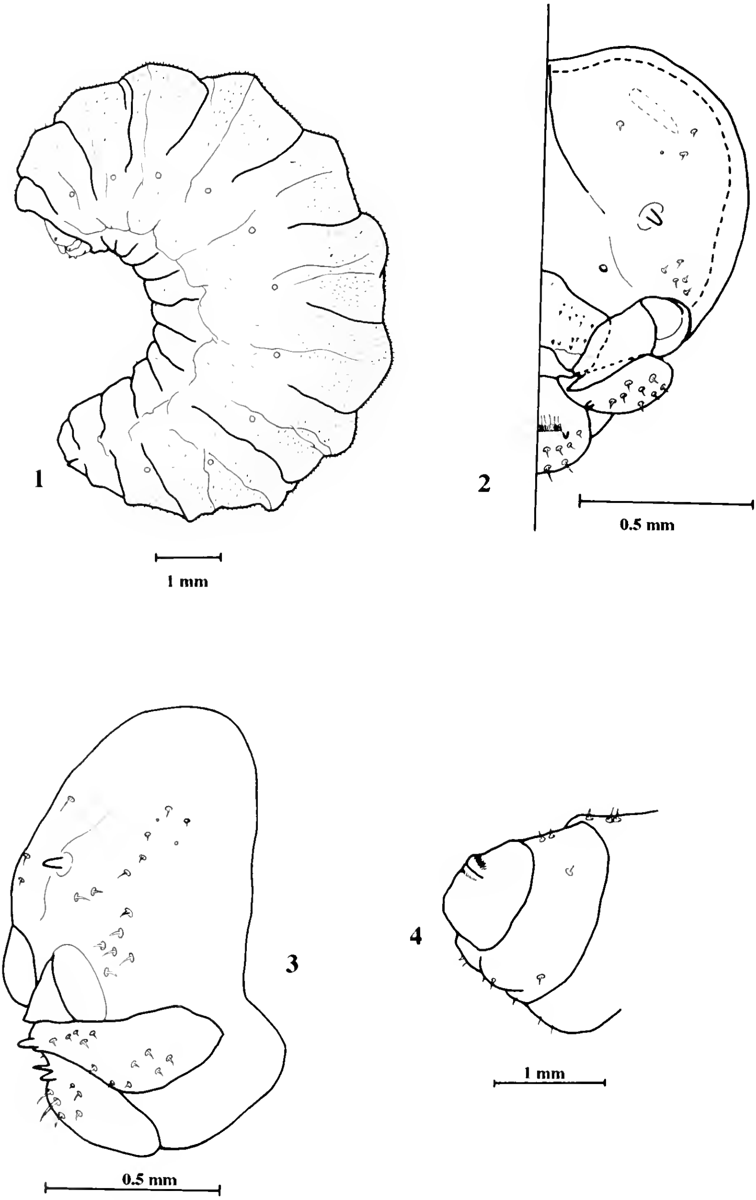
abdominal segment (Fig. 1). Color yellowish-white. Thoracic segments with large dorsal folds which cover head. Intersegmental lines well marked on dorsal and ventral zones, disappearing in pleural areas. Conspicuous dorsal intrasegmental lines, dividing segments into cephalic and caudal annulets. Dorsal tubercles present, expanded and relatively little elevated (Fig. 1); ventrolateral bulging present. Integument slightly sclerotized, with long setae distributed principally on dorsal region of intermediate segments; setae more scarce on thoracic segments and abdominal segments IX and X as on ventral region. Abdominal segment X centered on IX. Anus transverse and dorsoapical, with two labia bordering it (Fig.4). Perianal area setae on ventral zone of anus, very small, in immediate vicinity of anus and increasing with distance from it. Integument below anus with parallel striae, above anus smooth. Spiracles globular (h = 0.058-0.062mm, m = 0.060mm; w = 0.079-0.082mm, m = 0.080mm), slightly raised above surface, atrial walls ringed externally and internally (Fig. 7). Internal walls with large number of short thick spines. Neither tubercles nor sclerites observed. Peritreme wide (w = 0.015-0.017mm, m = 0.016mm), occupying 2/5 of total width of stigmatic orifice. Subatrium with 9 rings of smooth walls.

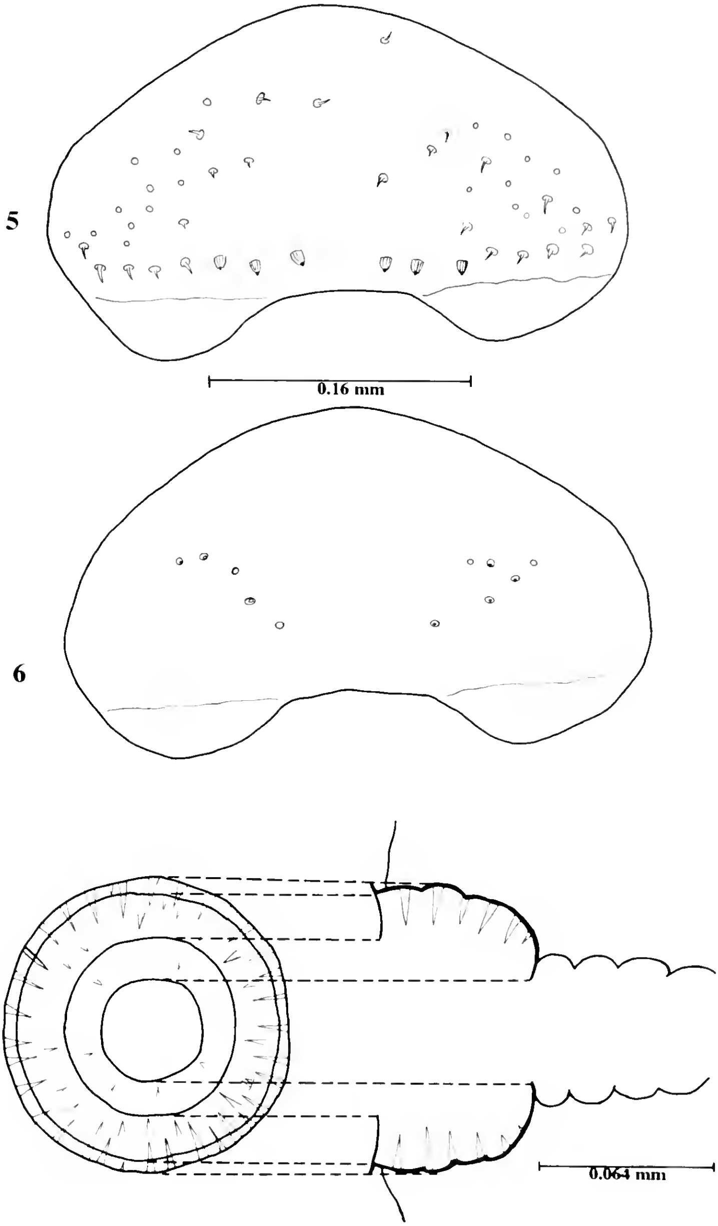
HEAD: Head capsule small in relation to body (1 = 0.70mm; w = 1.19mm), sclerotized; mandibular apices, tentorium, lateral zones of labrum and antennal palpi remarkable for their dark pigmentation. Scarce and dispersed setae located in greater numbers and of greater size on pleurostomal zones (Fig.4); setae relatively abundant but smaller on frontoclypeal region. Placoid sensilla in lesser numbers than setae and dispersed over whole surface of head capsule. Tentorium well developed, anterior and posterior tentorial arms clearly distinguishable. Anterior tentorial pits situated in a position similar to other species in family, posterior tentorial pits located behind mandibular bases. Parietal bands short and little marked. Antennal disk moderate in size (d = 0.060mm), on small prominence. Antennal papilla little less than twice as long as wide (1 = 0.048mm; w = 0.029mm), narrowing toward apex, on which three small sensilla can be distinguished.

Vertex uniformly rounded (Fig. 3), without tubercles or projections. Postoccipital ridge well marked and visible. Frontoclypeal area smooth and without special features, except for small setae and sensilla previously mentioned. Frontoclypeal suture not evident and clypeus only marked by an arc formed by six setae on its apical third. In lateral view, labrum weakly projected toward the exterior; presenting a series of setiform and placoid sensilla, irregularly dispersed over whole surface. Six dome-shaped sensilla distinguishable (3+3) on apical margin (Fig. 5). Labral tubercles absent. Margin of labrum straight with large rounded prominences on both sides (Fig. 5). Epipharynx with two groups of sensilla (6+5) on mediolateral zones (Fig.6); rest of surface smooth.

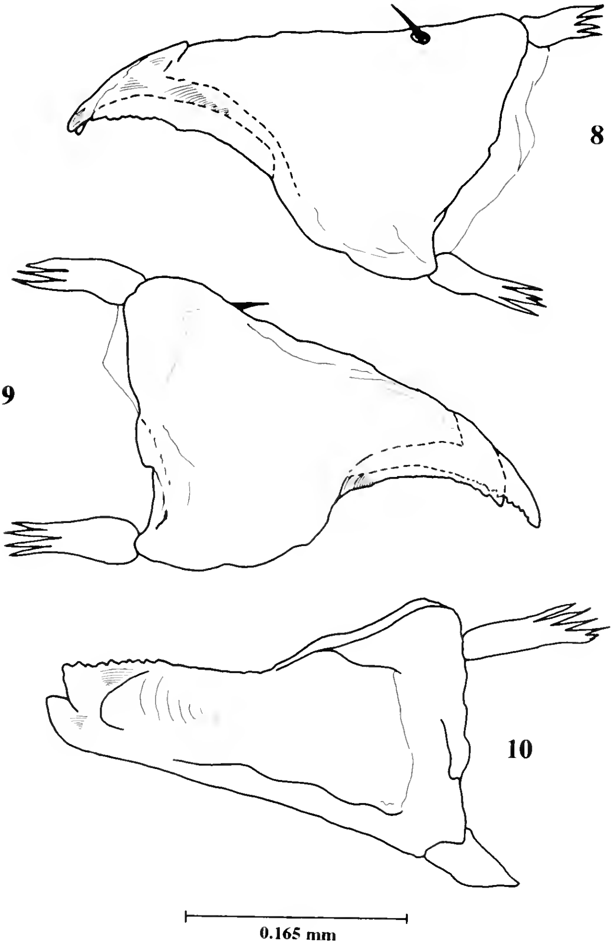
Mandibles (do not meet at the midline) bidentate (Figs. 9, 10) with teeth unequal (ventral slightly larger); inner concavity well defined (Fig. 10); cusp inconspicuous; edges smooth except for upper border of dorsal tooth, serrated at apical end with small denticles (Figs. 8, 10). Strong seta on external surface near mandibular base. Labiomaxillary region slightly projected forward in lateral view (Fig. 3). No evident fusion between maxillae and labium. Maxilla weakly sclerotized; strong setae on its external surface, fundamentally behind maxillary palpi. Small group of setae of lesser size in front of maxillary palpi (Fig. 2). Galeae absent. Maxillary palpus situated on apical third of external surface; subapical in lateral view; a little less than twice as long as wide (1 = 0.032mm; w = 0.019mm), narrowing toward apex. Two small sensilla at apex. Labium with evident prementum and postmentum; slightly sclerotized except for salivary lips; in dorsal view, triangular in form with vertices rounded. Labial palpi situated below salivary lips and a little separated from their ends; smaller than antennae and similar to maxillary palpi (1 = 0.029mm; w = 0.019mm), with two small sensilla in their apices. Two groups of setae in zones adjacent to labial palpi directed toward lower zone and increasing size farther from palpi. Salivary lips project strongly in lateral view, occupying a width of approximately half that of prementum. Hypopharynx smooth and without differentiations.



Figs. 1-4.- *Osmia nigrobarbata,* mature larva; 1, lateral view; 2, frontal view of head; 3, lateral view of head; 4, anal opening and IX-X abdominal segments.



Figs. 5-7.- *Osmia nigrobarbata*, mature larva; 5, frontal view of labrum; 6, frontal view of epipharynx; 7, spiracle.



Figs. 8-10.- *Osmia nigrobarbata*, mature larva; 8, dorsal view of right mandible; 9, ventral view of right mandible; 10, inner view of right mandible.

DISCUSSION

The family Megachilidae is very homogeneous in its larval characters (Michener, 1953; Rozen, 1973), an aspect which seems to be confirmed within the genus *Osmia,* including the larva described here. Nevertheless, certain characteristics of the larva studied allow us to separate it from those of *Osmia* previously described, despite the limitations imposed by the study of a single specimen.

Dorsally developed thoracic segments, similar to those of the larva studied, are only found in *Osmia aurulenta,* where they also hide the head capsule (Marechal, 1926). In the same way, the presence of ventrolateral bulges, which can be considered as tubercles, only exist in *O. nigrobarbata* and *O. aurulenta* (Marechal, 1926; Michener, 1953), although the latter is differentiated by the presence of dorsally elevated caudal annulets (Michener, 1953), and also by the different distribution of the setae on the tegument (Marechal, 1926). *O. nigrobarbata* and *O. lignaria,* in contrast to the rest of the known species, have the antennal disk on a small elevation (Michener, 1953) and in *O. lignaria lignaria* a serration in the mandibular teeth can be observed (Baker *et al.,* 1985). However, the proportion of width/length of the antennal papilla – greater in *O. lignaria* – and of the maxillary palpus – lesser in *O. lignaria* – similar to the slightly evident inner concavity in *O. lignaria* (Michener, 1953) allows the differentiation between both species.

Of all the previously described species, only in *O. submicans* is the presence of an apical row of papilla (Michener, 1953) or eight sensorial lamina on a strongly pointed labrum (Maneval, 1939) mentioned. That could be interpreted as similar to the dome-shaped sensilla described for *O. nigrobarbata,* although in no case are placoid or setiform sensilla mentioned, and these are noted for other genera of the family (Grandi), 1935). Further, no reference has been made, up to now, to the existence of sensilla on the epipharynx and on the head capsule (placoid sensilla). The fundamental differences between the larvae of *O. nigrobarbata* and *O. submicans* are in the distinct width/length proportion of the antennal papilla, and of the maxillary palpus, greater in both cases in *O. submicans* (Michener, 1953). Five sensilla at end of the maxillary palpus of *O. submicans* (Maneval, 1939) contrast to the three present in the species studied here. They are also differentiated by the morphology of the salivary lips, unusually long in *O. submicans* (Michener, 1953).

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THE GENUS *LEPTOGASTER* (DIPTERA:ASILIDAE) FROM THE WEST INDIES[1]

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ABSTRACT: Three new West Indian species of *Leptogaster: hyacinthina, lineatus* and *bahamienses* of the *obscuripes* species group are reported and a key to all known species is presented. The identification of *L. obscuripes* and *L. obscuripennis* is discussed and *L. roederi* is redescribed. Lectotypes are designated for *L. obscuripennis* and *L. roederi.*

The genus *Leptogaster* Meigen is nearly world wide in distribution and contains at least 120 valid species (Hull 1962). These long, slender, flies are particularly abundant in tropical regions, especially Asia and southward in the South Pacific. Adults inhabit grasslands and undergrowth of forests (Melin 1923, Martin 1957a, Hull 1962, Farr 1963, Scarbrough & Sipes 1973). They are readily recognized by a one-segmented, apically clavate palpus, face strongly divergent, absence of alula and pulvilli, long, thin hind legs, and only open cells along the wing margin (Martin 1957a, Hull 1962). Unfortunately, little taxonomic or life history studies have been done on species of *Leptogaster*. Consequently, many species remain undiscovered and those in collections remain undescribed.

While attempting to identify specimens sent to me by entomologists who are involved in other studies in the West Indies, I found three undescribed species of *Leptogaster* Meigen. Presently, *L. obscuripes* Loew (Loew 1862) from Cuba, *L. lerneri* Curran (Curran 1953) from Bimini Island in the Bahamas, and *L. jamaciensis* Farr, *L. bengryi* Farr and *L. martini* Farr (1963) from Jamaica, and *L. roederi* Williston (Williston 1896) from St. Vincent Island are known. This paper describes three new species, increasing the number of species to nine from that region, *L. roederi* is redescribed, the identification of *L. obscuripes* and *L. obscuripennis* Johnson is discussed, and a key to the known West Indian species of *Leptogaster* is presented. *Leptogaster obscuripennis* is included in the key because of its possible occurrence in the West Indies.

Key to the species of *Leptogaster* Meigen

Adults

1. Dorsum of mesonotum polished, tomentum limited to narrow lateral margin and posterior fourth or less 2
– Dorsum of mesonotum partially or wholly covered with tomentum, at least narrow lines of tomentum present dorsally 5

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2. Wing brown, surface entirely with abundant microtrichia; anterior four femora yellow; southeastern United States .... *obscuripennis* Johnson
– Wing hyaline, surface with largely sparse microtrichia, most abundant at narrow apex of wing; anterior four femora largely brownish to brown; West Indies 3
3. Thorax largely or entirely black 4
– Thorax largely brownish yellow with yellow apical corners; CuA_1+M_3 vein unusually long, 4.7 times as long as r-m crossvein; sternite 8 as in Fig. 23; St. Vincent Island .... *roederi* Williston
4. Mesonotum entirely black with purplish reflections; genitalia as in Figs. 9-16; Dominican Republic.. .... *hyacinthina*, new species
– Mesonotum mostly black, wide apical corners reddish, purplish reflections absent; Cuba, Texas .... *obscuripes* Loew
5. Mesonotum dorsally entirely tomentose; epandrium strongly recurved apically, U-shape, with apex directed anteriorly; Bimini Islands, Bahamas .... *lerneri* Curran
– Mesonotum dorsally at least partially subshiny; epandrium apically not recurved, apex directed posteriorly 6
6. Thorax blackish, mesonotum dorsally with one or more wide subshiny stripes outlined by thin, brown tomentum 7
– Thorax largely reddish, mesonotum dorsally largely shiny with only two thin lines of brown-yellow tomentum 8
7. Postpronotum and postalar callus brownish; Jamaica .... *martini* Farr
– Postpronotum and postalar callus yellow; genitalia as in Figs. 17-22; Dominican Republic .. .. *lineatus*, new species
8. Discal cell short with r-m crossvein beyond middle; vein M_{1+2} above discal cell much shorter beyond r-m crossvein than before; genitalia as in Figs. 1-8; Bahamas, Cuba .... *bahamiensis*, new species
– Discal cell long with r-m crossvein usually before middle; vein M_{1+2} above discal cell beyond r-m crossvein longer, slightly shorter than or slightly longer than before 9
9. Vein M_{1+2} distinctly longer beyond r-m crossvein than before; epandrium apically wider than subapex, corners divergent, distinctly angular; Jamaica .... *bengryi* Farr
– Vein M_{1+2} only slightly shorter beyond r-m crossvein than before; epandrium apically as wide as subapex, ventroapical corner obtusely angular to broadly rounded; Jamaica .... *jamaciensis* Farr

Taxa

Leptogaster bahamiensis, NEW SPECIES

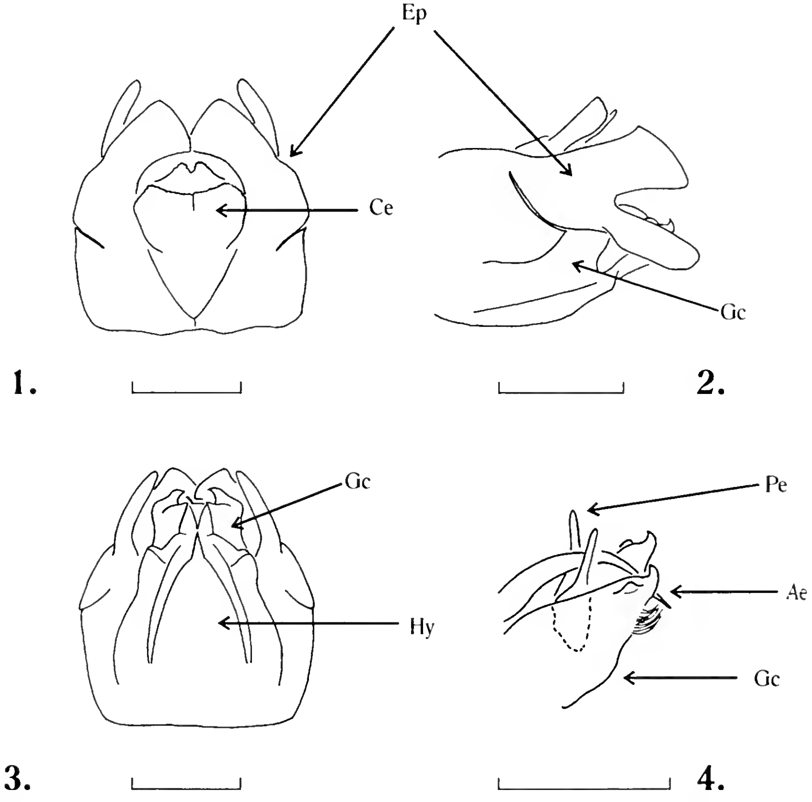
Figs. 1-8

Male. Reddish brown to dark brown. Length, body 10.7-13.3 mm; wing 5.7-7.7 mm. Face white to pale yellow tomentose, mystax with eight pale yellow setae. Proboscis dark brown to blackish with base ventrally yellowish, palpus brownish to yellowish brown, each with sparse yellow vestiture. Front yellowish tomentose with sparse, fine vestiture. Scape and pedicel bright yellow with yellow setae; flagellum and stylus dark brown, flagellum more than twice as long as wide, and as long as combined length of scape and pedicel; stylus 2.0-2.3 times as long as flagellum, subapex flattened and flared, about twice as wide as base of stylus. Occiput yellowish white or gray tomentose with mostly whitish vestiture; two-three short, yellow, postocular present.

Mesonotum mostly reddish, a median stripe and most of posterior third black, postalar callus yellow; dorsum polished except as follows: narrow lateral and posterior with whitish to pale yellow tomentum, posterior fourth medially and narrow streak bordering median black stripe with brown-yellow to golden yellow tomentum. Mesonotum with abundant short, mostly brown setae, especially medially and anteriorly, that of lateral margins of mesonotum pale yellow; a short yellow and a much longer brown bristle present. Scutellum yellow to reddish with pale yellow tomentum and short, thin, brown to yellow marginal setae, setae much shorter than r-m crossvein. Mesopleuron largely yellow to yellowish red, katepisternum and meron largely dark brown to blackish; tomentum pale yellowish white with pale yellow vestiture. Halter pale yellow with a sooty brown tint apically.

Wing hyaline, violaceous, with sparse microtrichia, most abundant microtrichia limited to narrow apex. Vein M_2 long, 2.5 times as long as crossvein m-m; CuA_1+M_3 three times as long as crossvein r-m. Fork of vein M_{1+2} at middle of distance between crossveins r-m and mm.

Coxa yellow with pale yellow vestiture. Trochanter largely yellow, with narrow brown streak posteriorly. Femora mostly dark yellow-brown to brown with apices darkest, bases narrowly yellow; fore and mid femora posteriorly slightly lighter in color. Mid and hind femora with a preapical, yellowish brown to yellowish band; hind femur largely swollen on apical one-third. Fore and mid tibiae anteriorly yellowish brown, much darker in lateral view, remaining surfaces much lighter in color, yellowish; all bristles yellow. Hind tibia slender, gradually expanding apically with apex about twice as wide as base; brown with basal one-fifth yellow

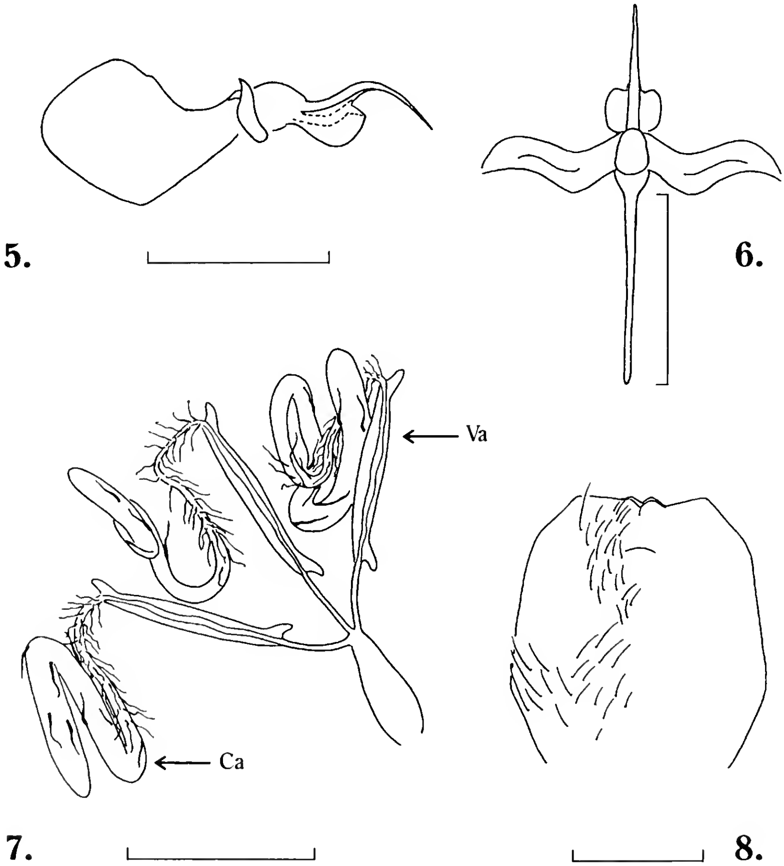


1-4. *Leptogaster bahamiensis,* New Species. 1-3. Male terminalia, dorsal, lateral, and ventral views; Ep = epandrium, Ce = cercus, Hy = hypandrium, Gc = gonocoxite. 4. Penal valves; Pe = penal valve, Ae = aedeagus. Scale, 0.4 mm for Figs. 1-3, 0.3 mm for Fig. 4.

anteriorly and posteriorly, bristles yellow and brown. Tarsi with basal three tarsomeres entirely yellow, the apical two tarsomeres slightly brownish to brownish yellow; narrow apices of the latter contrastingly brown; apex of apical tarsomere dark brown; all bristles brown except for one yellow bristle on basal segment.

Abdomen largely reddish brown to black in ground color, most segments with the apices, bases and lateral margins narrowly yellowish; tergites 2-4 dorsally polished; segment 1 and basal third of 2 grayish tomentose, all sternites and lateral margins of tergites 2-8 with yellow-brown to yellowish tomentum, tergites dorsally with brown tomentum; tergites dorsally largely or entirely with brown setae, remaining setae pale yellow.

Genitalia (Figs. 1-6) largely yellowish, dorsal branch of epandrium brown with tint of yellow basally. Epandrium with wide dorsal branch, apex subtruncate with corners weakly project-



5-8. *Leptoqaster bahamiensis,* New Species. 5-6. Aedeagus, lateral and dorsal views. 7. Spermathecae; Ca = capsule, Va = valve. 8. Female, sternite 8. Scale, 0.5 mm for Figs. 5-6, 0.5 mm for Fig. 7, 0.4 mm for Fig. 8.

ing; ventral branch about as long as dorsal branch, yellow with apex rounded. Hypandrium triangular to subrectangular. Primary penal valves (in sense of Martin 1957a; = aedeagal guides of McAlpine 1981) urnshape with a long slender neck, secondary valves much wider, longer and divided into two branches. Aedeagus as in Figs. 5-6.

Female. Same as male except as follows: Body length 14.7 15.7 mm, wing 8.3-8.7 mm. Each side of tergite 8 with a large subshiny spot. Spermatheca and sternite 8 as in Figs. 7-8.

Holotype ♂ and allotype ♀, **BAHAMA ISLANDS:** Grande Bahama Island, Freeport, malaise trap in Caribbean pine and palmetto scrub, 20-27 June, 1987, W. E. Steiner, M. J. & J. Molineaux (USNM). Paratypes: 4 ♂♂ & 1 ♀, same data and location as holotype ; 1 ♂, San Salvador Island, Bahama Islands, rd. n. Bahama Field Sta., malaise trap in red mangrove, 26.VI.91, A. Scarbrough (USNM). **CUBA:** 1 ♂, vic Havana, T. Barber; 1 ♀, Trinidad Mts., Bueno Aries, 17-23.VI.1939, C.T. Pearson (MCZ).

Etymology. The name *bahamiensis*, taken in part from the type locality, Grande Bahama Island.

Remarks. *Leptogaster bahamiensis* belongs to the *obscuripes* species group (Martin 1957a), and the male can be recognized by the combined characters of the genitalia. It will run to *L. jamaciensis* in Farrs' key (1963) but can be separated by the distinctly pointed dorsoapical corners of the epandrium. Females of *L. bahamiensis* are essentially identical to *L. jamaciensis*. The valves of the spermatheca lack the darker sclerotization in *L. jamaciensis*. Additionally, the narrow apices of most abdominal segments and the basal corners of two-three tergites are yellow in *L. bahamiensis* whereas they are more uniform brownish red in *L. jamaciensis*.

Leptogaster hyacinthina, NEW SPECIES

Figs. 9-16

Male. Black. Length, body 15.1 mm, wing 9.3 mm. Face dull yellow tomentose; front yellowish gray tomentose, only slightly divergent, width at ocellus slightly less than twice as wide as face at narrowest point; mystax with a row of 9-10 yellow setae. Proboscis and palpus brown, vestiture sparse, yellow. Flagellum dark brown, at least four times as long as wide, and only slightly longer than combined length of scape and pedicel; stylus dark brown, at least 2.5 times as long as flagellum. Scape and pedicel largely brown to brownish with brown setae; pedicel with apex yellowish. Occiput with dull yellow tomentum and thin, yellow vestiture.

Thorax largely black, mesonotum dorsally polished black with sparse black to dark brown setae, postpronotum and postalar callus yellow, narrow lateral margin and posterior fourth of mesonotum with dense yellow tomentum; two stout, yellow bristles present laterally. Scutellum and mesopleuron with yellowish dense tomentum and sparse yellow vestiture; scutellum with five-six thin, marginal setae, about as long as crossvein r-m; metapleuron yellow. Halter yellow.

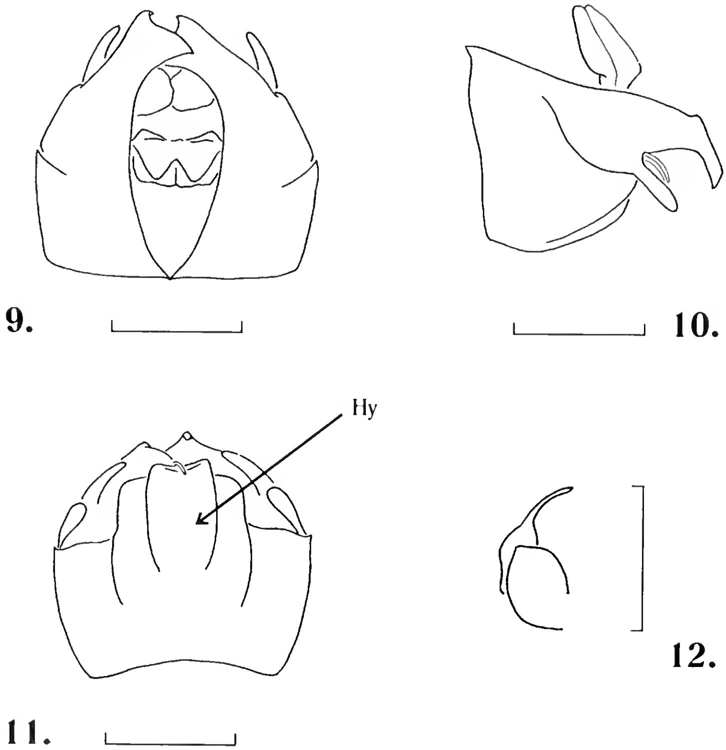
Wing hyaline, violaceous; microtrichia generally sparse, most dense at narrow apex of wing. Base of vein M_2 long, at least three times as long as m-m crossvein. Vein CuA_1+M_3 long, at least twice as long as crossvein r-m.

Legs slender; coxae yellow with pale tomentum and vestiture; fore femur largely yellow with narrow apex and a long ventral stripe brown, mid and hind femora brown anteriorly and ventrally with a preapical narrow yellow band; mid femur dorsally and posteriorly and dorsal one-half and ventrobasal third or more of hind femur, yellow. Fore and mid tibiae largely yellowish with a brown streak anteriorly, all setae entirely or largely yellow. Hind tibia brown, at least as a dark streak laterally, basal fourth to one-third dorsally and ventrally with a narrow yellow streak. Tarsi with only dark brown to black bristles, basal three tarsomeres of fore tarsi light yellow with narrow apices brown, apical two tarsomeres yellowish brown basally to brown apically; claws and empodium black, empodium about two-thirds as long as claws.

Abdomen dark brown to yellowish brown, tergites 2-7 with wide yellowish margins, sternites brownish; tomentum yellowish gray to yellowish brown; tergites 2-4 dorsally with a large polished spot. Tergite 1 laterally with a fan of six or more black setae and bristles.

Genitalia (Figs. 9-16) largely yellow with dorsal branch of epandrium brown. Epandrium divided to middle, dorsal branch much wider and slightly longer than ventral branch, apex wide, subtruncate with ventral corner slightly hooked posteriorly; ventral narrow, flat, with a rounded apex. The primary penal valves erect, urn-shaped with a long, slender neck; the secondary pair flat, leaf-like. Aedeagus (Figs. 13-14) with distiphallus long, curved downward apically and a flat, spatulate plate ventrally. Hypandrium with two parallel grooves, forming a subrectangular plate or area medially.

Female. As male except as follows. Length, body 15.0 mm; wing 9.5 mm. Style twice as long as flagellum; flagellum 1.3 times as long as scape and pedicel combined. Mesonotum laterally with one yellow and one blackish bristle. Legs darker brown than in male. Abdomen blackish, tergites laterally with only a very faint light color. Spermatheca (Fig. 15) with a narrow, elongate, intermediate gland which has a process on each end, one digitate and one mound-like, both slightly flattened; narrow ductus with abundant, weak, capitate tentacles and a wider,

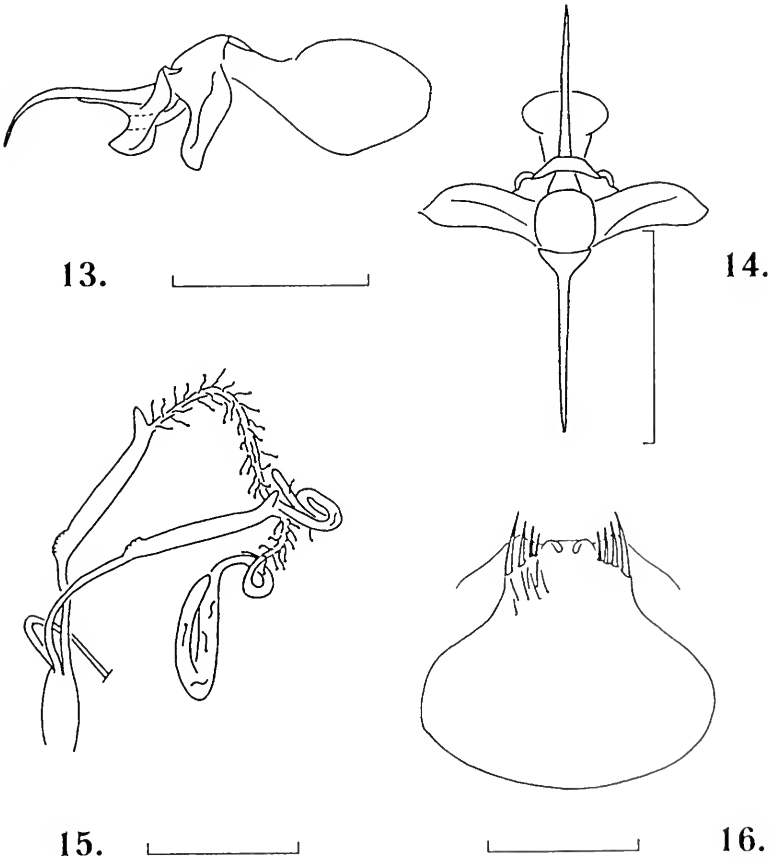


9-12. *Leptogaster hyacinthina*, New Species. 9-11. Male terminalia, dorsal, lateral, and ventral views; Hy = hypandrium. 12. Penal valves. Scale, 0.4 mm for Figs. 9-11, 0.1 mm for Fig. 12.

folded, tubular apical gland; median spermatheca slightly more slender and with a longer narrow ductus than the lateral spermatheca. Sternite 8 (Fig. 16) urn-shaped, broad oval base with a narrow, subtruncate apex, lateroapical margin with a row of four-five thick bristles of increasing thickness.

Holotype ♂. **DOMINICAN REPUBLIC:** Pedernales, 3.3 km, NE Los Arroyos, 18-15N, 71-45W, 1450 m, 16-18 July, 1990, sweep net samples in montane forest, Lubomir Masner (CMNH); allotype ♀, Independencia, 3 km ese El Aguacate, north slope of Serra de Baoruco, 1980m, 18-18N, 71-42W, pine woodland, 28-29 September 1991, J. Rawlins, R. Davidson, C. Young, S. Thompson (CMNH)

Etymology. Latin *hyacinthina*, refers to the purplish (color of the hyacinth) reflection of the shiny black dorsal surface of the mesonotum.



13-16. *Leptogaster hyacinthina*, New Species. 13-14. Aedeagus, lateral and dorsal views. 15. Spermathecae. 16. Female, sternite 8. Scale, 0.5 mm for Figs. 13-15, 0.4 mm for Fig. 16.

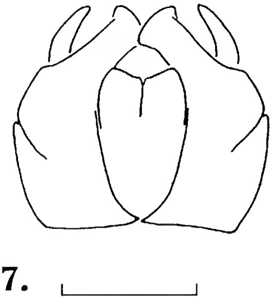
Remarks. *Leptogaster hyacinthina* is easily recognized by the purplish reflection of the shiny black mesonotum, the dark body and the shapes of the epandrium, aedeagus and penal valves.

Leptogaster lineatus, NEW SPECIES

Figs. 17-22

Male. Dark brown to black body. Length, body 10 mm; wing 5.8 mm. Face grayish tomentose with four pale yellow bristly setae. Front gray tomentose with a light brownish tint, slightly divergent above, at ocellus 1.3 times as wide as face at narrowest point; mystax with seven pale yellow setae. Proboscis and palpus dark brown, palpus with sparse grayish setae. Antenna with stylus and flagellum dark brown, basal two segments light brownish yellow, setae brownish; style 2.1 times as long as flagellum; flagellum 2.6 times as long as wide and as long as combined length of scape and pedicel. Occiput slightly brownish tomentose with mostly pale yellow vestiture, two-three stout, dark brown postocular setae present.

Thorax largely black, postpronotum and postalar callus yellow. Mesonotum largely with thin, brown tomentum, a wide median and a shorter stripe on each side, each black and subshiny, the median stripe divided longitudinally by a narrow streak of brown tomentum; mesonotum



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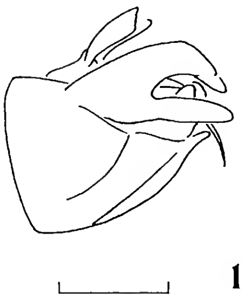

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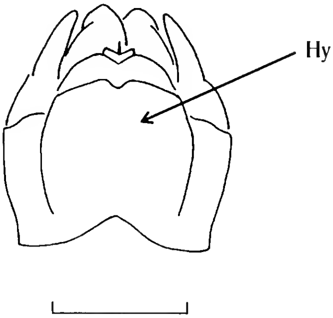

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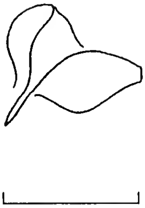


20.

17-20. *Leptogaster lineatus*, New Species. 17-19. Male terminalia, dorsal, lateral, and ventral views. 20. Penal valves. Scale, 0.4 mm for Figs. 17-19, 0.1 mm for Fig. 20.

with narrow lateral margins and posterior third, and entire scutellum and mesopleuron yellowish gray to white tomentose; sparse setae, including a short row of dorsocentral setae, and two lateral bristles, all brown. Margin of scutellum with six-seven thin, brown setae, about half as long as r-m crossvein. Mesopleuron largely reddish yellow, katepisternum blackish. Halter sooty brownish yellow.

Wing with violaceous reflections, vein M_2 three times as long as crossvein m-m, CuA_1+M_3 three times as long as crossvein r-m; microtrichia largely sparse, most abundant at extreme apex of wing.

Legs slender; coxae yellow with pale tomentum and vestiture. Fore and mid femora largely yellow, with brownish yellow anteriorly and dorsally. Hind femur gradually swollen on apical half, largely brownish with a yellowish preapical band, narrow apices brown. Fore and mid tibiae largely yellowish, brownish anteriorly, setae pale yellow; hind tibia largely brownish to brown, basal half posteriorly yellow. Tarsi with dark brown to black bristles, claws and empodia; basal four tarsomeres pale yellow to yellow with narrow apices brown; apical tarsomere largely brown with only narrow base yellow. Empodium two-thirds to three-fourths as long as claws.

Abdomen largely dark brown to blackish with narrow margins of tergites 2-6 yellowish; basal segments with mostly grayish to yellowish gray tomentum, and grading to brownish on the apical segments. Tergites 2-4 dorsally with subshiny bare spots; tergite 1 laterally with two-three stout, brown bristles.

Genitalia (Figs. 17-22) largely brown, lower branch of epandrium yellow. Epandrium divided to about half distance to base, dorsal branch wide with apical margin slightly rounded, oblique pointed subapically in lateral view; lower branch flat with rounded apex, about as long as dorsal branch. Primary penal valves small, leaf-like; secondary valves much large, flat, with ventral margins fused forming a groove in which the distiphallus rests. Aedeagus as in Figs. 21-22. Hypandrium subrectangular.

Female unknown.

Holotype ♂. **DOMINICAN REPUBLIC:** Prov. Pedernales, cat 35 km NNW Cabo Rojo 1430 m, El Aceitillar, 20 Aug. 1988, pine forest, M. Ivie, Phillips & Johnson (USNM).

Etymology. Latin, *lineatus*, adj. meaning striped, referring to the longitudinal, subshiny, black stripes on the mesonotum.

Remarks. *Leptogaster lineatus* differs from other West Indian species by the blackish body, and the combined characters of the mesonotum and genitalia, especially the fused leaflike penal valves. It differs from *L. hyacinthina*, also from the Dominican Republic, in the largely tomentose mesonotum.

21. 22.

21-22. *Leptogaster lineatus*, New Species. Aedeagus, lateral and dorsal views. Scales, 0.5 mm for Figs. 21-22.

Leptogaster lineatus is most similar to *L. martini*, and will run to that species in Farrs' key (1963). It differs primarily in that the median subshiny stripe is partially subdivided by a thin line of brown tomentum, the yellow postpronotum and postalar callus, and the combined characters of the terminalia.

Leptogaster obscuripennis Johnson

Leptogaster obscuripennis Johnson, 1895: 304,323. Cotypes, ♂ & ♀, type locality St. Augustine, Florida, MCZ; Back, 1909: 167-168 (description); Martin 1957a, 3: 367; Hull 1962: 299 (catalog).

Remarks. *Leptogaster obscuripennis* was described from two specimens (cotypes 7573). The male cotype lacks the right antenna, hind right leg, the left fore tarsi and fore tibia, the mid leg, the left wing is partially absent, and the genitalia is partially covered with debris. The female cotype lacks the fore tarsus and the apical four segments of the left hind tarsus. The male and female are designated Lectotype and paralectotype, respectively.

Leptogaster obscuripennis is only known from the southeastern United States but may also exist on some of the nearby islands (Martin 1957b, Farr 1963). It belongs to the *obscuripes* species group (Martin 1957a), and is readily distinguished from others in the group by its lighter color, predominately yellow to yellowish red, the reddish yellow mesonotum polished dorsally with tomentum limited to the narrow lateral margins and posterior, the brown wing entirely covered with dense microtrichia. In addition, the combined characters of the genitalia easily separate it from its nearest relative.

Specimens examined. Lectotype ♂, paralectotype ♀, 1 ♀, Naples, Florida (MCZ).

Leptogaster obscuripes Loew

Leptogaster obscuripes Loew, 1862, 6: 191, type locality Cuba; (sex?) MCZ; Aldrich, 1905: 254 (catalog); Kertesz, 1909: 55 (catalog); Bromley 1929: 273 (redescription); Martin 1957a: 366 (diagnosis), 1968: 2 (catalog); Hull 1962: 299 (catalog).

Leptogaster ramoni Jaennecke, 1867, 6: 354, type locality Cuba; Martin 1957a: 366 (synonymy), 1968: 3 (catalog); Hull 1963: 299 (catalog).

Remarks. The type of *L. obscuripes* is in poor condition with the absence of the hind legs and the abdomen. It is a dark species with brown antenna, mesonotum dorsally devoid of tomentum, shiny, mostly black with the wide apical corners reddish, tomentum limited to the posterior fourth and narrow lateral margins of the mesonotum; mesopleuron entirely blackish; femora and tibiae largely brown anteriorly; and wings hyaline with microtrichia limited to the narrow apex.

I examined the cotypes of *L. obscuripennis* and the lectotype of *obscuripes* plus a second specimen of *L. obscuripes* from Cuba (label with 128/258, green label with Cuba, Gunh.). The two latter specimens are identical including the absence of the posterior pair of legs and abdomen. *Lepto-*

gaster obscuripes is easily recognized by its dark body, *i.e.* the brown antenna, the blackish mesopleuron, the mesonotum is largely black with only the wide apical corners red, and the femora are largely brown anteriorly. In contrast, *L. obscuripennis* is much lighter, being reddish yellow, and without the dark structures mentioned for *L. obscuripes*. Additionally, the hyaline wings of *L. obscuripes* with microtrichia limited to the anterior margin of the wing easily separate the two species.

Bromley (1929) redescribed *L. obscuripes* based upon new material from Cuba. In his redescription, he noted two thin lines of tomentum on the mesonotum which are present on both *L. jamaciensis* and *L. bahamiensis* but are absent, clearly not rubbed off the lectotype of *L. obscuripes*. I have examined two females from Cuba that were identified as *L. obscuripes* by Bromley. Also, Farr (1963) obtained a male from Cuba identified by Bromley and illustrated its epandrium. The illustration is essentially identical to that of *L. bahamiensis*, n. sp. The much lighter thorax of these specimens, presence of the two, thin, tomentose lines on the dorsum of the mesonotum, and an identical epandrium suggests that Bromley described another species, not *L. obscuripes,* but possibly *bahamiensis,* n. sp.

Specimens examined. **CUBA:** type, 1 additional specimen, (MCZ); USA: 1 ♀, Florida, Key Largo, 26 March, 1954, K. V. Krombien (USNM).

Leptogaster roederi Williston

Fig. 23

Leptogaster roederi Williston 1896: 304. Type-locality: West Indies, St. Vincent (WI), ♂ & ♀, BMNH; Martin 1968, 35a: 4 (catalog).

A female in the BMNH is in poor condition, the apical two segments of the antenna, most of the vestiture of the head and thorax, proboscis, fore legs except fore femur, right hind leg, and halter are absent. The abdomen is broken and glued to the specimen pin. The following labels are attached to the specimen pin: 1) circular label with yellow borders and the word cotype; 2) location label with "wind ward side", St. Vincent, WI, H.H. Smith; 3) date-location label with "West Indies", 1907-66; 4) a syntype label with "*Leptogaster roederi* Williston", det. J.E. Chainey, 1982; and a folded identification label with two red rectangle lines around the hand written (ink) name "*Leptogaster roederi* Will." Williston (1896) based the original description on a male and female. However, Martin (1968) only listed a female type in this catalogue of the Neotropical species of *Leptogastridae*. Unfortunately, a thorough search for the male has been unsuccessful, and the specimen is presumed lost (pers. comm. F. C. Thompson, USDA, Washington D.C.). The female in the BMNH is here designated Lectotype.

Redescription. female. Mostly yellow with head entirely and thorax partly dark brown to black, abdominal tergites 1-5 mostly reddish brown tomentose with wide apical corners yellow.

Length, body 8.9 mm; wing 6.9 mm. Face yellow tomentose with four bristly yellow setae. Front yellow to brownish yellow tomentose, front slightly divergent dorsally, width at ocellar tubercle three times as wide as face at narrowest point. Palpus yellow with sparse brown setae. Scape and pedicel brownish yellow with mostly brown setae. Occiput yellowish tomentose with yellowish vestiture, postocular setae plus several setae on dorsal half of occiput bristly.

Thorax yellow to black; mesonotum mostly shiny or polished brownish yellow, posterior half laterally blackish, broad anterior corners yellowish, laterally and posteriorly with brownish yellow tomentum; two lateral bristles and sparse brown setae present laterally and medially. Scutellum brownish yellow with yellowish tomentum and sparse brownish and yellow setae; four-six marginal setae (sockets); postscutellum blackish. Mesopleuron largely dark as a wide, oblique stripe with yellow-brown tomentum, anteriorly and posteriorly yellow to yellowish brown with yellowish tomentum. Halter yellow.

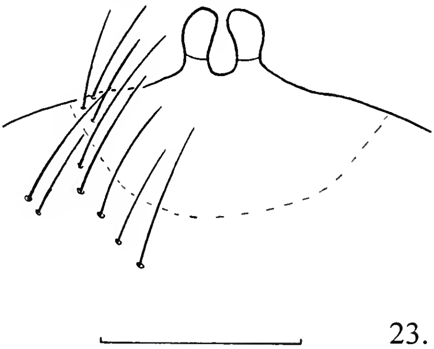
Wing with violaceous reflections. Microtrichia sparse, apical fourth of wing with dense microtrichia. Vein M_2 2.5 times as long as m-m; CuA_1+M_3 4.7 times as long as r-m; r-m crossvein well before the middle distance between base of cell d and fork of M_1+M_2. Legs slender; coxa and trochanter yellow. Femora and tibiae shiny brown-yellow, femora with a narrow, preapical yellowish band. Hind femur with apical half gradually swollen, apical third widest anteriorly. Mid tibia with a wide yellow apex, hind tibia only narrowly yellow; apex of hind tibia 2.3 times as wide as base, and subequal to greatest anterior width of hind femur; apical fourth of hind tibia anteriorly with one brown bristle. Tarsi mostly yellow to brownish yellow with brown slightly increasing sequentially from second tarsomere to fifth and from base to apex of each tarsomere; apical tarsomere entirely dark brown; hind tarsus brownish yellow to brown; bristles, claw and empodium brown to dark brown; empodium of mid and hind tarsi one half as long as and two-thirds as long as claw, respectively.

Abdomen largely reddish brown tomentose, basal 5-6 tergites with wide apical corners yellow, segments 7-8 brown; sternites 3-6 with large median brown spot, apically and basally yellow; sternites 3-7 apically with 2-6 long, bristly yellow setae. Medioapical margin of sternite 8 produced forward as a narrow bilobed, yellow process, each branch digitate, separated medially by a deep sinus; laterally, sternite 8 with numerous bristly setae.

Male. Unknown.

Specimens examined. Lectotype ♀ (BMNH).

Remarks. *Leptogaster roederi* is recognized by its small size, the presence of several yellow, bristly occipital setae, the wide, dark, oblique stripe



23.

23. *Leptogaster roederi* Williston, ♀. Sternite 8. Scale, 0.3 mm.

of the mesopleuron which is bordered anteriorly and posteriorly by yellow, wide yellow apical corners of tergites 1-5, the long, bristly setae of sternites 3-7, the narrow, yellow, preapical band of the femur only about half as wide as in other species, the presence of only one, strong, brown bristle on the apical fourth of the hind tibia, and the narrow, bilobed, digitate process of the medioapical margin of sternite 8. *Leptogaster roederi* is similar to *L. jamaciensis* and *L. bahamiensis* but differs in the lighter color of the body and legs, the much smaller body, only four bristly setae on the face, and the wide, dark, oblique stripe on the mesopleuron. It differs further from *L. martini* and other Caribbean species in the absence of the narrow stripes of tomentum on the dorsum of the mesonotum, the strong, anterior, brown bristle on the apical; fourth of the hind tibia, and the gradual increase in brown from base to apex in the apical tarsomeres. The apical and basal halves of the apical tarsomeres of most known Caribbean species are contrastingly dark and light, respectively.

ACKNOWLEDGMENTS

My sincere thanks to Mike Ivie of Department of Entomology, Montana State University, C. Young and John Davidson of the Carnegie Museum of Natural History, Pittsburgh; and F. Christian Thompson, Systematic Entomology Laboratory, USDA, at the National Museum in Washington, D. C. for bringing these flies to my attention. Appreciation is also expressed to Stefan Cover of the Museum of Comparative Zoology, Cambridge, MA, USA, for the loan of the types of *obscuripes* Loew and *obscuripennis* Johnson, and to J. Chainey of the British Museum of Natural History (BMNH), London for *Leptogaster roederi* Williston. William Grogan of the Department of Biology, Salisbury, Md., C. Riley Nelson, Department of Zoology, University of Texas, and F. Christian Thompson, ARS, USDA, USNM, Washington, D. C., read the manuscript and made valuable suggestions for its improvement. F. Christian Thompson also provided valuable information concerning the male type of *L. roederi*.

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1996 CALVERT AWARD PRESENTED TO ANDREW SHORT

At the April 24 membership meeting, Andrew E. Short of Glasgow, Delaware, became the tenth recipient of the American Entomological Society's Calvert Award. The award recognizes a young person in the greater Delaware Valley who has demonstrated outstanding accomplishments in insect-related study. The Award is named in honor of Dr. Philip P. Calvert [See ENT. NEWS 95(4): 155-162 (1984)] who joined the Society as a teenager, later became its president, and was a member for 74 years. As a professor of biology at the University of Pennsylvania and as associate of the Academy of Natural Sciences of Philadelphia, Dr. Calvert played an importaut role in stimulating an interest in insects among young people.

Among Andrew's many activities and accomplishments that led to the Calvert Award, the selection committee highlighted his volunteer activities. Through the Delaware Academy of Science, he developed and taught the week long junior entomologists camp at the Iron Hill Museum in 1994 and 1995 – a course that he will teach again this summer. He presented units on insects and butterflies to several classes at Marshall Elementary School in 1994 and 1995 and has taught several entomology workshops for the 4-H. Last year he participated in the first systematic macro invertebrate study of the White Clay Creek coordinated by the Ashland Nature Center (DE) and the Stroud Water Research Center in Avondale, Pennsylvania. This involved collecting and identifying all the insects in samples taken at several locations along the creek. Among Andrew's plans for this year are to restore the 60 year old insect collection at Lums Pond State Park (DE) and construct a new stream environment as part of the Mesocosm at Glasgow High School where he is in the tenth grade. Perhaps it is not surprising that Andrew placed first in the entomology competition at the Delaware State Science Olympiad in 1993, 1994, and 1995. He lamented that the category was not included in this year's Olympiad. When asked which group of insects most interests him, Andrew declared a fondness for beetles, a collection of which he displayed at the award ceremony. He also called attention to the coincidence that his initials, A. E. S., match those of the Society!

As the winner of the Calvert Award, Mr. Short received memberships in the American Entomological Society and the Young Entomologists' Society as well as a $50 check. Joseph Sheldon, president of the Society, made the presentation at the membership meeting of the Society at the Academy of Natural Sciences in Philadelphia.

Harold B. White,
Chair, AES Education Committee

NEW DIAGNOSTIC CHARACTERS FOR THE MAYFLY FAMILY BAETIDAE (EPHEMEROPTERA)[1]

T.-Q. Wang, W. P. McCafferty[2]

ABSTRACT: Two newly discovered universal characteristics are proposed to distinguish larvae of the family Baetidae (Ephemeroptera) from those of all other families of mayflies. These include the orientation of the lateral branches of the epicranial suture anterior of the lateral ocelli, and the ventral orientation of the dorsal lobe at the apices of the femora. Use of these new characters should eliminate the previously necessary use of complex combinations of characters that have been used in keys and that have continued to meet with exceptions.

The family Baetidae usually can be distinguished in the larval stage by a combination of general characteristics. These include a streamlined body, hypognathous head, relatively long antennae, antennae originating anteriorly or anterolaterally on the head, long and narrow glossae and paraglossae of the labium, abdominal segments without well-developed posterolateral projections, and in mature male larvae, developing turbinate compound eyes (e.g., Edmunds, *et al.* 1976). Unfortunately, on a world level, each of these characteristics fails in certain genera of Baetidae, and several of them fail in a few genera. For example, *Platybaetis* Müller-Liebenau (1980) has a prognathous head with short antennae originating dorsally (Fig. 5), and a depressed body. Recently, Lugo-Ortiz and McCafferty (1996) described a new genus of Baetidae that, remarkably, lacks the male turbinate eyes, one characteristic that historically has been considered a unique and consistent characteristic for the family. The turbinate eyes of baetids continue to be regarded as a synapomorphy defining the family phylogenetically, and are regarded to have been secondarily lost in this one particular baetid lineage (Lugo-Ortiz and McCafferty 1996).

In the Northern Hemisphere, diagnosis of all baetids from Ameletidae and Siphlonuridae [previously equal to Siphlonuridae (see McCafferty 1991)], has been problematic because there could be exceptions to the key couplets involving the relative length of the antennae and development of the posterolateral processes, even if augmented with mouthpart characters, as was discussed by McCafferty (1981). In the Southern Hemisphere, a somewhat similar problem is found in distinguishing the Baetidae from Metamoniidae [previously considered Siphlonuridae in part (see McCafferty (1991)] in keys to Australian mayfly families (e.g., Peters and Campbell 1991). The dilemma in North America was partly rectified by McCafferty (1981), who showed that, in North America, two-tailed baetid larvae were easily distinguished from Siphlonuridae and Ame-

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letidae, and that these latter three-tailed mayflies could then be separated from three-tailed baetid larvae by the relative length of the antennae. This, of course, meant keying out the family Baetidae in multiple places in keys to families.

An exception to all three-tailed baetids having relatively long antennae subsequently became apparent with the discovery of the new genus *Barbaetis,* which possesses a well-developed median caudal filament and relatively short antennae (Waltz *et al.* 1985). Even in a recently published key to the families of mayflies by Edmunds and Waltz (1995) in the third edition of "An Introduction to the Aquatic Insects of North America," a characteristic – included in the couplet leading to Baetidae to account for the variability expressed by *Barbaetis* – is stated as "or, antennae shorter than twice width of head, but labrum with notched distal margin." Quite unintentionally, this causes the genus *Ameletus* and the family Ameletidae to be incorrectly keyed out as Baetidae.

An obvious way to alleviate these identification problems, and the complex key couplets that result, would be to have at least one characteristic that would separate all Baetidae larvae from all other mayflies with which they might be confused. Historically, this grouping would include only mayflies with minnowlike bodies (pisciform mayflies), but recently "flatheaded" baetid larvae have been discovered in the Orient (Müller-Liebenau 1980, Mol 1989) that are reminiscent of Heptageniidae as well as some Leptophlebiidae.

NEW CHARACTERS

We have discovered external morphological larval traits that appear to distinguish larvae of the family Baetidae from those of all other mayflies thoughout the world. In larval specimens of Baetidae that we have examined (representatives of all known and some undescribed genera), lateral ocelli are posterior to the initial lateral branches of the epicrannial suture (e.g., Figs. 1-6). In all specimens of other mayflies, the initial lateral branches of the epicranial suture either connect with the lateral ocelli, usually near the center of the ocelli, but also at the posterior edges of the ocelli, or are slightly posterior to the ocelli (e.g., Figs 7-12). In all female larvae and males of broad-headed baetid larvae, the branches of the epicranial suture are easy to see. In very mature male larvae of Baetidae with narrow heads, some manipulation of the overshadowing large eyes may be required.

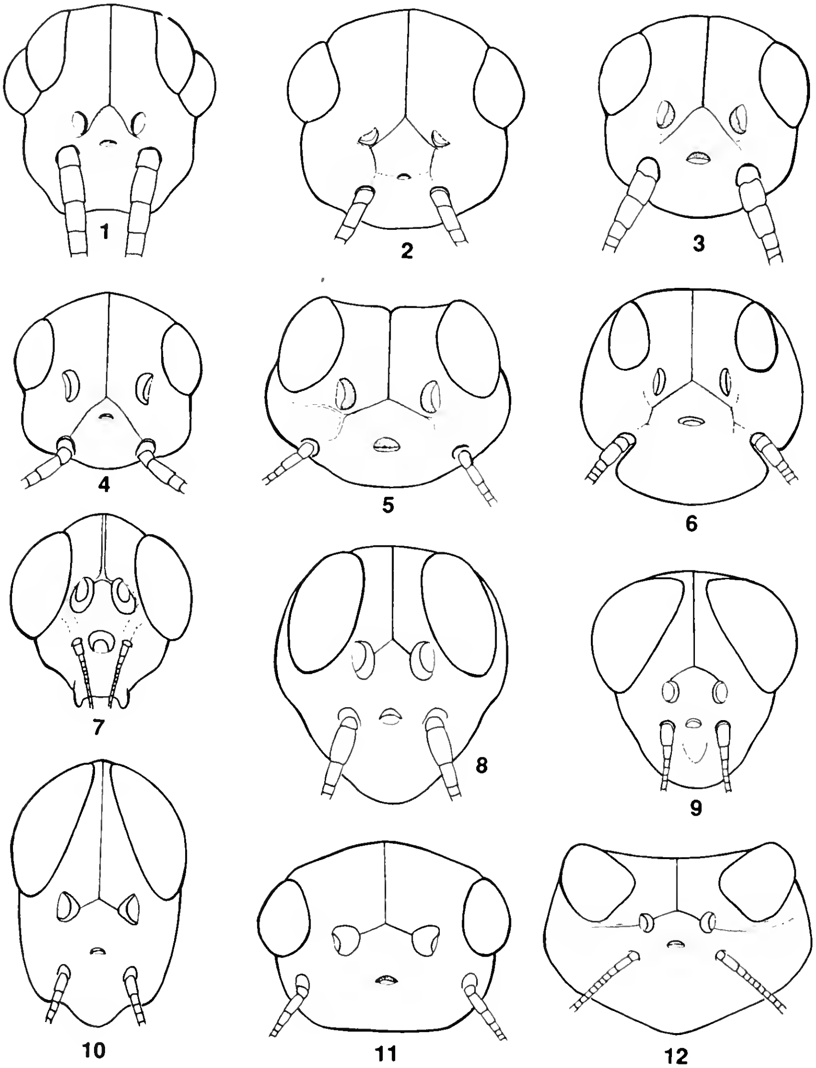
In certain instances among non-baetid families, lateral ocelli may not be readily evident and the epicranial suture, itself, may be obscure. Closer observation, however, will usually reveal these structures, although lateral branches can be extremely short, for example, on the aberrant head of *Ametropus* (Ametropodidae) larvae. Unfortunately, many published figures of mayflies, especially whole larval drawings, do not show details of the epicranial suture, and thus it can be futile to attempt comprehensive comparisons based only on published figures.

The initial lateral branches of the epicranial suture in Baetidae larvae not only run anterior to (below) the lateral ocelli, but in many, they continue for some distance beyond the lateral ocelli (Figs. 2-6), and in some groups, each initial lateral branch becomes subsequently branched (Figs. 2, 3, 5, 6). In many other mayflies, the lateral branches of the epicranial suture end at the ocelli (Figs. 8-11). In Heptageniidae and genera of some other families, however, the lateral branches continue to extend laterally beyond the lateral ocelli (Fig. 12), and a somewhat extreme example of this is seen in *Atopopus* [Fig. 1 of Wang and McCafferty (1995)]. In Siphlaenigmatidae, the initial lateral branches directly meet the lateral ocelli, but a weak suture line also connects the anterior edge of the lateral ocelli with the median ocellus (Fig. 7).

A second useful character appears to be the shape of the apices of the larval femora. In representatives of all genera of Baetidae known as larvae, we have found that the apex of the dorsal lobe of the femoral apex is oriented ventrally (e.g., Figs. 13-16). To fully understand this somewhat more complex character, it must be kept in mind that we follow the terminological suggestion of Hubbard (1995) in recognizing the narrow edges of the femora as dorsal and ventral aspects. The tibia adducts toward the ventral edge of the femur. (In some Ephemeroptera literature, the dorsal aspect of the larval femur is referred to as posterior, and the ventral aspect as anterior because of the *in situ* orientation of legs often encountered.) It must also be realized that there is a distinguishable separation of the apex of the femur into an ventral portion (sometimes appearing as a lobe) and dorsal portion (always a lobe in baetids). These ventral and dorsal areas are evidenced by a slight to moderately deep medial incision (sometimes a clear furcation, sometimes only a fusion line) or by obvious differences in shape and development.

In Baetidae, the dorsal and ventral femoral lobes, when both are developed, can together give the impression of an entirely convex femoral apex (Figs. 13, 14), although the dorsal lobe makes up the greater part of the convexity because it is oriented ventrally and thus tends to wrap around the ventral lobe, or part of it. R. D. Waltz (pers. comm.) has pointed out to us that, in certain *Callibaetis* and some other genera, the dorsal lobe is not rounded but more truncate (e.g., Figs. 15, 16). However, even in these baetids, we found that the ventral orientation of the dorsal lobe is still obvious from its oblique medial margin.

In all non-baetid mayfly larvae that we have examined, the apex of the femur does not have a ventrally oriented dorsal lobe (e.g., Figs. 17-20). Oftentimes, the dorsal lobe is not developed (e.g., Figs. 18, 19), whereas the ventral lobe may be variously developed and sometimes highly developed (e.g., Fig. 19). In some Oligoneuriidae (e.g., Figs. 20), the apex of the femur is convex, but the two lobes are essentially symmetrical. In some Leptophlebiidae, a similar situation is found, but lobes are not as well developed [e.g., see *Notachalcus* (Fig. 59) of Peters and Peters (1981)]. The dorsal lobe is never ventrally oriented in non-baetids, even in some Leptophlebiidae whose dorsal lobe is slightly larger than the ventral lobe [e.g., see *Fasciamirus* (Fig. 87) of Peters *et al.* (1990)].

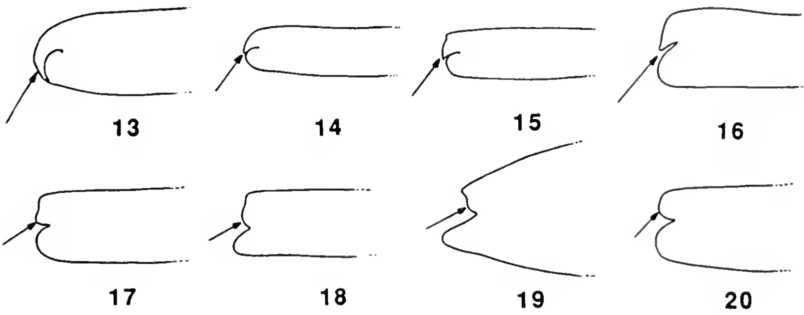


Figs. 1-12. Epicranial sutures of the larval heads of mayflies. 1. *Callibaetis* sp. (Baetidae). 2. *Barbaetis* sp. (Baetidae). 3. *Acentrella* sp. (Baetidae). 4. *Baetodes* sp. (Baetidae). 5. *Platybaetis* sp. (Baetidae). 6. *Echinobaetis* sp. (Baetidae). 7. *Siphlaenigma* sp. (Siphlaenigmatidae). 8. *Ameletus* sp. (Ameletidae). 9. *Siphloplecton* sp. (Metretopodidae). 10. *Ameletoides* sp. (Metamoniidae). 11. *Paraleptophlebia* sp. (Leptophlebiidae). 12. *Compsoneuriella* sp. (Heptageniidae).

We have found the femoral apex character easy to see and use. Again, however, illustrators of mayfly larvae have often neglected or incorrectly figured details of this new character, or, often, the orientation of legs in their drawings do not clearly show apical femoral structure.

The non-baetid orientation of the initial lateral branches of the epicranial suture and the non-baetid shape of the apices of the femora also apply to the family Siphlaenigmatidae, a group of New Zealand mayflies shown by McCafferty and Edmunds (1979) to be intermediate between certain other pisciform mayflies and the Baetidae proper. These differences would appear to provide additional arguments for not considering this grouping as a subfamily of Baetidae (McCafferty 1991), as was done previously by McCafferty and Edmunds (1979) and Landa and Soldán (1985).

We are learning, in the study of Ephemeroptera, that entirely universal and exclusive character states are difficult, if not impossible, to find for very diversified and ubiquitous higher taxa (i.e., extant families Baetidae and Leptophlebiidae). Due to their highly radiated nature and worldwide distribution, they are prone to convergences and secondary losses in at least some of their many lineages. With this in mind, we would not be surprised if, in the future, a convergence of one or both of the new baetid characteristics reported here are found at perhaps the genus or species level in some other group of mayflies. We would predict, however, that the epicranial suture character is probably the most stable of the two. The shape of the apices of the femora, on the other hand, may be more susceptible to homoplasy because there is considerable variation both within Baetidae and within non-Baetidae mayflies although we have yet to find any overlap. Leptophlebiid lineages are always candidates for such homoplasy, as witnessed by the incredible convergences in certain lineages of this family for character states usually associated with other groupings of mayflies [e.g.,



Figs. 13-20. Distal apices of larval right hindfemora of mayflies (anterior view, pointer to dorsal lobe; see text for explanation of directional terms). 13. *Baetis* sp. (Baetidae). 14. *Cloeon* sp. (Baetidae). 15. *Cloeodes* sp. (Baetidae). 16. *Callibaetis* sp. (Baetidae). 17. *Ameletus* sp. (Ameletidae). 18. *Siphlonurus* sp. (Siphlonuridae). 19. *Afronurus* sp. (Heptageniidae). 20. *Elassoneuria* sp. (Oligoneuriidae).

the pannote-like thorax of adult *Traverella* (McCafferty and Edmunds 1979) and the ephemerellid-like wing venation of *Melanemerella* (Wang and McCafferty 1996)]. One other caveat is that a large fraction of Baetidae of the Southern Hemisphere is as yet unknown.

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DISTRIBUTION OF *SPEYERIA DIANA* (LEPIDOPTERA: NYMPHALIDAE) IN THE HIGHLANDS OF ARKANSAS, MISSOURI AND OKLAHOMA, WITH COMMENTS ON CONSERVATION[1]

C. E. Carlton[2], Lori Spencer Nobles[3]

ABSTRACT: Information from recent field observations, museum specimens, collectors' lists and published records is provided to update knowledge on the distribution and habitat associations of the Diana fritillary in the Interior Highlands of Arkansas, Missouri, and Oklahoma. *Speyeria diana* has been observed at 11 localities since 1980 and nine localities prior to 1980, the earliest of which is a Missouri state record from 1819. Two records are known from Missouri and two from Oklahoma since 1980, the remaining recent records are from Arkansas. Extant populations of the Diana fritillary in the Interior Highlands are few in number and most appear to consist of small numbers of individuals. These populations appear to be isolated from those in the southern Appalachians due to the species' extirpation from the middle portion of its historical range. Conservation efforts should focus on identifying and preserving habitats occupied by females, since they occupy a more limited range of habitats than males.

Several North American species of the fritillary butterfly genus *Speyeria* have become a source of concern for conservation biologists. Distributions have become increasingly fragmented and reduced, presumably due to human disturbances to the butterflies' optimal habitats, and those of the larval foodplants, violets (Violaceae: *Viola* spp.) (Hammond, 1995; Hammond and McCorkle, 1983). Several authors have documented or suggested that the Diana, or Great Smokies fritillary, *Speyeria diana* (Cramer), has undergone such a range reduction. Clark (1951) noted its decline in Virginia. Shull (1987) reported that it had not been collected in Indiana since 1962 and Howe (1975) suggested that it might be extinct in Missouri. The species is a candidate for listing as a protected, threatened or endangered species (PETS) under the Endangered Species Act of the United States (Federal Register, 1991, Vol. 56, no. 225, p. 58,831).

The Diana fritillary is a forest species, the larvae of which feed on a variety of forest-dwelling *Viola* spp. (Opler and Krizek, 1984; Scott, 1986; Allen, in press). Published records indicate a historical range throughout the southern Appalachian Mountains from West Virginia to northern Georgia and eastern Tennessee and Kentucky, scattered localities in southern Ohio, Indiana, Illinois

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and Mississippi, and the Interior Highlands of Arkansas and Missouri (Fig. 1) (Allen, in press; Holland, 1931; Hovanitz, 1963; Mather and Mather, 1958; Opler, 1992; Opler and Krizek, 1984; Scott, 1986). A sight record for Louisiana (Tallulah, Madison Parish) is mentioned by Mather and Mather (1958), but we do not consider it reliable enough to include Louisiana in the historical range.

Recent distributional data indicate a broad disjunction across the middle portion of the range, again suggesting that the species' distribution is becoming more restricted. In the eastern portion of its range, the Diana fritillary is widespread and individuals may be abundant at some localities in West Virginia (T. J. Allen, personal communication, Aug. 1995). The distribution of the species in the Ozark and Ouachita Interior Highlands (as defined by Thornbury, 1965) is more problematic. For a number of years, the only well-known population in Arkansas was in Logan County in west-central Arkansas. Several localities in Missouri and Oklahoma were known to local collectors. The overall impression has been that the Interior Highland populations were isolated, few in number, and comprised small numbers of individuals.

We conducted a survey for the Diana fritillary during 1992-1995. In this paper, we report field observations by ourselves and colleagues, data compiled from museum specimens, and published and unpublished records to update the known distribution and habitat associations of the Diana fritillary in the western portion of its range. We also discuss the status of the Diana fritillary in the Interior Highlands from a conservation perspective in light of these additional data.

METHODS

This survey was conducted in conjunction with other research projects that required extensive travel throughout the Interior Highlands of Arkansas. The primary survey method was visual searching for patrolling males. No attempts were made to capture the butterflies, but they were observed until a positive species determination was made. Several specimens were captured in malaise traps set out for other purposes. These specimens were cleaned, mounted, and deposited in the University of Arkansas Arthropod Museum.

These observations were supplemented by interviews with individuals having knowledge of butterfly identification. Only reliable field observations are reported, and the identities and affiliations of the persons who made the observations are provided. Finally, data were collected from specimens housed in entomology museums in the region and from private collectors' lists.

Because these populations are small they may be at risk from overcollecting. Therefore, county records only are provided for recent records. More detailed locality data are available from the senior author to researchers.

The only sympatric butterfly species in the Interior Highlands that is likely to be confused with male Diana fritillaries is the great spangled fritillary (*S.*

cybele [F.]). Close observation is necessary to distinguish the two species. Male Diana fritillaries have abruptly bicolored brown and yellow-orange wings, and bear only small lunate silver spots on the undersides of the hind wings, whereas great spangled fritillaries have more gradually bicolored brown and orange-yellow wings and have large, conspicuous silver spots on the undersides of the hind wings.

RESULTS AND DISCUSSION

Published records. MISSOURI: "Missouri" 1819; "Missouri" (Proc. Ent. Soc. Philadelphia 3: 432, 1864; Bull. Buffalo Soc. Entomol. 2: 259, 1895, not seen, information provided by Mike Skinner, Missouri Department of Conservation); **Greene Co.,** SE of Springfield, 22 August (Sell, 1916); **Taney Co.,** Hollister, August 1925, male and female (Kite, 1934). **ARKANSAS:** "Ozarks" (Scott, 1986); **Scott Co.,** Mill Creek, 10 June 1992, Gary Gier (McKown, 1993).

Collectors' lists. MISSOURI: Jackson Co., Kansas City, Miner Park, 27 June 1986, 1 male, Gary Gier. **OKLAHOMA: Cherokee Co.,** Cherokee Landing on Lake Tenkiller, 8 August 1962, Pete Loy, John Nelson; **Leflore Co.,** 8 June 1992, Gary Gier; **Mayes Co.,** Jeff Frey, no additional data; **McCurtain Co.,** Bill Carter (collection record), Connie Taylor (photograph), no additional data; **Pittsburg Co.,** 5 July 1983, Robert J. Warren.

Additional records: John Masters in letter dated 9 March 1968: **ARKANSAS: Conway Co.,** Petit Jean Mtn.; **Faulkner Co.,** "various spots"; **Newton Co.,** Ponca, Lost Valley, "very common"; **MISSOURI: Iron Co.,** Tom Sauk Mtn. and Current River.

Museum specimen data. Acronyms: Louisiana State Arthropod Museum-LSAM; University of Arkansas Arthropod Museum-UAAM; Wilbur Enns Entomology Museum, University of Missouri-UMEM. **ARKANSAS: Logan Co.,** 23 June 1984, L. D. Newsome, 1 female (LSAM); 18 August 1984, upland hardwood forest, 1 male, 4 females, R. T. Allen (UAAM); 20 June 1985, hardwood/pine, developed campground, 2 males, R. T. Allen (UAAM); 10 July 1985, L. D. Newsome, 4 males (LSAM); June 1986, L. D. Newsome, 1 male (LSAM); 23-26 June 1988, T. J. Riley, D. LeDoux, 1 male (LSAM); **Montgomery Co.,** pine/hardwood forest adjacent to pine/hardwood shelterwood stand one year post-harvest, malaise trap, 1 July 1993, 1 male, C. E. Carlton (UAAM); **Perry Co.,** group selection stand one year post harvest, 17 June 1993, malaise trap, 1 male, C. E. Carlton (UAAM); **Washington Co.,** 22 August 1977, 1 female (UAAM). **MISSOURI: Jefferson Co.,** Pevely, 21 June 1896, 1 male, H. Hurter (UMEM).

Field observations. ARKANSAS: Crawford Co., hardwood/pine edge habitat, 6 June 1995, 1 male, Lori Spencer Nobles; **Howard Co.,** second growth pine hardwood forest and even-aged pine stands of various ages, 7 June 1994, 5 males, C. E. Carlton; **Newton Co.,** public swimming/picnic area, upland hardwood forest, visiting : moist gravel, June 1994, males and females, Linda Bishop, (National Park Service, Harrison, AR); **Perry Co.,** group selection stand one year post-harvest, 17 June 1993, 1 male, C. E. Carlton; **Sebastian Co.,** tallgrass prairie/patchy forest and dense undergrowth, 16 June 1994, 1 male, C. E. Carlton. **MISSOURI: Barry Co.,** mature upland hardwood forest, August 1994, numerous males, K. S. Johnson (Department of Biological Sciences, Ohio University, Athens).

These records total 11 localities for the Diana fritillary since 1980, nine prior to 1980, and two undated, excluding the early state records (Fig. 2).

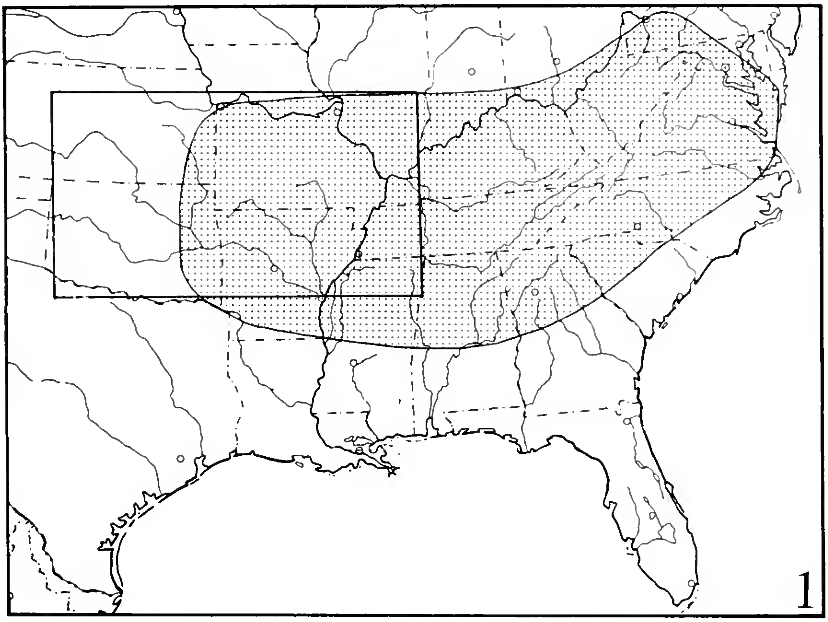
The predominant natural habitats at the Logan and Newton County, Arkansas localities are mature upland hardwood and pine/hardwood forests, although most specimens were in edge habitats within or near campgrounds and highway rights of ways. Habitats at the Montgomery and Perry County localities are mixed pine-hardwood upland forests, slightly to moderately disturbed by recent timber harvesting but with relatively undisturbed mature forests nearby. In Howard County, where five males were observed during a one-hour period, the habitat was a mosaic of severely disturbed pine and second growth mixed forest in various stages of succession with a dense understory of woody vines, shrubs and small trees. The landscape in the area gave the impression of being degraded by years of even-aged timber management. The Sebastian County record is in an area of mixed agriculture and heavy industry. Scattered remnants of natural habitat included tallgrass prairie, patchy thickets of small oaks, elms and black locusts, and a few stands of mature hardwood and pine/hardwood forest.

The Barry County observation is the first report of the Diana fritillary in Missouri since the Kansas City record from 1986. Richard Heitzman (personal communication) stated that the Kansas City specimen was worn and probably a stray since there are no other records within 200 miles of the site. Confirmation of the Barry County record is necessary to establish with certainty that the species is extant in Missouri.

Nelson (1979), in his species list for Oklahoma, noted that the species "is found only in the eastern counties where the Ozark Plateau just extends into the state." In recent correspondence, Dr. Nelson indicated that he has seen specimens in 4-H collections at the Tulsa County Fair with some frequency.

Notably absent from the field observations are females. Clark (1951) noted that females prefer well wooded ravines and mountain sides, often in association with cold seepages and streams. Males patrol a wider range of habitats (Opler, 1992), a behavior which assists in field surveys, but contributes little to understanding the habitat limitations affecting the success of the species. The Diana fritillary is not restricted to large continuous areas of mature forest, but requires patches of moist, dense forest for female habitat, and to support the growth of violets and provide protection for overwintering first instar larvae (Clark, 1951; Allen, in press). Although Hovanitz (1963) argued that deforestation was not the primary cause for the decline of the species, the scale of deforestation in the middle portion of its range, from Illinois to Ohio, cannot be discounted as a contributing factor.

The Diana fritillary is widely distributed in the Interior Highlands based on available data (Fig. 2). However, extant populations appear to be isolated from each other, and comprise few individuals. If this characterization is accurate, these populations are at risk from unfavorable weather conditions, particularly the droughts that are characteristic of the region and from human disturbances to the habitats necessary for the females. Further, it appears likely that the Interior Highlands populations are geographically isolated from those in the southern Appalachians due to the extirpation of the species from the middle portion of its historical range across southern Illinois, Indiana, and Ohio. This could lead to reduced fitness due to loss of genetic variability as populations become



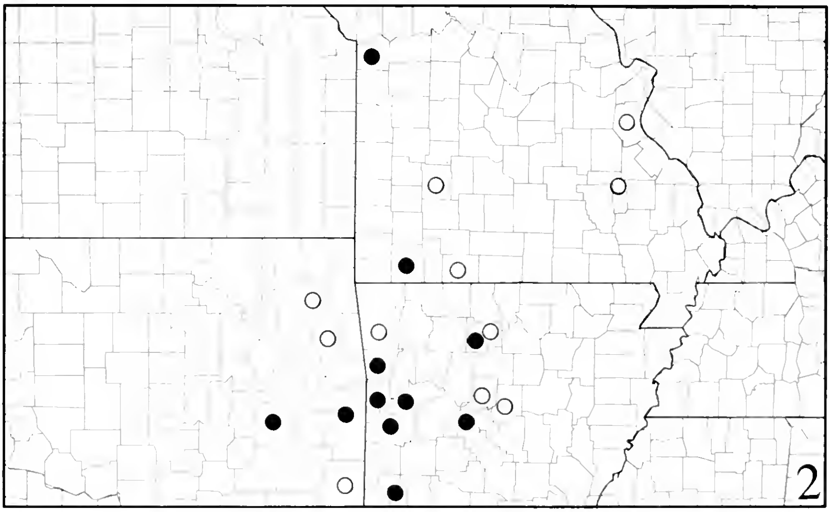


Fig. 1. Dotted area indicates the historical range of Speyeria diana based on references cited in text and current data. Inset indicates area covered by Fig. 2.
Fig. 2. Locality records of *S. diana* in the Interior Highlands. Open circles = records prior to 1980. Solid circles = records 1980-1994.

more isolated from each other and from the larger pool of populations in the east.

The Diana fritillary has never been regarded as common in the Interior Highlands, so the data provided here neither support or refute a significant decline of the species' density in recent years, but clearly it remains uncommon. The species should be monitored in the Interior Highlands as an environmentally fragile species that is surviving in patchy habitats near the western limit of its range. Additional research is necessary to develop a better understanding of the conservation needs of the Diana fritillary in the Interior Highlands. Studies of larval food preferences and overwintering microhabitats would document differences in larval habits and causes of mortality between Interior Highlands and southern Appalachian populations. Investigations of potential competitive interactions with its more abundant congener, the great spangled fritillary *(S. cybele)* would clarify the role, if any, of interspecific competition in limiting the species' success. Molecular studies of Diana populations throughout its current range would contribute to our understanding of gene flow within the Interior Highlands populations and between them and southern Appalachian populations.

Perhaps the most practical approach to preserving individual populations of the Diana fritillary in the Interior Highlands and elsewhere for the near future would be to extend survey efforts to females and determine the sizes of the areas where females occur. Active measures could then be taken to preserve and monitor those areas and adjacent areas of similar habitat.

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BOOK REVIEW

INSECTS THROUGH THE SEASONS. Gilbert Waldbauer. 1996. Harvard Univ. Press. 289 pp., Hd. $24.95.

Not since Ross E. Hutchins in the 1960's has anyone written about insects in such a fascinating and engaging, yet scientifically accurate, manner as Waldbauer has in this outstanding volume. Truly, this is one of those rare books that, once started, is hard to put down until completed.

The author's stated purpose is to explore, from an ecological perspective, the reasons why insects are the most successful of all animal groups and to consider some of the evolutionary adaptations that have made it possible for them to be so successful. Waldbauer has achieved this purpose admirably. Starting from the basic premise that achievement of evolutionary fitness involves three imperatives: the insect must avoid being eaten; it must itself eat and grow; and it must successfully reproduce itself. Waldbauer proceeds to take a reader through segments of the life cycles of different insects from thier emergences from winter diapause throughout the seasons of the year. Some of the chapter headings are: Finding and Courting a Mate; After the Courtship's Over; Caring for Offspring; Defense against Predators; The Parasitic Way of Life; Recognizing Food; Taking Nourishment; Coping with the Seasons; Silken Cocoons; and Winter.

Far from being staid chapter headings, together these read almost like a who-done-it novel as one constantly wants to know what ecological event is next to be related. For example, the great diversity of methods employed in the Caring for Offspring chapter and the adaptations for survival recounted in the chapter on Defense against Predators are both fascinating and the study of insect sex lives is well supported with the example of the eradication of the screwworm fly. Throughout this work, Waldbauer illustrates and supports his many points with abundant and diverse citations based on research.

One does not have to be an entomologist, professional or amateur, to appreciate this book. Its interesting writing style makes it easily readable by ecologists, naturalists and even laymen, though a basic knowledge of entomology would greatly enhance a reader's appreciation of this work. Every entomologist, no matter his or her discipline or how advanced in his or her knowledge in this field, will surely appreciate and enjoy this fascinating offering.

H.P.B.

TWO NEW SPECIES OF *SOYEDINA* (PLECOPTERA: NEMOURIDAE) FROM THE APPALACHIAN MOUNTAINS[1]

R.W. Baumann[2], S.A. Grubbs[3]

ABSTRACT: Two new Nemouridae are named from the Appalachian Mountains of eastern North America. *Soyedina kondratieffi* and *S. merritti* are described in the male and female adult stages. Illustrations are provided for the important genitalic characters that will separate them from the known species. The new species are only recorded from small geographical areas in North Carolina and Pennsylvania.

While studying the Nemouridae of eastern North America, it became apparent that the genus *Soyedina* contains more species than previously realized. Three species are presently recognized from this region: *Soyedina carolinensis* (Claassen), *S. washingtoni* (Claassen) and *S. vallicularia* (Wu). Claassen (1923) named the first two species from specimens collected in 1877. Wu (1923) then described *S. vallicularia* as part of his doctoral research. Ricker (1952) questioned the status of *S. carolinensis,* but most North American authors have treated it as a valid species (Stark *et al.*, 1986). However, a study of the type specimens indicated that there are two previously undescribed *Soyedina* species in the Appalachian Mountains. One species is known from a small area in Pennsylvania and the other has been recorded from only one locality in North Carolina. This paper provides the descriptions of these two interesting species.

Soyedina kondratieffi, NEW SPECIES

(Figs 1-3)

Male: Macropterous. Length of forewings 6.5-7.5 mm; length of body 5.0-6.0 mm. General color dark brown; legs light brown. Wings fumose, with darker areas near base and at cord; venation typical for genus with veins A_1 and A_2 joined near wing margin. Gills absent. Anterior abdominal terga unmodified. Cerci small, membranous and one segmented. Hypoproct well developed, base broad covering most of ninth sternum, apex narrow and ending in a pointed, lightly sclerotized tip; vesicle narrowest at base, elongate and thin, parallel sided and terminating in rounded tip. Paraprocts with two lobes: inner lobes small, narrow and lightly sclerotized; outer lobes greatly enlarged, darkly sclerotized broadest at base, narrowed at midlength, apical portion forming broad, ax-shaped structure, ending in narrowly pointed tip along concave margin, which margin displays a thin, more darkly sclerotized band reminiscent of an outer paraproctal lobe (Fig. 2). Epiproct short, stout and not completely recurved but directed upward and away from head region; slightly

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asymmetrical, with right half larger than left; ventral sclerites elongate, sausage-shaped, slightly broader near apex, with rounded tips, pointed, sclerotized extension present near base of outer margin; lateral arms short, thin and extending from base of ventral sclerites to darkly sclerotized portion of dorsal sclerite; basal sclerites broad and triangle-shaped; dorsal sclerite with broadly rounded, lightly sclerotized apical portion, open at apex, revealing sclerotized inner structures, basal area of sclerite bearing darkly sclerotized, triangle-shaped bars, which encircle the basal cushion (Figs. 1-2).

Female. Macropterous. Length of forewings 8.0-9.0 mm; length of body 6.0-7.5 mm. Body, appendages and wings similar to male. Subgenital plate well developed, base broad, apex narrowly rounded, extending completely over middle of eighth sternum. Median area of eighth sternum broadly excavated at vaginal opening (Fig. 3).

Diagnosis. *Soyedina kondratieffi* can be distinguished from most described species of *Soyedina* by the shape of the paraprocts, which are narrow apically and terminate in sharply pointed tips along the inner margin. The other species that has apically pointed paraprocts is *S. merritti*, but the tip is near the middle and the whole paraproct is shorter and stouter. *Soyedina kondratieffi* can best be separated from *S. carolinensis* and *S. washingtoni* by its epiproct. The epiproct in both *S. carolinensis* and *S. washingtoni* is long and narrow with small teeth, while it is short, stout and naked in *S. kondratieffi*. Also, the epiproct of *S. kondratieffi* is nearly symmetrical as in the western *S. producta* (Claassen). However, the distinctive, anterior tergal modifications serve to easily identify *S. producta*.

Material. Holotype male and allotype female, North Carolina, Macon County, upper Ball Creek, Coweeta Hydrologic Laboratory, 1,100-1,200 m, 22 February-23 March 1984, A.D. Huryn (malaise trap), deposited at the United States National Museum, Smithsonian Institution, Washington, D.C. Paratypes: 6 males and 19 females, same locality data as holotype; 5 males, 20 March-7 April, deposited at Museum of Natural History, University of Georgia. Athens, Georgia; Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah, and C.P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, Colorado.

Etymology. This species is named in honor of Dr. Boris C. Kondratieff of the Department of Entomology, Colorado State University. He made the first specimens available to the senior author and has provided much support and encouragement over the years during our studies on the stoneflies of eastern North America. In addition, his passion for the stonefly fauna of the southern Appalachian Mountains has been an inspiration to everyone in the field.

Discussion. This species is presently known only from the type locality in North Carolina. The habitat is a headwater stream that is surrounded by seeps (Huryn and Wallace, 1987). The adults were collected in February and March before most entomologists are collecting. Two other *Soyedina* species were also found in the malaise trap samples: *S. carolinensis* in late March and early April and *S. washingtoni* in late April and early May. Additional specimens will probably be collected when biologists search appropriate habitats in the Southern Appalachian Mountains early in the year.

Soyedina merritti, NEW SPECIES

(Figs. 4-6)

Male: Macropterous. Length of forewings 7.0-8.0 mm; length of body 5.0-6.0 mm. General color dark brown; legs light brown. Wings fumose, with darker area near the cord: venation typical for genus, with veins A_1 and A_2 joined near the outer wing margin. Anterior abdominal terga unmodified. Cerci small, membranous and one segmented. Hypoproct well developed, base broad covering most of ninth sternum, apex narrowing abruptly to lightly sclerotized, thin, pointed tip; vesicle broadest medially and narrowing at base and apex, relatively short and stout, terminating in a rounded tip. Paraprocts with two lobes; inner lobes small, thin and lightly sclerotized; outer lobes greatly enlarged, darkly sclerotized, broadest at base, constricted slightly at midlength, apical portion forming large, distinctive, saber-shaped structures, which appear somewhat like the head of a bird in profile, apex pointed apically and inner margin less concave and almost straight (Fig. 4). Epiproct elongate but very broad, with apex nearly as wide as base, asymmetrical, with right half larger; ventral sclerites long and thin, bearing a few small teeth along outer margins; lateral arms long and thin, extending from base of ventral sclerites to beyond sclerotized base of dorsal sclerite; basal sclerites broad and triangle-shaped; dorsal sclerite with large, lightly sclerotized apical portion that terminates in a broadly rounded apex, open throughout apical two thirds, exposing darkly sclerotized inner structures, basal portion of sclerite composed of large, darkly sclerotized, triangle-shaped bars. which encircle the basal cushion (Figs. 4-5).

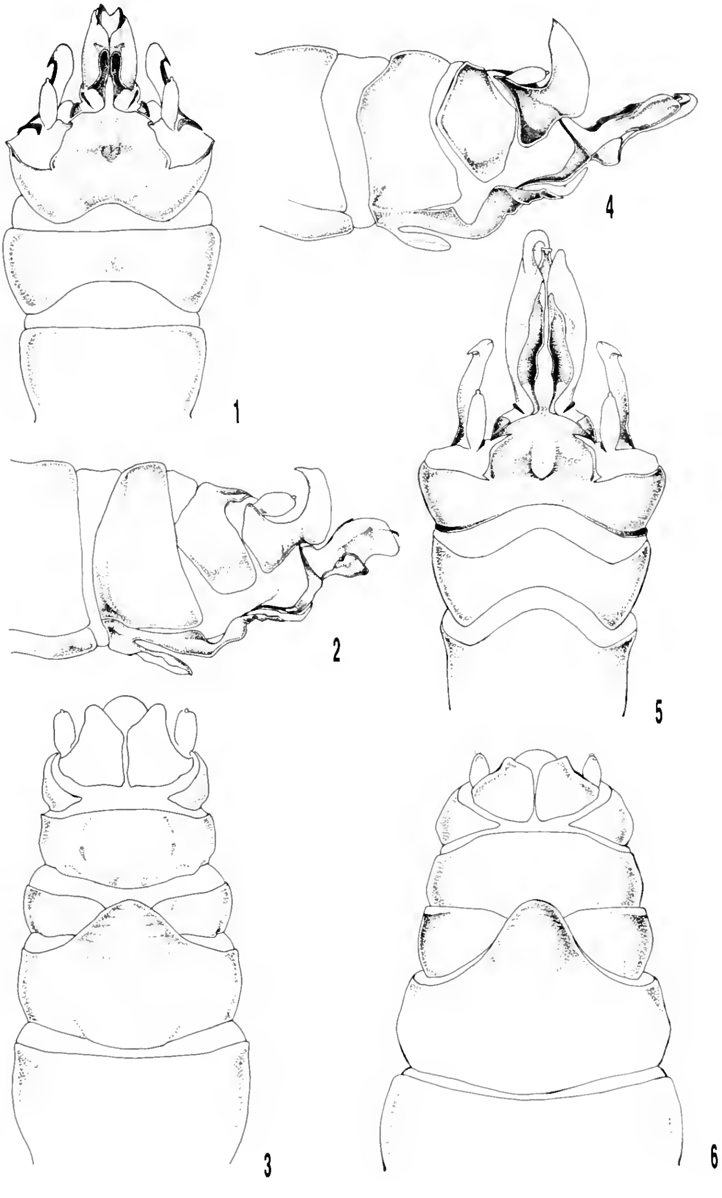
Female. Macropterous. Length of forewings 9.0-10.0 mm; length of body 6.0-8.5 mm. Body, appendages and wings similar to male. Subgenital plate well developed, base broad, extending completely over eighth sternum and to anterior margin of ninth, apex more darkly sclerotized, terminating in a narrowly rounded tip (Fig 6).

Diagnosis. *Soyedina merritti* has a large, broad epiproct which separates it from all other *Soyedina* species. The paraprocts are saber-like with pointed tips and differ trom *S. carolinensis, S. washingtoni,* and *S. vallicularia*, which have blunt tips. *Soyedina kondratieffi* has pointed paraprocts but they are more elongate and sickle-like with a distinctively concave inner margin that ends in a sharply curved apex. In addition *S. kondratieffi* has a short, stout epiproct.

Material. Holotype male, Pennsylvania, Westmoreland County, Maul Spring, Powdermill Nature Reserve, 19 March 1975, R.W. Baumann, O.S. Flint, Jr. and J.L. Sykora, deposited at the United States National Museum, Smithsonian Institution, Washington, D.C. Paratypes: Pennsylvania, Westmoreland Co.: 1 male,.Powdermill Nature Reserve, 3 May 1957 (CMNH); 1 male, 14 March 19??, (CMNH); 1 male, same data as holotype, 21 April 1994, S.A. Grubbs: 4 males and 1 female (allotype), spring-fed stream into Powdermill Run, Powder Mill Nature Reserve, 3-8 April 1993, S.A. Grubbs; 1 male, 1 May 1993, S.A. Grubbs; 3 males and 2 females, 4 April 1994, S.A. Grubbs; 3 males and 2 females, seep into Powdermill Run. Powdermill Nature Reserve, 1 April 1995, S.A. Grubbs, M. Gray and P. Trieu; 1 male and 1 female, seep into Indian Creek, Rt. 381, 1/2 mile north of Rt. 31, 7 April 1995, J.I. Earle and S.A. Grubbs (JEC). Paratypes deposited at the following places: Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah; C.P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, Colorado and the personal collection of S.A. Grubbs.

Etymology. This species is named in honor of Dr. Joseph P. Merritt, Director of the Powdermill Nature Reserve. Dr. Merritt has been an outstanding supporter of the junior authors' research activities.

Discussion. *Soyedina merritti* is presently known only from springs in and near the Powdermill Nature Reserve in Westmoreland County, Pennsylvania. Additional collecting in nearby states could expand the range of this distinctive species.



Figs. 1-3. *Soyedina kondratieffi*. 1. Male genitalia, dorsal view. 2. Male genitalia, lateral view. 3. Female genitalia, ventral view. Figs. 4-6. *Soyedina merritti*. 4. Male genitalia, lateral view. 5. Male genitalia, dorsal view. 6. Female genitalia, ventral view.

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We wish to thank the following individuals and institutions: Jane Earle, Mount Holly Springs. Pennsylvania (JEC); Richard Hoebeke, Cornell University; Boris C. Kondratieff, Colorado State University; Ed Masteller, Behrend College, Pennsylvania State University; Joseph P. Merritt, Powdermill Nature Reserve; Philip Perkins, Harvard University; John Rawlins, Carnegie Museum of Natural History (CMNH); Cecil L. Smith and J. Bruce Wallace, University of Georgia. The illustrations were made by John Bybee.

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FIRST LARVAL DESCRIPTIONS OF TWO SPECIES OF *PARALEPTOPHLEBIA* (EPHEMEROPTERA: LEPTOPHLEBIIDAE)[1]

R. P. Randolph, W. P. McCafferty[2]

ABSTRACT: The larval stages of *Paraleptophlebia assimilis* and *P. jeanae* are described for the first time from specimens associated by rearing male adults. Both species are distinctive as larvae, and mouthpart structure is useful for differentiating them from similar species. Materials examined of *P. assimilis* in Maryland and *P. jeanae* in Indiana extend the known range of both species.

The larval stage of mayfly species is critical not only because it is the life stage most sampled by aquatic biologists, but also because it is often of vital importance to understanding the systematics of mayflies (e.g., McCafferty and Edmunds 1979). Of the 37 species of *Paraleptophlebia* now recognized in North America (McCafferty 1996), three have remained unknown in the larval stage. Based on reared adult-larval associations of two of these latter species present in the Purdue Entomological Research Collection, we are able to provide the first larval descriptions and diagnoses of *P. assimilis* (Banks) and *P. jeanae* Berner.

Paraleptophlebia assimilis (Banks)

Larva. (in alcohol, from last instar exuviae). Body length 7.0-8.0 mm.

Head capsule brown with small, oval, pale medial spot between antennal bases. Antennae brown; pedicel dark brown; articulations with sparse, encircling hairlike setae (articulations in some specimens darker brown). Labrum (Fig. 1) with scattered, long, hairlike setae dorsally; anterior margin densely covered with shorter hairlike setae. Mandibles (Figs. 2, 3) without tusks (apices not extending beyond head margin); one-third of body of mandibles extending beyond lateral margins of head capsule and visible dorsally; incisors of left mandible (Fig. 3) directed medially, at about 45° angle with distal plane. Maxillary palpi (Fig. 4) about as long as galealacinae with segments 2 and 3 together 2.5 times as long as segment 1; segment 3 about 2.0 times as long as segment 2; segments 1 and 2 with very few setae; segment 3 with numerous, long, hairlike setae. Lingua of hypopharynx (Fig. 5) short, about one-half length of superlinguae, only gradually and slightly emarginate apically, slightly rounded laterally. Labium (Fig. 6) with broad basal palpal segments, strongly produced and convex along medial margin; palpal segment 2 less than one-fourth length of segment 3; paraglossae more or less triangular, and setate in apical third.

Thorax brown with pair of pale, circular spots medially on mesonotum anterior to forewingpad bases. Legs brown; femora pale apically and with scattered, long, bristlelike setae dorsally and short, spinelike setae ventrally; fore- and midfemora with pale medial patch dorsally; tibiae and tarsi with row of spinelike setae ventrally (more setae on forelegs than mid- and hindlegs); foreclaws with 13-17 denticles, increasing in size apically.

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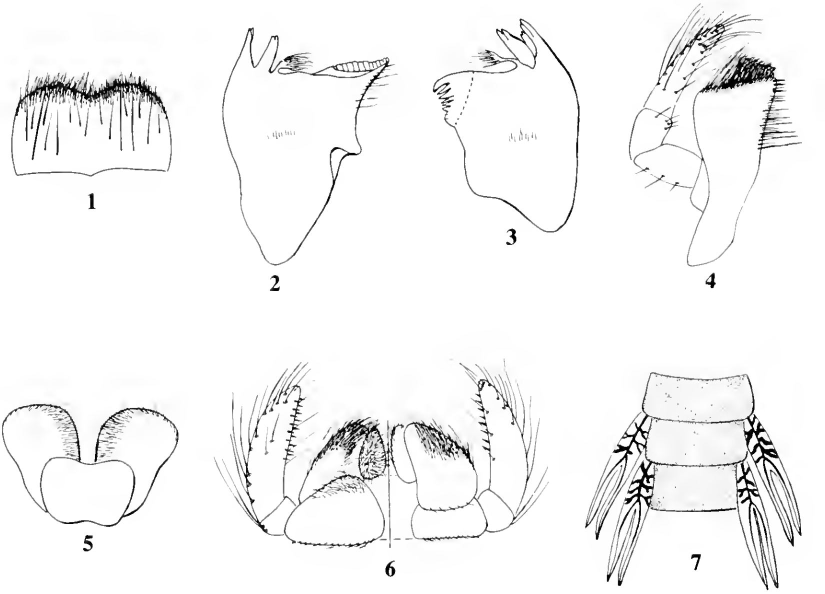
Abdominal terga (Fig. 7) brown with pale, oval area sublaterally on terga 2-8, and with white, oval spot medially within posterior third to one-half and sometimes extending anteriorly on terga 2-8 or 2-9; posterolateral corners of segments 8 and 9 extended into sharp projections. Sterna uniformly brown. Gills on abdominal segment 1 smaller than gills 2-7; all gills (Fig. 7) forked in distal two-thirds or less of length; middle trachea with dark lateral branches. Caudal filaments brown with sparse, hairlike setae at articulations.

Material Examined. Twelve reared specimens (adults with larval exuviae), Maryland, Baltimore Co., tributary to the north-east corner of Loch Raven Reservoir, IV-9, 12, 21-27-1970, R. W. Koss.



Figs. 1-7. *Paraleptophlebia assimilis,* larva: 1. Labrum. 2. Right mandible. 3. Left mandible. 4. Left maxilla. 5. Hypopharynx. 6. Labium (left ventral, right dorsal). 7. Abdominal terga 4-6 and gills 4-5.

DISCUSSION

In present keys to the larvae of *Paraleptophlebia, P. assimilis* will key to couplet 5 of Traver (1935: 515) and couplet 2 of Burks (1953: 90), where *P. adoptiva* (McDunnough) and *P. mollis* (Eaton) are now keyed. This is because of the similarity in gill structure and tracheation (see Fig.7). Larvae of *P. assimilis,* however, can easily be separated from those species because they have posterolateral projections on both abdominal segments 8 and 9. *Paraleptophlebia mollis* and *P. adoptiva* have such projections only on segment 9. On the basis of their gill and terminal abdominal segment characteristics, *P. assimilis* larvae are similar to the larvae of the western species *P. memorialis* (Eaton), which were described by Kilgore and Allen (1973). Abdominal coloration [compare Figs. 10 and 11 of Kilgore and Allen (1973) with Fig. 7, herein] and differences in mouthpart structure, however, easily separate the two species. Based on our study of the previously undescribed mouthparts of *P. memorialis,* we have found that labial palp segments 2 and 3 are subequal in length. In *P. assimilis,* segment 3 is much longer than segment 2 (Fig. 6). Also, the paraglossae and basal palpal segments of the labium of *P. memorialis* are not convex medially as in *P. assimilis.*

Banks (1914) first described the adults of *P. assimilis* (as *Leptophlebia)* from the North Fork of the Swannanoa River, North Carolina. The species has since been collected in South Carolina and Georgia (Berner 1977). The reared specimens reported here from Maryland extend the known range of *P. assimilis* northward, but still within the southeastern region of North America as recognized by McCafferty and Waltz (1990).

Paraleptophlebia jeanae Berner

Larva. (in alcohol, from whole larvae and last instar larval exuviae). Body length 6.0-8.0 mm. Caudal filaments 5.0-7.0 mm.

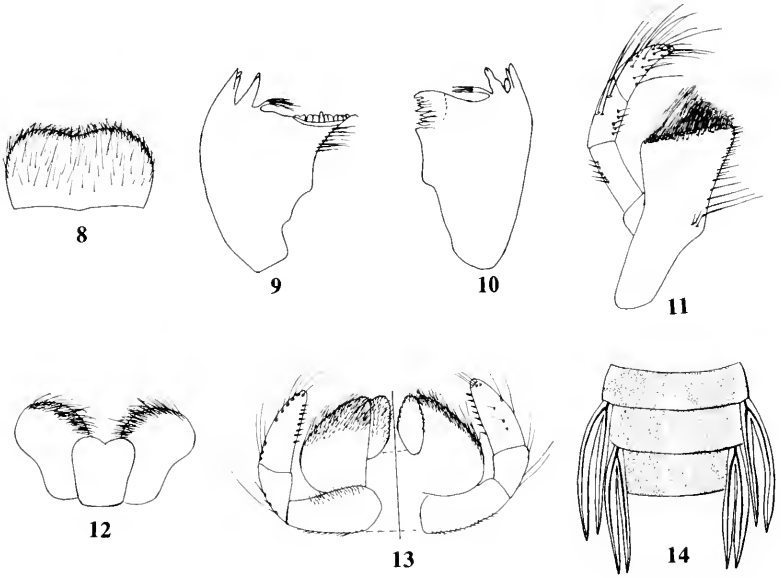
Head capsule brown dorsally, with pale, oval medial spot between antennal bases; black streak between each eye and antennal base; and pale patch posterior to black streak between each lateral ocellus and eye. Eyes of males with upper two-thirds brown and lower third black. Antennae pale; articulations with sparse, encircling, hairlike setae. Labrum (Fig. 8) dorsal surface with scattered, long hairlike setae; anterior margin also densely covered with shorter hairlike setae. Mandibles without tusks (Figs. 9, 10) (apices not extending beyond head margin); one-half of body of mandible extending beyond lateral margin of head capsule and visible dorsally. Maxillary palpi (Fig. 11) about as long as galealacinae; segments 2 and 3 subequal in length, together about 1.33 times as long as segment 1; segment 1 with row of four to six setae on outer margin; segments 2 and 3 with numerous, long, hairlike setae. Lingua of hypopharynx (Fig. 12) about one-half length of superlinguae, with distinct medioapical cleft. Labium (Fig. 13) with basal palpal segments more or less rectangular; palpal segment 2 at least one-half as long as palpal segment 3; segment 3 with numerous scattered, long, hairlike setae, and row of short, stout setae sublaterally.

Thorax with widely scattered black spots, more dense laterally; prothorax with paired, sublateral black streaks extending from posterolateral corner to anterior margin. Legs pale with distinct brown bands basally on tarsus, at articulation of femur and tibia, and in distal half of both femur and tibia; femora and tibiae with scattered, spinelike and hairlike setae dorsally; tibiae and tarsi with scattered, spinelike setae ventrally. Foreclaw with 18-25 denticles, increasing in size apically.

Abdominal coloration variable: abdominal tergum 1 brown; terga 2-9 (Fig. 14) often with paired crescent-shaped pale markings submedially on each tergum; submedial tergal markings less often coalescing, forming larger pale area in posterior area of terga; submedial tergal markings also less often appearing as pair of submedial streaks along entire dorsum of abdomen; lateral margins of abdominal terga 2-9 pale; tergum 10 brown, pale medially. Posterolateral corners of segments 8 and 9 extended into sharp projections. Sterna pale. Gills on abdominal segment 1 smaller than gills 2-7 (Fig. 14); all gills forked at base; trachea without dark lateral branches. Caudal filaments brown with articulations dark brown; each articulation with short, spinelike setae and long, hairlike setae; cerci and median caudal filaments subequal in length.

Material examined. 50 reared specimens (adults with larval exuviae) and 26 larvae, Indiana, Crawford Co., tributary of the Little Blue River, 1 mi. north of English at Hwy. 37, IV-25-1976, A. V. Provonsha and M. Minno; Crawford Co., Stinking Fork Blue River at St. Rd. 66, 1.5 mi. south of Sulfur Springs, V-19, 20-1977, M. Minno and S. Yocum; Harrison Co., Little Indian Creek 3 mi.

east of Corydon, V-10-1973 (one adult male was also collected), V-7-1974, A. V. Provonsha and K. Black; Jennings Co., Green Brook at Crosley St. Fish and Wildlife Area, V-7-1974, A. V. Provonsha and L. Dersch; Lawrence Co., Gullets Creek 1 mi. north of Needmore, IV-25-1975, A. V. Provonsha and M. Minno; Perry Co., Oil Creek approximately 2.5 mi. north of Leopold, IV-25-1976, A. V. Provonsha and M. Minno.



Figs. 8-14. *Paraleptophlebia jeanae,* larva: 8. Labrum. 9. Right mandible. 10. Left mandible. 11. Left maxilla. 12. Hypopharynx. 13. Labium (left ventral, right dorsal). 14. Abdominal terga 4-6 and gills 4-5.

DISCUSSION

In present keys to the larvae of *Paraleptophlebia, P. jeanae* will key with *P. debilis* (Walker) at couplet 9 of Traver (1935: 515) and couplet 7 of Burks (1953: 90). This is because of the similarity of gill structure (Fig. 14), postero-lateral projections on abdominal segments 8 and 9, and brown banding on the legs in *P. jeanae* and *P. debilis. Paraleptophlebia debilis,* the larvae of which were first described by Ide (1930), is widespread and overlaps geographically with *P. jeanae.* Although abdominal coloration may prove to be unreliable to differentiate the larvae of these two species, mouthpart structure will consistently distinguish them. The outer margin of maxillary palp segment of *P. jeanae* (Fig. 11) has a row of setae rather than the setal patch of *P. debilis* [see Fig. 2, page 510 of Traver (1935)]. In addition, segments 2 and 3 of the labial palps of *P. jeanae* (Fig. 13) together are longer than segment 1. In *P. debilis,* labial palp segment 2 and 3 together are subequal to segment 1. Also, the inner margin of the paraglossae (Fig. 13) is straight rather than concave as in *P. debilis.*

Since the keys of Traver and Burks appeared, larvae of *P. altana* Kilgore and Allen (1973), *P. placeri* Mayo (1939), and *P. quisquilia* Day (1952) were described from California. All three larval descriptions were incomplete, but these species do apparently have at least gills and abdominal segments 8 and 9 similar to those of *P. jeanae* and *P. debilis.* Further study of these California species will be required to properly diagnose their larvae from those of other species, including *P. jeanae.* In the meantime, their disparate distribution will provisionally differentiate them from *P. jeanae.*

Berner (1955) first described *P. jeanae* from male adults collected at Sumter Co., Alabama and Amherst Co., Virginia. Since then, adults have been reported only from South Carolina (Berner 1975). The specimens of *P. jeanae* studied here are from southern Indiana, significantly extending the range of the species northward into the extreme southeastern part of the northeast North America region of McCafferty and Waltz (1990).

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EMENDATIONS TO THE *CALLIBAETIS* (EPHEMEROPTERA: BAETIDAE) OF SOUTH AMERICA[1,2]

W. P. McCafferty[3]

ABSTRACT: *Callibaetis opacus*, comb. n. is shown to be the senior synonym of *C. zonalis*. *Callibaetis trifasciatus* is verified to be a junior synonym of *C. fasciatus*, but is not a junior synonym of *C. sellacki*, although specimens of *C. sellacki* have been misidentified as *C. trifasciatus*. *Callibaetis nigrivenosus* is an emendation of *C. nigrivenosa*, which was incorrectly formed. No emendation of the name *C. pollens* is apparently necessary.

The generic makeup of Neotropical Baetidae is just beginning to be known (e.g., Lugo-Ortiz and McCafferty 1995, 1996), and species of most genera remain relatively poorly known. The genus *Callibaetis* Eaton, however, is one of the better known speciose genera at this time due to the recent work of Gillies (1990), wherein he presented a partial species revision based on examination of many of the type specimens and other materials of enigmatic South American species described by the Spanish Jesuit Longinos Navás. Gillies (1990) treated 11 of the 14 South American species of *Callibaetis* that are considered valid at this time, and regarded one other, *C. abundans* (Navás), as a *nomen dubium*. This work was based on alate stages because all types examined were adults, and the larvae of South American *Callibaetis* remain very poorly known. Some additional emendations and observations regarding *Callibaetis* of South America are necessary with respect to species nomenclature and synonymies.

EMENDATIONS AND OBSERVATIONS

Gillies (1990) recognized *C. zonalis* Navás, 1915 (known from Argentina, Brazil, and Paraguay) as a valid species and correctly associated several synonyms with it, including *Baetis opacus* Navás, 1915. Both of the latter names were described in the same paper by Navás (1915), but *B. opacus* has page priority (page 12) over *C. zonalis* (page 13). Neither of these names, nor the many other synonyms associated with this species, are well established. *Callibaetis opacus*, n. comb. becomes the valid name, as the senior synonym [= *Baetis virellus* Navás, *Callibaetis amoenus* Navás, *C. apertus* Navás, *C. depressus* Navás, *C. sobrius* Navás, *C. vitreus* Navás (1915), *C. vitreus* Navás (1919), *C. zonalis*]. The rather remarkable synonymic homonyms represented by *C. vitreus*

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Navás, both 1915 and 1919, were discussed by Hubbard and Edmunds (1977).

Gillies (1990) considered *C. trifasciatus* Esben-Petersen, 1912 to be a new junior subjective synonym of both *C. fasciatus* (Pictet 1843) (known from Argentina, Brazil and Chile) and *C. sellacki* (Weyenbergh 1883) (known from Argentina and Chile). I agree that Esben-Petersen's (1912) description and type concept of *C. trifasciatus* is clearly referable to *C. fasciatus,* but the name *C. trifasciatus* is not synonymous with *C. sellacki.* Some specimens referred to, or identified as, *C. trifasciatus* in the past by such workers as C. Bruch and L. Navás are indeed misidentifications of *C. sellacki* (Gillies 1990). However, these should be considered only misidentifications under the synonymy of *C. sellacki,* and the names *C. trifasciatus* and *C. sellacki* are not technically synonymous. Any future possible designation of a lectotype or neotype of *C. trifasciatus* should certainly coincide with Esben-Petersen's published concept of that name.

The name *C. nigrivenosa* Banks, 1918, which is referable to an Ecuadorian species of *Callibaetis,* was incorrectly formed by Banks (1918) and should be emended to *C. nigrivenosus.* The Latin word "venosus" is adjectival (transl. veiny), and therefore must agree in gender with the masculine genus group name.

Finally, there evidently has been some confusion as to the valid specific epithet of the Brazilian species *C. pollens* Needham and Murphy, 1924. The original name published by Needham and Murphy (1924) is spelled "pollens", however, it appears as "pallens" in Hubbard's (1982) list of South American mayflies. Hubbard's spelling cannot be regarded as a demonstrably intentional emendation because the original spelling was not cited. In an offprint of the Needham and Murphy (1924) paper that was owned by J. Traver but which I now have in my possession, an "a" is penciled over the "o" in "pollens" in her handwriting wherever that name appears in that paper. I have not, however, been able to locate any published attempt to emend that name officially. The name was not mentioned in Traver's (1944) review of Brazilian mayflies. Needham and Murphy (1924) did not give the etymology of their name, and admittedly the word "pallens" [if derived from the Latin "pallidus" (transl. pale)] does appear to be a more logical name than "pollens". Nonetheless, "pollens" does not require emendation because it can be regarded as a non-Latin name, based on the English word, and therefore indeclinable and not contravening rules of Latin name formation.

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SCIENTIFIC NOTE

SOUTH AMERICAN COCCINELLIDAE (COLEOPTERA) PART III: CORRECTION AND ADDITION[1]

Robert D. Gordon[2]

Part III of the South American Coccinellidae series (Gordon 1994) in which the tribe Coccidulini was revised must have the title changed to "Part IV" and the genus *Zenoria* Mulsant must be accounted for in the tribal classification.

A revision of the genus *Delphastus* (Gordon 1994), another part of that series, was in press at the same time in another journal and was inadvertently assigned the same part number. Therefore "South American Coccinellidae (Coleoptera). Part III: definition of Exoplectrinae Crotch, Azyinae Mulsant, and Coccidulinae Crotch: a taxonomic revision of Coccidulini" is corrected to read "South American Coccinellidae (Coleoptera). Part IV: ————."

In the same publication the tribe Ortaliini Mulsant and the genus *Zenoria* Mulsant were omitted from the tribal and generic list on page 687. *Zenoria* is the only South American representative of Ortaliini.

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THE OCCURRENCE OF *NITIDULA FLAVOMACULATA* (COLEOPTERA: NITIDULIDAE) ON A HUMAN CORPSE[1]

Thomas W. Adair[2], Boris C. Kondratieff[3]

ABSTRACT: We report the infestation of a human corpse by the Palearctic nitidulid beetle *Nitidula flavomaculata* in Adams County, Colorado. The human corpse was discovered in early January. This introduced beetle may have become a member of the cold-season carrion community, previously dominated by a fly, the cheese skipper, *Piophila casei,* along the Front Range of Colorado.

Under various environmental conditions, a human corpse is colonized by an array of necrophagous and saprophagous arthropods, particularly insects. This succession of species has been described or reviewed by many authors, including Leclercq (1969), Nuorteva (1977), Rodriguez and Bass (1983), Simpson (1985), Smith (1986), Catts and Haskell (1990), and Goff and Flynn (1991). During the warm months of the year, flies (Diptera) are the major initial decomposers. Species of Calliphoridae (blow flies) and Sarcophagidae (flesh flies) are known as important forensic indicators (Greenberg 1991). A wide variety of insects besides these flies colonize a corpse, including beetles. Specific beetles (*e.g.* species of Cleridae, Dermestidae, Histeridae, Nitidulidae, Scarabaeidae, Silphidae and Staphylinidae) that feed on carrion have been documented by Morley (1907), Payne and King (1970), Crowson (1981), and Shubeck *et al.* (1981).

A clothed, partially decayed human female corpse was discovered on January 11, 1996 in a field in Thornton, Adams County, Colorado. An examination of the body revealed numerous puparia containing pharate adults of the black blow fly, *Phormia regina* (Meigen) and the larvae of the cheese-skipper, *Piophila casei* (L.) (Diptera: Piophilidae). The piophilid larvae were found in the head and shoulder area of the corpse. Also found were large numbers of Nitidulidae larvae in the genital area of the victim. An adult beetle was recovered during the autopsy. Larvae were collected and reared on chicken livers, and the subsequent adult beetles were identified as the Palearctic *Nitidula flavomaculata* Rossi.

The presence of pre-emergent *P. regina* adults in puparia at the crime scene indicated the victim was left in the field sometime during the last two weeks of

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September or early October. The average minimum developmental time of *P. regina* under ideal temperature conditions is about 14-16 days along the Front Range of Colorado. Air temperature records provided by the City of Northglenn Water Treatment Plant, 5.6 km from the crime scene indicated that after October 21, 1995, adult blowfly egg laying activity or emergence would have ceased for the remainder of the season. Based on the temperature data, a three week window where temperatures averaged 13°C occurred in the last two weeks of September or early October. Subsequent air temperatures probably precluded any blowfly activity. Following the identification of the victim, it was determined that she was reported missing on September 20, 1995.

Our collection is the first report of *N. flavomaculata* on a human corpse. This species is a native of Europe and has also been reported from North Africa, the Near East and the U.S. (Parsons 1943). The senior author also collected *N. flavomaculata* from exposed pig carcasses at the Highlands Ranch Law Enforcement Training Facility P.I.G. site. Individual beetles were collected in July, August, and January 1996 (5, 6, and 11 months after carcass deposition, respectively).

This record of *N. flavomaculata* adds an additional species to the cold-season carrion community along the Front Range of Colorado. Generally during the winter (November through April), exposed corpses are colonized only by *P. casei* and occasionally by several species of *Dermestes.*

Nitidulids or "sap-beetles" are well-known as important members of the carrion feeding community (Payne 1965 and Shubeck *et al.* 1981). In Shubeck's *et al.* study, nitidulids comprised over 35% of all beetles collected from the carrion. The most common species was *Omosita colon* (L.), an introduced Eurasian or Holarctic species. Both *Nitidula* and *Omosita* are associated usually with the decay and dry stages of carcasses (Edwards 1949, Reed 1958, Payne and King 1970). Both genera feed on fluids exuding from decomposing carrion (Shubeck *et al.* 1981). Additionally, adults of carrion feeding Nitidulidae have been reported to become more abundant later in the season (Reed 1958, Payne 1965). Nitidulids have been previously recorded from human corpses (Rodriquez and Bass 1983). *Nitidula bipunctata* (L.) has been found associated in Europe with carrion, including human corpses (Zacker 1927, Kemper 1939).

We present an illustration (Fig. 1) of the habitus of *N. flavomaculata* to aid other workers in the identification of this species. Illustrations of other nitidulid species mentioned are available in Hinton (1945) and USDA (1991). Specimens of *N. flavomaculata* are deposited in the C. P. Collection of Arthropod Diversity, Colorado State University.

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The authors are grateful to Dr. Stephen W. Bullington, Falls Creek, PA and Dr. Richard E. Johnsen, Colorado State University for reading a draft of this paper. Lynn C. Bjork, Larval Fish Laboratory, Colorado State University provided the illustration.

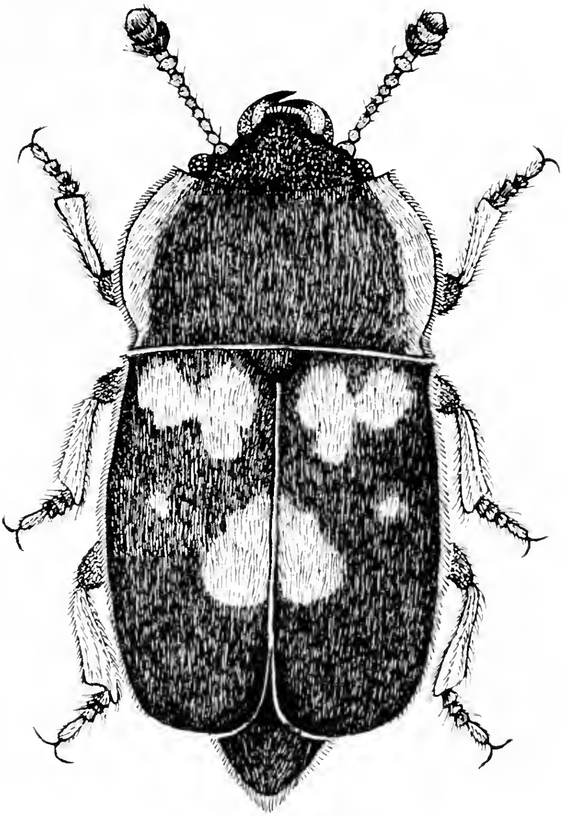

Figure 1. *Nitidula flavomaculata* Rossi, habitus, length 4.5 mm.

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NEW RECORDS OF EPHEMEROPTERA, PLECOPTERA AND TRICHOPTERA FROM ALABAMA[1]

Steve C. Harris[2], Boris C. Kondratieff[3], Bill P. Stark[4]

ABSTRACT: Eleven mayfly, three stonefly and eight caddisfly species are newly recorded for Alabama. Additionally, nomenclatorial changes are given that resulted from recent revisions to previously available Alabama species lists.

In the intervening years since publication of the initial checklists of mayflies (Kondratieff and Harris 1986), stoneflies (Stark and Harris 1986), and caddisflies (Harris *et al.* 1991) from Alabama, additional collecting throughout the state by SCH and his graduate students and colleagues has revealed several new distribution records. This paper reports new state records in these groups with annotated notes on their occurrence and taxonomy.

Ephemeroptera

Kondratieff and Harris (1986) reported 112 species of mayflies from Alabama. Wester and Folkerts (1987) added the tuskless burrowing mayfly *Dolania americana* Edmunds and Traver from Escambia Co. Also, numerous nomenclatorial changes have been published since the 1986 list. Specimens are deposited in the C. P. Gillette Museum of Arthropod Diversity, Colorado State University.

New State Records

Siphlonuridae

Siphlonurus mirus: Eaton (Cleburne Co.). This large and beautiful species is widely distributed from Atlantic Canada to Georgia.

Baetidae

Baetis flavistriga McDunnough (Calhoun Co.). A transcontinental species, but apparently more common in mountain ranges (McCafferty and MacDonald 1994), including the Appalachians (Morihara and McCafferty 1979). Lenat and Penrose (1987) recorded *B. flavistriga* as a common and pollution tolerant species in North Carolina.

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Heptageniidae

Rhithrogena anomala McDunnough (Talladega Co.). This species has been previously recorded from Quebec, New York and Virginia (Traver 1935, Kondratieff and Voshell 1983).
Stenonema carlsoni Lewis (Coosa Co.). Bednarik and McCafferty (1979) considered this species an upland form and more southerly distributed than its close relative *S. pudicum* (Hagen). *Stenonema carlsoni* was previously known from Georgia, Kentucky, South Carolina, Tennessee and Virginia.
Stenonema vicarium (Walker) (Cherokee Co., DeKalb Co.). This mainly upper midwestern and northeastern North America species previously was known along the Appalachians to North Carolina (Bednarik and McCafferty 1979).

Leptophlebiidae

Paraleptophlebia mollis (Eaton) (Cleburne Co.). Berner (1975) noted that this more northeastern North American species was listed from North Carolina by Traver (1937). The Alabama record represents a significant southern range extension.
P. moerens (McDunnough) (Jackson Co.). As Berner (1975) noted, this species has been rarely collected in the southeast. Nearby records are from Georgia and North Carolina.
P. praepedita (Eaton) (Hale Co.). This species was not included by Berner (1975) in his review of southeastern species. It is considered a northeastern and midwestern North America species (Burke 1953).

Caenidae

The excellent revision of *Caenis* by Provonsha (1990) allows species determination of this formerly difficult genus.
Caenis punctata McDunnough (Henry Co.). Previously unknown from the southeast, Provonsha (1990) recorded this species from the surrounding states of Florida, North Carolina, South Carolina and Tennessee.
Caenis macafferti Provonsha (Chilton Co.). This species was described from South Carolina and is known from Arkansas, Florida, Georgia, New York, Pennsylvania and Virginia.

Provonsha (1990) recorded *C. latipennis* Banks from Dallas Co. and Limestone Co. He also synonymized *C. jocose* McDunnough with C. *latipennis*. We have additional specimens from Wilcox Co. Provonsha (1990) also regarded *C. simulans* McDunnough a synonym of *C. amica* Hagen.

Baetiscidae

Baetisca laurentina McDunnough (Fayette Co.). Pescador and Berner (1981) previously listed this species from the surrounding states of Florida and Mississippi.

Taxonomic changes

McCafferty and Waltz (1990) provided the following nomenclatorial changes in their review of North American Baetidae:
Centroptilum fragile McDunnough = *Procloeon fragile*
C. hobbsi Berner = *Procloeon hobbsi*
Cloeon rubropictum McDunnough = *Procloeon rubropictum*
C. viridocularis Berner = *Procloeon viridocularis.*
Cloeon alamance (Traver) = *Centroptilum alamance*
Pseudocloeon bimaculatum Berner = *Baetis bimaculatus*
P. dubium McDunnough = *Baetis dubius*
P. parvulum McDunnough = *Baetis armillatus* McCafferty and Waltz

P. punctiventris McDunnough = *Baetis punctiventris*
P. carolina Banks = *Acentrella turbida* (McDunnough) (McCafferty *et al.* 1994).

McCafferty and Bae (1990) proposed the genus *Anthopotamus* for North American species formerly placed in *Potamanthus*. Bae and McCafferty (1991) added *A. myops* from Alabama (Jackson Co.).

A total of 121 species of mayflies are now known from Alabama. In comparison with nearby states, Kondratieff and Voshell (1983) listed 138 species from Virginia, and Berner and Pescador (1988) reported 71 species from Florida. As Kondratieff and Harris (1986) indicated, the range of physiographic regions found in Alabama allows for a rich diversity of mayfly species.

Plecoptera

Stark and Harris (1986) reported 71 stonefly species from Alabama. Since this time, published records have added two additional stonefly species. Stark and Lentz (1988) described *Neoperla harrisi* from Colbert and Lauderdale counties, and Young *et al.* (1989) reported *Ostrocerca truncate* (Claassen) from DeKalb Co. The following three new state records are reported: *Neoperla catharae* Stark and Baumann, *Acroneuria carolinensis* (Banks), and *A. frisoni* Stark and Brown. New nomenclatural changes are also included. All these changes, reported below, bring the current list of Alabama stoneflies to 76 species.

New State Records

Perlidae

Acroneuria carolinensis (Banks) (Autauga Co., DeKalb Co., Marion Co.). This large and widely distributed species is particularly common in the southern Appalachian region of Tennessee and the Carolinas. Its discovery in Alabama is not surprising.
Acroneuria frisoni Stark and Brown (Lauderdale Co., Limestone Co.).
This species was previously known as *A. evoluta* Klapalek (*sensu* Frison 1942), but it had not been reported from Alabama. *Acroneuria frisoni* is common in the midwestern states and into the Ozarks (Stark and Gaufin 1976), but these are the southernmost records of this species from east of the Mississippi River.
Neoperla catharae Stark and Baumann (Colbert Co.). This species is found primarily in the midwestern states, but occurs as far west as Oklahoma and as far east as Virginia. Stark (1990) reported this species from south central Tennessee.

Taxonomic Changes

Four species listed by Stark and Harris (1986) are now known by different names as a result of taxonomic revisions. These include:
Acroneuria mela Frison = *Acroneuria evoluta* Klapalek. Stark and Brown (1991) found the holotype of *A. evoluta* to be consistent with the species known as *A. mela.* The species known as *A. evoluta* (*sensu* Frison 1942 and Stark and Gaufin 1976) was then renamed *A. frisoni.*
Neoperla freytagi Stark and Baumann = *Neoperla occipitalis* (Pictet). Zwick (1987) examined the

type of *N. occipitalis*, previously considered synonymous with *N. clymene* and found it to be distinct. Stark (1990) placed *N. freytagi* as a synonym.
Perlinella fumipennis Walsh = *Perlinella zwicki* Kondratieff, Kirchner and Stewart. Kondratieff *et al.* (1988) found *P. fumipennis* to be a synonym of *P. ephyre* and proposed *P. zwicki* as a new name for the distinctive southeastern species regarded as *P. fumipennis* by Zwick (1971).
Hansonoperla appalachia Nelson = *Hansonoperla cheaha* Kondratieff and Kirchner. Kondratieff and Kirchner (1996) revised *Hansonoperla* and proposed the name *H. cheaha* for the distinctive species known from Cleburne Co.

Trichoptera

Harris *et al.* (1991) reported 342 species of caddisflies from Alabama, including notes on distribution within the state. Eight new state records follow with notes on their range throughout North America. Specimens are deposited at the Department of Biology, Clarion University.

Hydroptilidae

Hydroptila jackmanni Blickle (Lauderdale Co.). This species is primarily north central in distribution, with Virginia representing its previous southernmost limit (Parker and Voshell 1981). This record from northern Alabama extends the southern range of this species considerably.
Oxyethira aculea Ross (Tuscaloosa Co.). A southwestern species recorded from Arizona, New Mexico, Oklahoma and Texas; it's occurrence in Alabama is a significant range extension. A single male was collected in March from a small, springfed stream.
Oxyethira parce (Edwards and Arnold) (Bibb Co.). Another southwestern species previously recorded from Texas south to Chile. One specimen was collected from a small stream in central Alabama; a significant eastern range extension.

Lepidostomatidae

Lepidostoma compressum Etnier and Way (DeKalb Co.). Previously recorded from Tennessee, the occurrence of this species in northern Alabama is not unexpected.
Lepidostoma ontario Ross (Cleburne Co.). A widespread eastern species; this record from northern Alabama represents its southernmost range extension.

Limnephilidae

Pycnopsyche guttifer (Walker) (Jackson Co.). A widespread species in central and eastern North America, including the southeastern United States. Its occurrence in northern Alabama is not surprising, with records from Tennessee, Georgia, and Florida.

Polycentropodidae

Polycentropus interruptus (Banks) (Tuscaloosa Co.). Similar to the preceding species in distribution. In the southeast there are records from Tennessee and Florida, so its occurrence in Alabama is not unexpected.

Rhyacophilidae

Rhyacophila formosa Banks (Bibb Co.). In Harris *et al.* (1991), the presence of this species in Alabama was listed as tentative, based on larvae collected by D. Etnier. The record of this widespread eastern species is now confirmed with the collection of seven males from the same larval locality.

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NEW RECORD AND RANGE EXTENSION FOR *ANISOCENTROPUS PYRALOIDES* (TRICHOPTERA: CALAMOCERATIDAE) FROM WEST VIRGINIA[1]

Donald C. Tarter[2], Eric S. Wilhelm[2], Jeffrey E. Bailey[3], Michael K. Nowlin[3]

ABSTRACT: The caddisfly *Anisocentropus pyraloides* is recorded for the first time from West Virginia. This record represents a northwest extension of the known range which was previously limited to the coastal plain and lower Piedmont at the northern end of its range. Larvae were collected from the Meadow River (Greenbrier County) among snags (e.g. logs) using a standard D-frame dip net. The number of caddisfly species now known from West Virginia is 191.

The family Calamoceratidae shows a tropical and subtropical distribution throughout all faunal regions (Wiggins, 1977) with the genus *Anisocentropus* occurring in the West Indies, Central America, Australia, and several oriental countries (Ross, 1967; Fischer, 1965). However, in North America the genus *Anisocentropus* has only one recognized species, *A. pyraloides* (Walker). Prior to this record, *A. pyraloides* was known from Florida, Georgia, South Carolina, Delaware, and Tennessee (Wallace and Sherberger, 1970; Edwards, 1966; and Wiggins, 1977). Generally, the species was limited to the coastal plain and lower Piedmont at the northern end of its range (Flint, pers. com.). Larvae and pupae of *A. pyraloides* were described from Georgia by Wallace and Sherberger (1970).

Larval collections were made in the main channel of the Meadow River, within the Meadow River wetland complex (latitude 37° 33'41" N, longitude-80° 24'39" W) in Greenbrier County, West Virginia. The river channel at this site has a mean width of 11 m and a mean depth of 1 m; the elevation is 732 m. The following water quality parameters were recorded at the time of collections: temperature 11.3 C; pH = 6.1; conductivity 175 micromhos; dissolved oxygen 1.9 mg/L; acidity 7 mg/L; alkalinity 11.0 mg/L $CaCO_3$; hardness 66 mg/L $CaCO_3$; sulfate 42.0 mg/L; dissolved solids 87.0 mg/L; total phosphates 0.016 mg/L; NH_3 -N 0.32 mg/L; and NO_2-NO_3 2.04 mg/L.

Eighteen larvae were collected on 13 October 1994 from among snags (submerged woody debris/logs) using a standard D-frame dip net (700 micron mesh). Logs were sampled by scraping the net along the surface. According to Wallace and Sherberger (1970), *A. pyraloides* larvae prefer smaller streams, 1-6 m wide with slow to moderate current, that are usually bordered by deciduous forest. They found larvae in streams ranging from 12-300 m in elevation in the south-

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east. Early instar larvae appear to be associated with leaf drifts and late instars with logs and rocks (Wallace and Sherberger, 1970).

The Meadow River wetlands comprise the second largest wetland complex in West Virginia, containing approximately 1392 ha (3131 acres) of swamp and wet meadow (Evans *et al.*, 1982). The wetlands are situated in the western end of Greenbrier County at the southern boundary of the Allegheny Mountain physiographic section of West Virginia (Strausbaugh and Core, 1978).

Following the addition of *Anisocentropus pyraloides* to the state checklist, 191 species of caddisflies, representing 16 families and 62 genera, are known from West Virginia (Stout and Stout, 1989; Tarter, 1990; Tarter and Sykora, 1990; Tarter and Kirchner, 1991; and Griffith and Perry, 1992).

ACKNOWLEDGMENTS

The authors are grateful to Oliver S. Flint, Jr. of the United States National Museum for identification of the caddisfly, and to Lu Ann South for typing the manuscript. Additionally, we thank Dean Adkins and Mike Little for reviewing the manuscript, and to Erica Midkiff for library research. All specimens were deposited in the West Virginia Benthological Survey at Marshall University.

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A MINUTEN PROBE FOR SMALL ORGANISMS[1]

Jorge A. Santiago-Blay[2], Claudia E. Ayala[3]

Careful dissection of small organisms requires fine tools. In doing classical and molecular genetics, we have been constantly challenged to dissect-out portions of the body, either to make observations or to remove alleged excessive amounts of inhibitors that reduce DNA polymerase activity in PCR (Do and Adams 1991, Fang *et al.* 1992, Gelfand 1989). By combining our backgrounds in organismic and molecular biology, we designed an easy-to-build and durable probe (Fig. 1) that has helped us perform good dissections. We call it the minuten probe.

To build a minuten probe, simply take a p20 pipet tip (cost approx. $0.03 US dollars per tip) and carefully melt its tip with the flame of a Bunsen burner or an alcohol lamp. Using fine forceps, promptly insert a stainless steel minuten (cost approx. $0.03 US dollars per minuten) in the melted tip and let them cool as this assures a firm grip of the minuten to the plastic. We have built up to five probes per minute. The stiffness of the minuten probe can be varied with the depth of penetration of the minuten into the pipet tip. The probe can be connected to a wooden stick (cost approx. $0.10 US dollars per stick) that serves as a handle. Total cost, approx. $0.15-0.20 US dollars, excluding labor.

The minuten probes are sterilizable (flaming has to be done carefully to prevent remelting of the pipette tip or damaging the wooden stick). The minuten

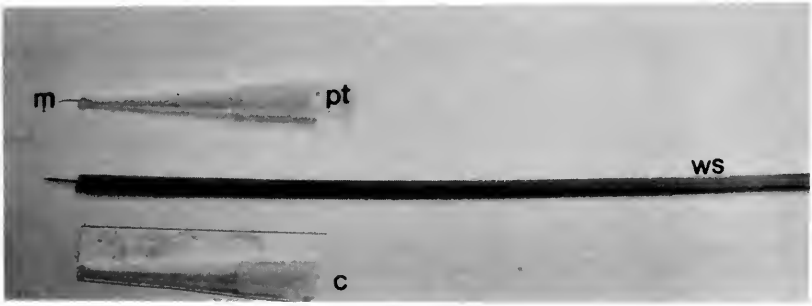

Fig. 1. Minuten probe. Pipet tip (**pt**), minuten (**m**), wooden stick (**ws**). Minuten can be protected with an additional pipet tip that serves as cap (**c**).

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does not need to be epoxied to the pipette tip, which takes hours to dry, or placed in metal pin-holders, which cost at least $8.00 US dollars each. Furthermore, since minutens are already quite fine (approx. 0.15-0.20mm) and about half or more of them are sold with one end already tapered to a point, a DC power supply, KOH solution, and a fume hood (Norton and Sanders 1985) may not be needed. In six months, we have not seen signs of corrosion or flaking in our probes.

ACKNOWLEDGMENTS

Our colleague and professional photographer, Patrick R. Craig, Monte Rio, A, kindly took the photograph. Gerald Larson and Carol Turner, Bio-Quip, Gardena, CA, provided insights into the nature of minutens.

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REVIEW

NEW CATALOGS ON WORLD ORTHOPTERA

ORTHOPTERA SPECIES FILE, NUMBERS 1-5

by Daniel Otte

Publications on Orthopteran Diversity. Orthopterists' Society and The Academy of Natural Sciences, Philadelphia, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, U.S.A. 1994-1995, ISBN 0-9640101-1-9 (Series). No prices listed.

Before discussing the contents of each of the five numbers (volumes), I wish to mention my impressions of the value of the series. This is the first time that the literature on orthopteroids has been brought together in a single series and will be indispensable for research workers on orthopteroid insects in the future. I have used it quite extensively and have found it to be an invaluable tool in research. The general arrangement is good and easy to follow. I recommend it highly. Every library and research establishment should have it.

The five numbers are presented in attractive style with soft plasticized covers, each with illustrations by the author on the front cover and on Numbers 1 and 3 also on the back cover. Each of the illustrations depicts a species included in that number.

All categories, family, subfamily, tribe, genus and species are included. Some orthopterists, including myself, do not agree with the major classification but this does not affect the value of the series as the emphasis is, as the overall title indicates, on the species, not on higher categories.

The entire series is computerized and the text is computer generated. Generic names used alone are CAPITALIZED and in **bold face type**; when used in conjunction with a species name they are in lower-case **bold face,** as are valid species names. All generic names when used alone are preceded by a blank line. The type species are given for genera, and for species the holotypes, type localities and type depositories are included. Synonyms are in *italics*; other data are in lower-case Roman type. For each species, all of the known references are given, with the author surname, title and year of publication, volume and page numbers. The original genus in which a species was described is given in *italics* if different from that in which it is now considered to belong. The type font is small, in order to include maximum data in minimum space, but is not so small as to cause difficulties to readers.

Number 1, Orthoptera Species File 1. "Crickets (Grylloidea)". 126 pages, 1994. ISBN 0-9640101-2-7. The size of this number is 8-1/2 X 11 inches, different from the succeeding numbers. The covers are black with illustrations of *Matuanus elegans* Otte (front) and an unnamed species on the back cover. It has 126 pages, 6 unnumbered preliminary pages, 100 pages of text and 19 pages of Index. Each page includes about 94 lines.

All (or nearly all) of the known species of crickets are included. It is inevitable, for a number of reasons, that less than 100% of the references would be found. The computerized format makes the addition of these rather easy as they become known and a 6 page insert in the number adds many species, newly described after the number was printed.

ENT. NEWS 107(4) 247-248, September & October, 1996

Number 2, Orthoptera Species File 2. " Grasshoppers [Acridomorpha] A Eumastacoidea, Trigonopterygoidea, Pneumoroidea". ISBN 0-9640101-3-5. June, 1994. 169 pages: vii preliminary pages, including Contents, Acknowledgements, Introduction, Type depositories, and Abbreviations and Notations, 145 pages of text and 16 pages of index.

The size of this and succeeding Numbers is 6 X 9", a convenient size for handling and shelving. The shorter size has about 55 lines per page. The green cover is illustrated with an unnamed eumastacid grasshopper. The style and treatment of taxa is the same as in Number 1.

Pages 1-109 cover the Eumastacoidea; 110-133 deal with the Proscopiidae; 134-137 with the Trigonopterygidae, 138-143, and single pages are devoted to the small families Tanaoceridae (144) and Xyronotidae (145).

Number 3, Orthoptera Species File 3. "Grasshoppers [Acridomorpha] B, Pamphagoidea". ISBN 0-9640101-4-3. October, 1994. vii + 1-241 pp. The preliminary pages contain similar sections as in No. 2. The cover is burgundy in color and has an illustration of an unnamed pyrgomorphid grasshopper.

Most of the volume (141 pages) covers the Family Pyrgomorphidae, which is subdivided into two subfamilies with 31 tribes. The Pamphagidae is dealt with in pages 142-206; the Ommexechidae on pages 207-214; the Charilaidae on pages 215-216; and the Lathiceridae on pages 217-218. The index is on pages 219-241.

Number 4. Orthoptera Species File 4. "Grasshoppers [Acridomorpha} C, Acridoidea, including Lentulidae, Paulinidae, Tristiridae, Romaleidae and Acrididae (part)". ISBN 0-9640101-5-1. February 1995. vii + 518 pages. The preliminary pages contain the sections as in other numbers. The cover is blue and bears an attractive illustration of an unnamed grasshopper.

The Lentulidae and other smaller families are dealt with in the first 69 pages. The greatest part of the volume covers part of the vast Family Acrididae (Acridoidea of some authors). An index is included on pages 457-511. Following the index is an addendum, pages 512-518, containing taxa and records added to the computer database after this volume went to press.

Number 5. Orthoptera Species File 5. "Grasshoppers [Acridomorpha] D, Acridoidea: Acrididae (part)". "ISBN 0-9640101-6-X. May 1995. vii + 630 pages. The preliminary sections are as in the previous numbers. The cover is brown bearing an illustration of a band-winged grasshopper.

All of the remaining subordinate taxa of the Acrididae (Acridoidea of some authors) are included in this volume, completing the species of the "Caelifera" (or "Orthoptera *sensu stricto*"). The Coptacridinae, which is included in Number 4, is repeated and greatly expanded in this volume. The index, pages 467-630, covers all of the four numbers (volumes) and is a complete index to the entire group, the only index needed for Numbers 2 to 5. In addition, on page 456, is a short addendum to OSF 2.

Finally, I wish to express my admiration to Dan Otte and his helpers for this tremendous upgrading of the accessibility to data concerning this section of the orthopteroid insects. I hope the series will be continued to include all of the remaining taxa, those of the "Ensifera" ("Grylloptera").

Vernon R. Vickery, Emeritus Curator,
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NTOMOLOGICAL NEWS

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THREE NEW SPECIES OF *AMPHINEMURA* (PLECOPTERA: NEMOURIDAE) FROM EASTERN NORTH AMERICA[1]

R. W. Baumann[2]

ABSTRACT:: Descriptions of three new species of *Amphinemura* (Plecoptera: Nemouridae) from eastern and southern United States are presented. Illustrations of male and female genitalia are provided. Distributional records are given for each species.

During a study of the Nemouridae fauna of eastern North America, three previously undescribed species of *Amphinemura* were discovered. One species is only known from Alabama and a second species is recorded from a limited geographical region of Texas and Louisiana. However, the third species is distributed along the Appalachian Mountains from Pennsylvania south to Georgia. This paper presents the descriptions of these species and compares them with similar *Amphinemura* species found in eastern North America.

Amphinemura alabama, NEW SPECIES

(Figs. 1-3)

Male. Macropterous. Length of forewings 6.0-6.5 mm; length of body 5.0-5.5 mm. Body and wings brown, wing veins slightly darker in color; venation typical for genus. Two cervical gill remnants present on each side of midline, both with multiple branches near apex. Cerci small, membranous and one segmented. Hypoproct widest in basal 2/3, broadly rounded, apical 1/3 much narrower, with round tip; vesicle present, long, narrow and rounded at apex (Fig. 1). Paraprocts with three lobes: inner lobes long, thin, lightly sclerotized and nearly covered by apex of hypoproct; middle lobes, large, well developed and generally darkly sclerotized, tip rounded, naked and white, remainder of apical portion, beyond curve, bearing many dark, well developed spines on inner margin, basal portion large and expanded laterally below cercus; outer lobes, long, thin and bearing a fringe of short spines on sclerotized ridge, extending from rounded apex to completion of curve, base slightly expanded toward cercus (Figs. 1, 2). Epiproct broad at base in dorsal aspect, narrowing gradually to small, rounded apex, base of dorsal sclerite darkly sclerotized, apex exhibiting very darkly sclerotized area at the bilobed tip; lateral aspect with a narrow curved base, expanding gradually toward apex, with widest portion slightly anterior to midlength, apex shaped into a rounded upturned tip, lateral sclerite long and very thin, extending from base to apex, ventral sclerite shaped like narrow keel, which dips downward near widest portion in profile, bearing several small spines; basal sclerites large and triangle-shaped. Anterior margin of ninth tergum forming U-shaped band below apex of epiproct (Fig. 2).

Female. Macropterous. Length of forewings 7.0-7.5 mm; length of body 6.0-6.5 mm. Body, appendages and wings similar to male. Subgenital plate exhibiting large, median notch, bordered by sclerotized, truncate plates on posterior margin, with smaller notch lateral to large plates, and smaller sclerotized sclerite near lateral margins. Pregenital plate large, sclerotized and broadly rounded, extending over anterior margin of eighth sternum (Fig. 3).

Diagnosis. *Amphinemura alabama* males can be separated from males of the closely related *A.*

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delosa (Ricker) (1952) by the shape of the paraprocts and thc location of the spines. In *A. alabama* both the middle and outer lobes are long and thin and end in small rounded tips, which are naked of spines. The curved portion of both the middle and outer lobes are covered with numerous, dark, backward directed spines. However, in *A. delosa* the outer lobe is thin and without spines except for a small, narrow patch near the apex. The middle lobe bears many dark spines but only on the inner surface, at the bend. In addition, the apex is more bulbous and bears 6-10, large, laterally directed spines. The epiproct in *A. alabama* exhibits a long, upward curved tip laterally, while in *A. delosa* it is small and even with the dorsal margin. The anterior margin of the tenth tergum curves downward into a U-shape in *A. alabama* but it is straight in *A. delosa*. The female subgenital plates are quite similar but the small lateral lobes are smaller in *A. alabama* and do not reach the posterior margin of the eighth sternum.

Material. Holotype male, allotype female and 5 male and 2 female paratypes, Alabama, Limestone County, Cairo Branch, Elk River, 5-IV-1982, B.J. Armitage. Holotype and allotype deposited at the United States National Museum, Smithsonian Institution, Washington, D.C. Additional paratypes were studied from the following places: ALABAMA: same locality data as holotype, 24-IV-1982, 2 females; 27-IV-1982, 4 males and 3 females; 4-V-1982, 4 males and 6 females; 7-V-1982, 1 male and 2 females; 16-V-1983, 1 male and 3 females; Limestone Co., spring in Sugar Creek Estate, 2-V-1983, B.J. Armitage 1 male; 4-VI-1983, 1 male and 2 females.

Etymology. The specific name is a noun in apposition after the state where the type specimens were collected.

Discussion. *Amphinemura alabama* is only known from a small geographical area in north central *Alabama*. This interesting new species was brought to my attention by Boris Kondratieff after it was sent to him by the collector, Brian Armitage, then at Athens College. Examination of extensive collections from the surrounding states: Georgia, Mississippi and Tennessee has failed to produce additional records. Hopefully collecting efforts in the future will add to our knowledge of this species.

Amphinemura appalachia, NEW SPECIES

(Figs. 4-6)

Male. Macropterous. Length of forewings 7.5-8.5 mm; length of body 5.0-6.0 mm. Body and wings light brown, wing veins darker in color; veination typical for genus. Two cervical gill remnants present on each side of midline, both with multiple branches near apex. Cerci, small, membranous and one segmented. Hypoproct widest in basal 3/4, broadly rounded, apical 1/4 forming short, narrow point; vesicle present, long and narrow with rounded apex (Fig. 4). Paraprocts with three darkly sclerotized lobes: inner lobes large and L-shaped, inner portion with sharp point reaching to base of epiproct, lateral arm extending to base of cercus; middle lobe long and extremely thin, broadest at base, extending upward in a smooth C-shaped arc, which ends in a sharp point, apical area bearing 1-3 tiny spines, membranous area below basal sclerites bearing a few, stout, darkly sclerotized spines; outer lobe short and thin. beginning at cercus, encircling base of cercus from the ventral to dorsal side, around outer margin (Fig. 4). Epiproct broadest at apex in dorsal aspect, dorsal sclerite mostly darkly sclerotized, darkest coloration on lateral-apical margins, with tiny tube visible medially at bifurcate tip; ventral sclerite generally flat, no spines present but with textured pattern of dots throughout most of length; lateral aspect narrow at base and apex, slightly thickened beyond midlength; basal sclerites stout and somewhat triangle-shaped (Fig. 5).

Female. Macropterous. Length of forewings 8.5-9.5 mm; length of body 6.0-7.0 mm. Body appendages and wings similar in color to male. Subgenital plate with two large ear-like lobes separated medially by a V-shaped notch, lobes darkly sclerotized, especially in mature specimens, which also exhibit dark, rough area below notch, lobes extending well over base of ninth sternum (Fig. 6).

Diagnosis. *Amphinemura appalachia* males can be separated from the very closely related *A. wui* (Claassen) (1936) by the shape of the median lobe of the paraprocts and by the details of the epiproct. The median paraproctal lobe is extremely thin and delicately curved in a C-shape in *A.*

appalachia, while in *A. wui* it is thicker and quite angular where it bends, forming more of a block-like letter. The basic shape of the epiproct in these species is similar. However. the apex is thinner in *A. wui* and the dorsal sclerite is larger and more darkly sclerotized in *A. appalachia*.The lobes on the subgenital plate of the female of *A. appalachia* are more angular apically than in *A. wui*. In addition, the notch is more rounded in *A. wui* while in *A. appalachia* it is shallower and V-shaped.

Material. Holotype male, allotype female and one male paratype, South Carolina, Pickens County; Wildcat Creek, 20-III-1968, P.H. Carlson. Holotype and allotype deposited at the United States National Museum, Smithsonian Institution, Washington, D.C. Additional paratypes were examined from the following places: GEORGIA: Dawson Co., Amicalola Creek, Hwy 53, west of Dawsonville, 4-III-1991, R.W. Baumann and S.M. Clark, 2 males and 3 females. Lumpkin Co., tributary of Frogtown Creek, Hwy 19, near Desoto Falls, 4-III-1991, R.W. Baumann and S.M. Clark. 1 female. NORTH CAROLINA: Jackson Co., Willetts, 23-III-1940, T.H. Frison, C.O. Mohr and A.W. Hawkins, 2 males and 2 females. Macon Co., Upper Ball Creek, Coweta Hydrologic Laboratory, 7-22-IV-1984, A.D. Huryn, 2 males and 4 females; 20-IV-20-V-1984, 12 males and 13 females. PENNSYLVANIA: Carbon Co., Mud Run, Hickory Run State Park, 3-V-1996, E.C. Masteller, 1 female. Monroe Co., small stream below Camelback Ski Area, Pocono Mountains, 3-V-1991, R.W. Baumann and S.A. Wells, 2 males and 2 females. SOUTH CAROLINA: Same locality data as holotype: 4-III-1967, 1 male and 3 females; 20-III-1968, 3 males and 7 females; 9-IV-1968, 1 male and 6 females; 12-IV-1968, 11 females. TENNESSEE: Carter Co., tributary of Stony Creek, Hwy 91, Winner, 6-III-1991, R.W. Baumann and S.M. Clark, 3 males. VIRGINIA: Grayson Co., Lewis Fork, Rt. 603, 10-IV-1980. B.C. Kondratieff, 3 males and 3 females; 19-IV-1980, 1 male and 1 female. Madison Co., Big Meadows, Shenandoah National Park, 20-IV-1938, H.H. Ross and B.D. Burks, 2 males; Hog Camp Brook, tributary Rose River, Shenandoah National Park, 6-V-1987, S.Hiner, 3 males. Page Co., Lewis Spring, trail to Lewis Falls, Big Meadows, Shenandoah National Park, 3-VI 1983, B.C. Kondratieff, 5 males and 5 females. Patrick Co., Patrick Springs, Hwy 680, 3 miles north of Patrick Springs, 11-III-1991, R.W. Baumann and R.F. Kirchner, 1 female.

Etymology. This species is known from Pennsylvania to Georgia in the Appalachian Mountains. Thus the name *A. appalachia* was chosen to emphasize the fact that it is only found in this major mountain range.

Discussion. *Amphinemura wui* was originally described as *Nemoura sinuata* by Wu (1923). However, since the name *sinuata* was previously used for a European species, Claassen renamed the species after the describer. During the intervening years some stonefly workers noticed that *A. wui* seemed to be variable but until now the actual details were not clarified so that the two species could be separated consistently.

Even though *A. appalachia* is widely distributed in eastern North America, it is much less frequently collected than *A. wui*. This is because it emerges earlier in the year and prefers more pristine, spring-fed streams that usually occur at higher elevations. Additional collecting in the northern Appalachians, earlier in the year, will possibly add to its known range of distribution.

Amphinemura texana, NEW SPECIES

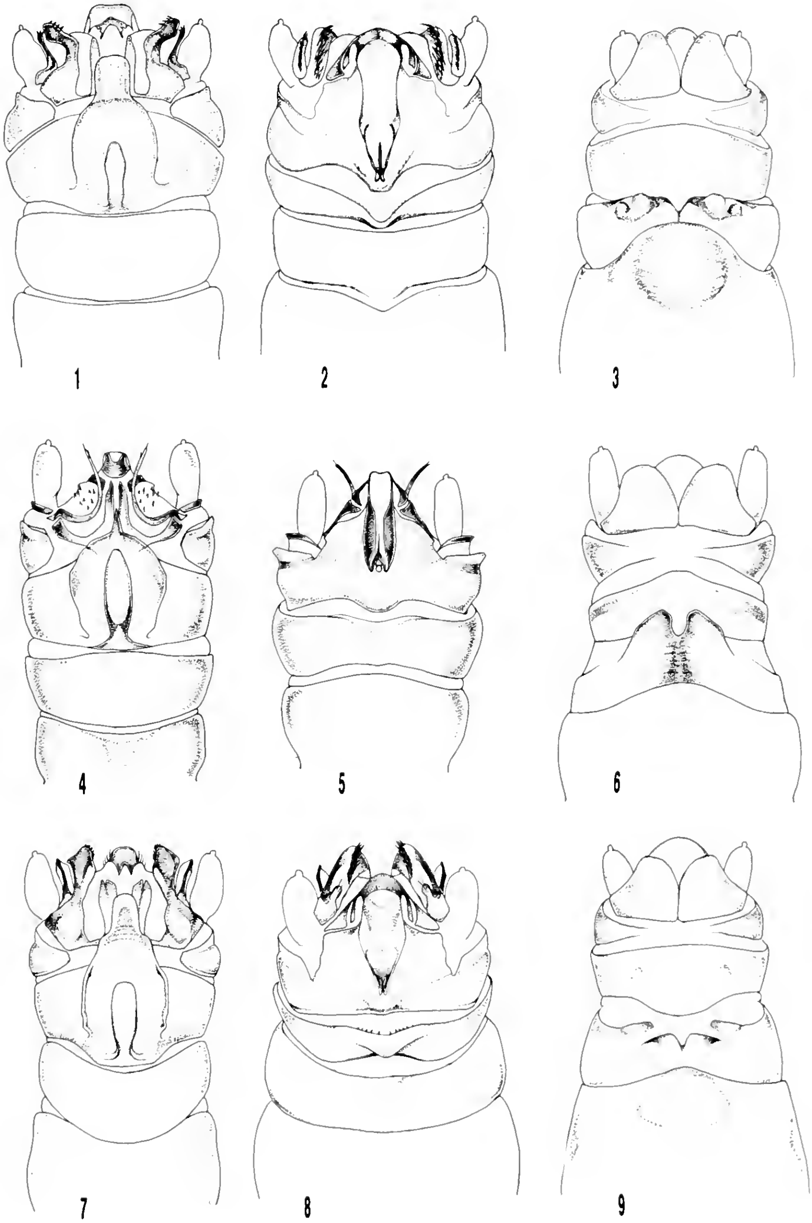
(Figs. 7-9)

Male. Macropterous. Length of forewings 6.5-7.0 mm; length of body 5.5-6.0 mm. General color brown, legs and abdomen yellow-brown, wings fumose, with darker areas along veins, venation typical for genus. Two cervical gill remnants present on each side of midline, both with multiple branches near apex. Cerci small. membranous and one segmented. Hypoproct widest in basal 2/3, broadly rounded, apical 1/3 narrower, with rounded tip; vesicle present, long and thin, with rounded apex (Fig. 7). Paraprocts with three lobes: inner lobes short, somewhat elongate, with bilobed apex, partially covered by hypoproct; middle lobes large, well developed and darkly sclerotized, base broad, narrowing before greatly expanded area at curve, which exhibits patch of inward directed spines, apex membranous ventrally but modified into distinctive, sclerotized, handle-like process dorsally, that points inward toward base of epiproct, bearing one to three spines at the tip; outer process, short, narrow and without spines, slightly wider at base, pointed apex not reaching forward beyond dorsal margin of cercus (Figs. 7, 8). Epiproct broadest at base in dorsal aspect, narrowing toward pointed, bilobed tip, producing wedge-shaped outline, dorsal sclerite darkly sclerotized at base but remainder of sclerite only lightly sclerotized; lateral aspect with lateral arms thin and reaching to apex, which forms slightly uptumed apical process, when compared to generally wide epiproct, ventral sclerite extending downward slightly, producing rounded keel behind apex, which bears rows of large, thin spines; basal sclerites, short, stout and somewhat triangle-shaped. Median, posterior margin of ninth tergum bearing row of short spines (Fig. 8).

Female. Macropterous. Length of forewings 7.5-8.0 mm; length of body 7.0-8.0 mm. Body, appendages and wings similar to male. Subgenital plate with large, median notch, bordered by elongate, gently rounded lateral lobes, which are sclerotized along outer margin, also with additional sclerotized patch on each side along lateral-posterior margin of eighth sternum, especially visible in mature specimens. Pregenital plate well developed, lightly sclerotized and extending over anterior-median area of eighth sternum in gently rounded arc (Fig. 9).

Diagnosis. *Amphinemura texana* is most similar to *A. nigritta* (Provancher) (1876). Males can be most easily separated by the shape of the paraprocts. The middle lobe of the paraprocts in *A. texana* ends in rounded apex which bears a large prong-like, oblique process. This process is heavily sclerotized and has 1-3 terminal spines. The rest of the membranous apex is naked or exhibits 1-2 very small, ventral spines, that are actually an extension of thc large patch of spines beginning at the median bend. In *A. nigritta* the middle lobe terminates in a lightly colored membranous lobe, which is essentially bulbous. The inner margin contains a patch of 3-5 tightly pressed spines and the outer margin has 3-4 more loosely scatted, dark spines (see Hitchcock 1974, Figs. 115 and 116). Females cannot be separated consistently from females of *A. nigritta* without associated males.

Material. Holotype male, allotype female and 2 male and 31 female paratypes, Texas, Houston County, Wood Spring Branch, Elm Creek, Hwy 7, 1 mile west of Kinnard, 21-IV-1990. R. W. Baumann and C.R. Nelson. Holotype and allotype deposited at the United States National Museum, Smithsonian Institution, Washington, D.C. Additional paratypes were studied from the following places: LOUISIANA: Grant Parish, Cypress Creek, Catahoula District, Kisatchie National Forest, Rd. 17, 2.5 miles west of Dry Prong, 8-IV-1984, R.E. DeWalt, 1 male (reared); 19-IV-1984, 1 female (reared); 29-IV-1994, 1 male. TEXAS: Anderson Co., Saddler Creek. Hwy 287, south of Palestine, 30-III-1974, S.W. Szczytko and K.W. Stewart, 1 male. Cass Co., Frazier Creek, Hwy 8, east of Red Hill, 14- IV-1973, S.W. Szczytko and K.W. Stewart, 3 males and 8 females; creek, Hwy 8, 5.8 miles north of Linden, 14-IV-1973, S.W. Szczytko and K.W. Stewart, 8 males and 8 females. Cherokee Co., creek, Hwy 21, 1-1/2 miles east of Alto, 14-III 1973, S.W. Szczytko, 3 males; 30-III-1974, S.W. Szczytko and K.W. Stewart, 4 males and 4 females. Harrison Co., creek. 12 miles east of Marshall, 26-III-1970, R. Greer, 1 male; creek, Hwy 59, 6 miles north of Marshall, 14-IV-1973, S.W. Szczytko and K.W. Stewart, 2 males and 1 female. Houston Co., Whiteley Creek, Hwy 227, 3 miles northwest of Ratcliff, Davey Crockett National Forest, 21-IV-1990, R.W. Baumann and C.R. Nelson, 1 male and 2 females. Nagodoches Co., Naconiche Creek, Hwy 593, southwest of Appleby, 30-III-1974, S.W. Szczytko and K.W. Stewart, 5 females. Muse Spring, tributary of Amaladeros Creek, Chireno, 22-IV-1990, R.W. Baumann and C.R. Nelson, 2 females. Sabine Co., creek, Hwy 87, 2.9 miles south of junction Hwy 21, 12-III-1973, S.W. Szczytko, 1 male; Moss Creek, 2 miles north of Milam, Red Hills Lake Campground, Sabine National Forest, 22-IV-1989, R.E. DeWalt, 11 males and 19 females; 23-IV-1990, R.W. Baumann and C.R. Nelson, 5 males and 22 females; Boregas Creek, Hwy 21, 1 mile west of Milam, 23-IV-1990, R.W. Baumann and C.R. Nelson, 1 female. Shelby Co., headwaters of Grannies Creek near Boles Field, Sabine National



Figs. 1-3. *Amphinemura alabama*. 1 . Male genitalia, ventral view. 2. Male genitalia, dorsal view. 3. Female genitalia, ventral view. Figs. 4-6. *Amphinemura appalachia*. 4. Male genitalia, ventral view. 5. Male genitalia, dorsal view. 6. Female genitalia, ventral view. Figs. 7-9. *Amphinemura texana*. 7. Male genitalia, ventral view. 8. Male genitalia, dorsal view. 9. Female genitalia, ventral view.

Forest, 23-IV-1990, R.W. Baumann and C.R. Nelson, 2 females. Tyler Co., creek, Hwy 287, north of Chester, 30-III-1974, S.W. Szczytlo and K.W. Stewart, 2 males.

Etymology. The name *A. texana* was chosen since the species was first recognized from Texas and it occurs widely along the eastern portion of the state.

Discussion. In Ricker (1952) he notes that what he recognizes as *A. nigritta* is a variable species. In fact, he illustrates three different forms of the two outer paraproctal lobes. His figure 10 is somewhat similar to *A. texana* but the range of variation observed in his Illinois specimen still falls within that of *A. nigritta.*

Amphinemura texana seems to be restricted to the Piney Woods of east Texas and the adjacent area in the Kisatchie National Forest of Louisiana. The habitat where the species occurs is in small headwater springs or creeks that are located in mixed deciduous and long leafed pine forests. While most collecting localities occur in National Forests, adequate habitats do exist on adjacent private lands. In 1974, Stewart *et. al.* erroneously recorded *A. delosa* from East Texas. Szczytko and Stewart (1977), in their study of the Texas stonefly fauna, listed *A. texana* as *A. nigritta*, and as the only *Amphinemura* species to occur in Texas. The ten counties listed for paratypes above include all those mentioned in Szczytko and Stewart (1977), since all of their specimens were examined as part of this study.

The Louisiana specimens and a series from Texas were supplied by Ed DeWalt of the Illinois Natural History Survey. Riley Nelson of the University of Texas, Austin aided the author in collecting fresh material from several localities in Texas.

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STONEFLIES (PLECOPTERA) OF THE POWDERMILL NATURE RESERVE, SOUTHWESTERN PENNSYLVANIA[1]

Scott A. Grubbs[2]

ABSTRACT: Species richness and flight records of Plecoptera occurring in the Powdermill Nature Reserve, southwestern Pennsylvania, are reported following (1) an extensive four-year (1991-1995) survey of a broad range of lotic habitats; and (2) inclusion and examination of historical collections (1956-1988). Overall, 52 species are recorded from Powdermill, including 7 species based solely on the historical collections. Three new state records (*Allocapnia harperi, Leuctra alexanderi,* and *Alloperla aracoma)* increase the number of species reported from Pennsylvania to 117. Notes on the local and regional distribution of individual species are provided.

The Powdermill Nature Reserve, the biological field station of the Carnegie Museum of Natural History (Pittsburgh), is located in the Allegheny Mountain Section of the Appalachian Plateaus Province of eastern North America (Berg *et al.*, 1989). Powdermill presently occupies nearly 900 hectares in the Laurel Mountains, Westmoreland County, southwestern Pennsylvania.

Previous surveys of the aquatic insect fauna of the Powdermill Nature Reserve have focused mainly on Trichoptera (Sykora *et al.*, 1976, Sykora and Weaver, 1978, Weaver and Sykora, 1979, Weaver, 1988) and Chironomidae (W. P. Coffman, University of Pittsburgh, unpublished data). The reserve contains the type localities for a recently-discovered species of Plecoptera (*Soyedina merritti* Baumann and Grubbs, 1996) and two species of Trichoptera (Sykora and Weaver, 1978). However, most aquatic groups (e.g. Ephemeroptera, Plecoptera prior to this study, Diptera other than Chironomidae) have been poorly studied despite the wide array of protected, high-quality habitats located in the reserve. In light of this, the primary objective of this study was to extensively survey the adult stonefly fauna from the broad range of habitats located in the Powdermill Nature Reserve.

STUDY SITES and COLLECTION METHODS

Fresh adult stoneflies were collected from 14 lotic habitats during a four-year period from April 1991 - July 1995. Habitats ranged from seeps and springs to a 4th-order stream (largest lotic habitat at Powdermill). Stream sediments in each habitat are dominated by cobbles and gravel, and each habitat is lined by a complete riparian canopy. Common woody flora within the reserve include tulip poplar (*Liriodendron tulipifera* L.), American beech (*Fagus grandifolia*

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Ehrh.), eastern hemlock (*Tsuga canadensis* [L.]), sugar maple (*Acer saccharum* Marsh.), red maple (*A. rubrum* L.), yellow birch (*Betula alleghaniensis* L.), black birch (*B. lenta* L.), northern red oak (*Quercus rubra* L.), white ash (*Fraxinus americana* L.), black cherry (*Prunus serotina* Ehrh.), witch hazel (*Hamamelis virginiana* L.), and shagbark hickory (*Carya ovata* [Mill.]).

Adults were collected by (1) visually searching cobbles and boulders, leaf packs and woody debris, tree trunks and intact green leaves, herbaceous annuals and perennials, and bridges; (2) beating riparian vegetation; (3) light-trapping; and (4) transporting live nymphs to the University of Pittsburgh and rearing in Living Streams® (Frigid Units, Inc).

In addition, stoneflies were examined from the Section of Invertebrate Zoology, Carnegie Museum of Natural History (CMNH). Published records (Stark and Szczytko, 1988) and additional records provided by Dr. R. W. Baumann (Brigham Young University) and Dr. R. F. Surdick were also included. Each latter collection is designated as historical because they were based on material collected between 1956 and 1988.

RESULTS and DISCUSSION

A grand total of 2176 fresh adult stoneflies were collected and identified, encompassing 43 species (Table 1). Two additional species were collected only as nymphs and exuviae (*Clioperla clio*) or nymphs (*Cultus* sp.). The historical collections provided records of 30 species based on 99 specimens. Overall, 52 species were recorded (fresh + historical) from Powdermill, encompassing 31 genera and all nine Nearctic families (Table 1). Seven species (*Megaleuctra flinti, Soyedina vallicularia, Alloperla usa, Rasvena terna, Utaperla gaspesiana, Diploperla duplicata,* and *Perlesta* sp. A) were represented solely by historical records.

Thirty-seven species display distribution patterns endemic to the Appalachian Mountains. An additional 15 species exhibit widespread boreal distributions, occurring primarily east of the Rocky Mountains. The Capniidae, Leuctridae, Nemouridae, and Chloroperlidae were the best represented families, owing to large collected numbers of *Allocapnia* spp. and *Paracapnia angulata, Leuctra* spp. and *Paraleuctra sara, Amphinemura* spp. and *Ostrocerca* spp., and *Sweltsa* spp., respectively. Nine genera were represented by multiple species, including *Leuctra* (7), *Allocapnia* (5), *Amphinemura* (3), *Isoperla* (3), and *Sweltsa* (3).

The highest species richness recorded for any single habitat was a 3rd-order stream (37). This probably indicates an artifact of sampling effort, however, because this habitat was represented by the highest proportion of freshly-collected specimens (44%). Seeps supported the lowest species richness, containing mainly *Allocapnia harperi, Ostrocerca truncata, Soyedina merritti,* and *Peltoperla arcuata.* All eastern North American species of *Ostrocerca* spp. have been previously considered to be a rare group of Appalachian stoneflies (Kondratieff and Kirchner, 1987). Both Powdermill species, however, are particularly abundant in seeps (*O. truncata*) and springs and 3rd-order streams (*O. albidipennis*).

Numerous species (*Allocapnia zola, Strophopteryx fasciata, Clioperla clio,* and *Pteronarcys biloba*) were only obtained from low-gradient reaches of 3rd- and 4th-order streams. Each habitat occurs adjacent to, or downstream of, pasturelands and contains a greater silt content than any other sampled habitat. Similarly, *Amphinemura delosa* was mainly collected from the above-mentioned habitats whereas *A. nigritta* and *A. wui* were primarily encountered in moderate-gradient springs and 3rd-order streams. In contrast, five species (*Allocapnia harperi, A. nivicola, Paracapnia angulata, Ostrocerca albidipennis* and *Soyedina merritti*) were collected from the broadest range of habitats (seeps to 3rd- and 4th-order Powdermill Run).

Three species, *Allocapnia harperi, Alloperla aracoma,* and *Leuctra alexanderi* represent new state records. Two (*Allocapnia harperi* and *Alloperla aracoma)* represent range extensions and the northern-most records for each species. *Allocapnia harperi* is apparently endemic to the southern and central Appalachians and has been previously recorded only from Virginia (Kirchner, 1980, Kondratieff and Kirchner, 1991) and West Virginia (Kirchner, 1982). Kondratieff and Kirchner (1991) listed the status of *A. harperi* in Virginia as special concern. *Alloperla aracoma* appears to be endemic to the central Appalachians and has been previously collected only from a few localities in West Virginia (Harper and Kirchner, 1978, Griffith and Perry, 1992). *Leuctra alexanderi* is also apparently endemic to the southern and central Appalachians and had been previously recorded as far north as northern West Virginia (Griffith and Perry, 1992). I have also collected *L. alexanderi* in northwestern Pennsylvania (Crawford Co., seep in Tryon-Webber Woods Natural Area, Western Pennsylvania Conservancy, 6 June 1994, 3 males, 3 females), which represents the northern-most record to date (P.P. Harper, Université de Montreal, personal communication). In addition, *Soyedina merritti* was recently described from material collected from seeps and springs in the Powdermill Nature Reserve and one additional habitat in the Laurel Mountains (Baumann and Grubbs, 1996). *Soyedina merritti* may be endemic to the central Appalachians.

Earle (1994) added 14 new records to Pennsylvania, and updated the earlier lists of Surdick and Kim (1976), Stark *et al.* (1986), and Stewart and Stark (1988), to bring the total number of species recorded in the state to 113. The three additions reported in this paper, plus *Soyedina merritti,* increase the total to 117 species.

Table 1. Flight records of Plecoptera from the Powdermill Nature Reserve based on fresh (1991-1995) and historical (1956-1988) collections. X = collected as adults; E = collected as exuviae; N = collected as nymphs. AP = Appalachian, CP = Coastal Plain, and WB = widespread-boreal distributed species. * new state record; # total number of specimens collected, examined, or included; ( ) number of specimens based on historical collections only.

Species	4th-order stream	3rd-order streams	2nd-order springs	1st-order springs	seeps	no site specified[1]	Dates collected	#
Capniidae								
Allocapnia frisoni (Ross and Ricker): AP		X					13 Dec - 14 Feb	16
A. harperi Kirchner*: AP		X		X	X		29 Jan - 4 Apr	16
A. nivicola (Fitch): WB	X	X	X	X	X	X	29 Dec - 24 Apr	207 (1)
A. recta (Claassen): WB	X	X					13 Dec - 7 Mar	21
A. zola (Ricker): AP	X	X					27 Jan - 27 Feb	14 (1)
Paracapnia angulata Hanson: WB	X	X	X	X	X		27 Feb - 4 May	342
Leuctridae								
Leuctra alexanderi Hanson*: AP		X	X		X		13 June - 19 July	3
L. duplicata Claassen: AP			X				20 May	1
L. ferruginea (Walker): WB		X	X	X			24 June - 13 Dec	157
L. grandis Banks: AP		X	X	X			10 May - 13 June	87
L. sibleyi Claassen: AP	X	X	X			X	10 May - 12 June	73 (3)
L. tenella Provancher: WB		X	X				13 May - 23 June	93
L. tenuis (Pictet): WB		X					18 July	5 (4)
Megaleuctra flinti Baumann[1]: AP				X			15 May - 21 May	7 (7)
Paraleuctra sara (Claassen): AP	X	X	X	X			27 Mar - 4 May	121
Nemouridae								
Amphinemura delosa (Ricker): WB	X	X				X	11 May - 18 July	20 (8)
A. nigritta (Provancher): WB		X		X		X	20 May - 18 July	57 (9)
A. wui (Claassen): AP		X	X	X			20 May - 31 Aug	76
Ostrocerca albidipennis (Walker): AP		X	X	X			4 May - 17 July	138
O. truncata (Claassen): AP		X	X	X	X		26 Apr - 16 May	39
Paranemoura perfecta (Walker): AP			X		X		4 Apr - 1 May	10
Prostoia similis (Hagen): WB		X					3 May	1
Soyedina merritti Baumann[1] and Grubbs: AP		X	X	X	X	X	14 Mar - 3 May	36 (2)
S. vallicularia (Wu)[1]: WB						X	14 Mar	1 (1)
Taeniopterygidae								
Oemopteryx contorta (Needham and Claassen): AP		X	X	X			17 Mar - 3 May	12
Strophopteryx fasciata (Burmeister): WB	X	X				X	27 Feb - 24 Apr	6 (3)
Taeniopteryx maura (Pictet): WB	X	X				X	24 Feb - 15 Apr	119 (7)

Species	4th-order stream	3rd-order streams	2nd-order springs	1st-order springs	seeps	no site specified[1]	Dates collected	#
Pteronarcyidae								
Pteronarcys biloba Newman: AP	X						24 May - 5 June	2 (1)
P. proteus Newman: AP		X		N			22 May - 4 June	4 (1)
Peltoperlidae								
Peltoperla arcuata Needham: AP		X	X	X	X	X	17 May - 11 Aug	19 (7)
Tallaperla maria (Needham and Smith): AP	X	X		X			11 May - 24 June	94 (3)
Perlodidae								
Clioperla clio (Newman): WB	N,E						22 April (exuviae)	0
Cultus sp.: AP		N					nymphs only	0
Diploperla duplicata (Banks)[1]: AP, CP						X	23 May	1 (1)
Isoperla holochlora (Klapalek): AP		X		X		X	2 June - 14 Sept	13 (3)
I. montana (Banks): AP		X				X	1 June - 19 July	2 (1)
I. similis (Hager): AP		X	X			X	1 May - 6 June	8 (1)
Malerikus iroquois Stark and Szczytko: AP		X		X			29 May - 19 June	7 (2)
Remenus bilobatus (Needham and Claassen): AP		X				X	6 June - 3 Aug	5 (3)
Yugus bulbosus (Frison): AP		X		N	N		14 May - 11 June	4
Chloroperlidae								
Alloperla aracoma Harper and Kirchner*: AP		X					2 June - 11 July	6
A. usa Ricker[1]: AP				X			11 June - 23 July	6 (6)
Haploperla brevis (Banks): WB		X		X		X	23 May - 5 Aug	21 (1)
Rasvena terna (Frison[1]): AP						X	20 May	2 (2)
Suwallia marginata (Banks): AP		X		X			11 July - 11 Aug	29
Sweltsa lateralis (Banks): AP		X		X		X	11 May - 19 July	149 (2)
S. naica (Provancher): AP		X		X			10 May - 15 June	117
S. onkos (Ricker): AP		X		X		X	10 May - 20 July	87 (2)
Utaperla gaspesiana Harper and Roy[1]: AP				X			20 May	1 (1)
Perlidae								
Acroneuria abnormis (Newman): WB		X				X	14 June - 10 Aug	8 (6)
A. carolinensis (Banks): AP	X	X				X	5 June - 20 July	5 (3)
Perlesta sp. A[2]: AP		X				X	31 July - 26 Aug	7 (7)

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[1] historical records only.

[2] *Perlesta* sp.A is an undescribed species and a formal description is pending.

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INCIDENTAL CAPTURE OF MALE *EPIAESCHNA HEROS* (ODONATA: AESHNIDAE) IN TRAPS DESIGNED FOR ARBOREAL *CALOSOMA SYCOPHANTA* (COLEOPTERA: CARABIDAE)[1]

Paul W. Schaefer[2], Susan E. Barth[2], Harold B. White, III[3]

ABSTRACT: Ten male *Epiaeschna heros*, the largest dragonfly in the northeastern US, were caught unexpectedly in traps designed to catch *Calosoma sycophanta*, a carabid beetle that feeds on the larvae of the gypsy moth, *Lymantria dispar* (Lepidoptera: Lymantriidae), and other lepidopterans. Examination of the intestinal contents and fecal pellets from five of the captured *E. heros* revealed the remains of prey insects but no identifiable fragments of lepidopterans. Only males were captured suggesting that the apparent attractiveness of the traps is related to breeding behavior. Modification of the traps might enhance their selectivity for aeshnid dragonflies.

The gypsy moth, *Lymantria dispar* (L.), was introduced from Europe into the United States in Medford, Massachusetts, in 1869 (Forbush and Fernald, 1896). Since then, its range has spread and it has become a major forest pest. At a peak in 1981, its larvae defoliated over 12.9 million acres (Anon, 1994). Among the predators introduced for control of gypsy moth larvae is a large, iridescent green carabid beetle, *Calosoma sycophanta* L. (Burgess, 1911). As part of a United States Department of Agriculture program to monitor biological control organisms of the gypsy moth, two of us (PWS and SEB) sampled populations of *C. sycophanta* at two locations in eastern Maryland during 1995. The sampling method used traps designed to collect *Calosoma* beetles as they foraged for caterpillars on tree trunks (Collins and Holbrook, 1929). While 83 *Calosoma* beetles were trapped for the season (77 at Site 1 and 6 at Site 2), ten male swamp darners, *Epiaeschna heros*, (Fabricius) [arguably the largest species of dragonfly in the northeastern United States (Needham and Westfall, 1955)] were also captured.

Study sites: Two woodlots with high densities of gypsy moth larvae and incipient defoliation were selected as study sites. Both are in Queen Anne's County, Maryland. Site 1, on the south side of Racetrack Road and 3.0 km south of Sudlersville, (39° 09.7' N, 75° 50.6' W; 21 m elev.), had 58 traps. Within a few hundred meters south of this site is a shaded woodland drainage ditch that is typical of *E. heros* breeding sites. Site 2, 10.6 km south of Site 1 on the west

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side of Rabbit Hill Road near Ingleside (39° 04' N, 75° 52' W; 18 m elev.), had 40 traps. The traps were distributed over a couple of acres at each site. They were located about 1.5 m off the ground on the trunks of oak trees, mostly white oak *(Quercus alba)*, but also red oak *(Q. rubra)*, willow oak *(Q. phellos)*, and swamp chestnut oak (*Q. michauxii)*, with diameters ranging up to 63 cm. Traps were set out between 15 and 23 May 1995 and checked at least twice weekly through 10 July 1995.

Trap description: The traps used in this study were modified from the original design of Collins and Holbrook (1929) and were essentially the same as used by Weseloh (1985). The body of each trap was a 24 oz clear plastic cup (P-24, SOLO Cup Co., Urbana, IL 61801) purchased from a local supplier. The cups had a height of 152 mm with a base diameter of 63 mm and a lip diameter of 102 mm. Four small holes were put in the base to prevent the accumulation of rain water. Two pieces of 0.2 mm clear polycarbonate plastic (such as Lexan©, General Electric Corporation) stapled to each cup created a 53 mm peaked roof sloping to the lip of the cup and a back wall containing a pleat with a 8 mm x 22 mm horizontal hole for beetles to enter as they climbed the trunk from below as shown by Weseloh (1985). *Epiaeschna* dragonflies entered through the large opening at the front that formed an isosceles triangle with slightly bulging sides. Maximum width of the entrance was about 100 mm with a height of about 140 mm. Due to the different materials used, these traps were larger and relatively transparent compared to those of waxed paper used by Collins and Holbrook, (1929).

The traps were attached to trees as follows. First a 68 mm wide barrier strip of Lexan© was wrapped around a tree trunk at about 1.5 m such that it was not quite horizontal. Then a 30 mm x 65 mm piece of black emery cloth was oriented vertically and stapled to the tree on the lower edge of the strip at its highest point. Finally, the trap was stapled to the tree with its entrance hole and triangular slot positioned over the emery cloth. The emery cloth was a modification made to provide better footing for beetles entering the trap. This feature would not be accessible to the dragonflies but perhaps it provided a visual cue.

Capture of *Epiaeschna heros*: Because the specific purpose of trapping was to obtain *Calosoma* beetles for chemical analysis, the fact that the traps designed to catch beetles also were capturing *E. heros* dragonflies was a curiosity. Thus, the following records do not fully document the capture of dragonflies at both sites. On 23 May 1995, three male *E. heros* were found, all in a single trap at Site 1. All were alive but all had broken their wings about 2.5 cm from the thorax. Three days later two more males were taken from different traps at both sites. On 19 June 1995, three more males were captured in separate traps. On at least two other occasions before 5 June 1995, single individuals were captured and released undamaged. At no time were both *E. heros* and *C. sycophanta* captured simultaneously in the same trap. The eight damaged dragonflies were killed in acetone and extracted for several days before drying. The intestinal contents of five individuals were subsequently examined as were several fecal pellets deposited in temporary holding cups.

Although *E. heros* were captured over a period of one month, their flight season is much longer. They are most common in May and June but are active throughout the summer. Two individuals were observed 10 July 1995 near the drainage ditch south of Site 1. It contained standing water during the period of this study.

Intestinal Contents: The intestinal contents of *E. heros* contained relatively large chitinous fragments, mostly legs with intact spines, of other insects that in many cases might be identified by persons familiar with individual prey species. None of the five specimens or the fecal pellets examined contained body parts that suggested any caterpillars had been eaten. Most of the adults were devoid of prey remains in the gut perhaps because of the time spent in the traps (up to four days). During that time, their gut contents were probably eliminated.

DISCUSSION

Dragonflies are large predators that search for prey visually and on occasion are caught in Malaise traps (Johnson *et al.*, 1995), ornithological mist nets (Baccetti *et al.*, 1990), spider webs (Ram and Prasad, 1978), or on surfaces with low surface tension (Labedzki, 1989). However, they are strong fliers that can escape entanglement and are known to avoid spider webs (White, 1979). It is remarkable that *E. heros*, a large dragonfly and a strong flier, would be captured on a number of occasions by a trap whose front entrance was slightly narrower than its wing span (116 mm). Escape would seem easy. However, *E. heros*, like other Anisoptera, cannot fold its wings and is apparently unable to climb the smooth walls of the trap. If smaller species were also attracted to the traps, they might be able to hover in the trap and escape without damaging their wings. Thus the species selectivity of the trap may be based solely on size; however, we suspect that species-specific behavior is involved. For example in this area, *E. heros* (and *Aeshna umbrosa* Walker) frequently fly in open windows and are collected inside buildings (Walker, 1958), a phenomenon associated with other crepuscular and forest dwelling species that normally fly in the shade (Corbet, 1962).

More remarkable than the fact that *E. heros* could not escape the trap is that they entered the trap at all. Since eight separate traps contained at least one individual, it seems probable that entry was active and not accidental. Most likely, something about the traps attracted them.

Given the high density of gypsy moth caterpillars and the fact that *E. heros* frequents woodlands, we first wondered whether *E. heros* could have been attracted to the infested woodlots to feed on caterpillars. That hypothesis is not supported by the contents of the gut or fecal pellets that show most, if not all, of the prey were small insects, probably Diptera. While Odonata can feed on nonflying prey, it is unusual, particularly among the Anisoptera (Corbet, 1962). The few reports of the eating habits of *E. heros* have them catching flying prey. For instance, large swarms of both males and females will feed on small flying insects at dusk in open areas near woodlands. Byers (1930) reported a swarm of *E. heros* that feasted on honey bees near an apiary, and Dunkle (1989) reported large prey including cicadas and moderately large dragonflies.

Certainly as intriguing as the species selectivity is the sex selectivity of the traps. The absence of females suggests attraction is related to breeding behavior rather than feeding behavior. Sawkiewicz (1989), adapting a collecting method used by children in southeast Asia, noted that only males of several species were attracted to an *Aeshna cyanea* Latreille tethered near a breeding site. However, unlike the males of most other aeshnid species, *E. heros* neither patrols over water nor establishes territories (Dunkle, 1989). Furthermore, *Epiaeschna* females typically oviposit at shaded woodland swamps, ditches, and vernal ponds, unattended by males (Walker, 1958). As noted by Corbet (1962), little is known about the mating sites of dragonflies that mate at one site and oviposit at another. Perhaps female *E. heros* perch on tree trunks where males actively search for them and that is why they were captured in the traps set for *Calosoma* beetles.

Although perching behavior has not been described for *E. heros*, it is not uncommon for other aeshnids to perch on sunlit tree trunks. They often hover facing a tree and appear to inspect the trunk as they fly upward. Wright (1946) observed *Coryphaeschna ingens* Rambur, another large woodland species, "flying up and down tree trunks searching for and catching gnats." While this undoubtedly was a search for food, similar behavior could be used by males seeking mates or confronting other males that are perched on tree trunks. This later possibility is suggested by our capture of three male *E. heros* simultaneously in a single trap.

If our hypothesis is correct, then some modification of the traps of the type we describe might attract aeshnids of a variety of species, particularly when placed on trees near suitable breeding sites. Although the *Calosoma* traps do not look like an *E. heros* to the human eye, there may be essential visual aspects of the trap in the forest environment that simulate distinctive visual cues attractive to males. For example, the clear plastic parts of the trap against the trunk might reflect light in much the same way that the wings of a large dragonfly would. The rough piece of black emery cloth might break up the pattern and appear as the body, and thus perhaps be the focus of a male as it approached the large clear opening of the trap. Alternatively, the clear plastic might act as a reflector to which hovering males are attracted by their own image or reverberation, responding as if they were confronting another male, either resting or flying.

Both Sones (1995) and Soltesz *et al.* (1995) reported the appearance of large numbers of *E. heros* (and other species that breed in vernal ponds) along coastal sections of the northeastern United States from New Jersey to Cape Cod, Massachusetts where they occur infrequently. The influx occurred in April, May, and early June 1995 and was attributed to a severe drought in Virginia, the Carolinas, and Georgia where vernal ponds had dried up. Storm systems that were associated with strong southerly winds and suspected northward migration occurred on May 17 to 19, 21, and 24, 1995, the week when our traps were set up and our first captures occurred. Thus it is possible that the entry of *E. heros* into *Calosoma* traps was detected fortuitously as a consequence of the migration of large numbers of *E. heros* coincident with our studies. Roger Fuester, who has used *Calosoma* traps for many years in southern New Jersey, never recalls capturing *E. heros* (personal communication). This suggests that at typical population densities capture of *E. heros* is a rare event.

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NOTE FROM EDITOR

It is a policy of *Entomological News* to publish papers as soon as possible after they have cleared reviews and editorial procedures. *Entomological News* does not hold papers already approved for publication until some future issue simply because a current issue, normally 64 pages, is 'full'. A considerably heavier influx of papers submitted and processed this year has resulted in this much larger than usual current issue. Present indications are this will continue at least through the first two issues in 1997.

H.P.B.

NEW RECORDS OF PREDACEOUS DIVING BEETLES (COLEOPTERA: DYTISCIDAE) IN MAINE[1]

L. R. Boobar[2], K. E. Gibbs[2], J. R. Longcore[3], A. M. Perillo[4]

ABSTRACT: Locations, habitat descriptions, and collection dates are listed for new records of 4 genera and 12 species of predaceous diving beetles (Coleoptera: Dytiscidae) in Maine. Previously, 17 genera and 53 species of the aquatic beetle family Dytiscidae were reported from Maine.

The family Dytiscidae, the largest family of aquatic beetles in Maine, is represented by records of 17 genera and 53 species. Thirty-three species were recorded during the Biological Survey of the Mount Desert Region (Procter 1946). A survey by Malcolm (1971) yielded another 10 species, and the remaining records were obtained from Larson (1989), Zimmerman and Smith (1975), Anderson (1971), Young (1963, 1954), Mairs (1957), Hatch (1928), and Fall (1922). Our review of Dytiscidae specimens in the University of Maine Insect Collection and in ~2,500 activity trap and 400 sweep-net samples from 2 recent studies in Maine has identified new records of 4 genera (*Agabetes, Hydrovatus, Matus, Neoscutopterus*), and new records of 12 species (*Agabetes acuductus, Acilius mediatus, A. sylvanus, Agabus erichsoni, A. phaeopterus, A. semipunctatus, Graphoderus perplexus, Hydaticus aruspex, Hydrovatus pustulatus, Matus ovatus, Neoscutopterus angustus,* and *Rhantus consimilis*). We deposited voucher specimens in the University of Maine Insect Collection. Because more than twice as many species of Dytiscidae have been found in other states (e.g., 143 in Wisconsin, W. L Hilsenhoff, pers. commun.) and forty other species of Dytiscidae have been collected from states and provinces near Maine, additional new records certainly will be found in Maine.

Format: The sequence of information is consistent within categories (e.g., Specimen(s) collected): information for 2 ponds or 2 collection points within a pond is separated by 'and', information for >2 ponds or >2 collection points within a pond is presented as a range (e.g., 2-5 refers to 2 through 5); ? = unknown.

Specimen(s) collected — number, gender, life stage

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Location(s) — general directions, specific x and y Universal Transverse Mercator (UTM) coordinates for pond(s) {(e.g., a) pond 1 and b) pond 2; for >2 ponds an area description without specific coordinates}

Habitat(s) — type; pH is *in situ* unless stated as equilibrated (eq) pH; specific conductance; (these data are for the pond); water depth; vegetation, (these data are for collection point(s) within pond(s) unless noted otherwise)

Date(s) collected — day/month/year

Identification key — reference(s)

AGABETES Crotch

A. acuductus (Harris)

Specimens collected — 5♀, 2♂ adults

Location — Massabesic Experimental Forest, Tatnic and Welch Hills area, and Cutts Island, York Co., USGS Quad. Maps - Alfred, North Berwick, and Kittery; UTMs ?

Habitat — Vernal pools; pH 4.5-5.7, specific conductance, 10-40 µmhos cm^{-1}, water depths (at deepest points in pools) 14.5-90 cm; vegetation ?

Dates collected — 19 Apr 95-30 May 95

Identification key — Peckarsky *et al.* (1990) to monotypic genus

ACILIUS Leach

A. mediatus (Say)

Specimen collected —1 ♀ adult

Location — Pettingill Brook near Coffin Road, 6.5 km w. of Washburn, Aroostook Co., USGS Quad. Map - Caribou, UTMs; x571750, y518050

Habitat — Beaver flowage; eqpH 8.42; specific conductance, 294 µmhos cm^{-1}; water depth, 20 cm; vegetation, 35% grass (Gramineae) and 15% speckled alder (*Alnus incana*)

Date collected — 8 Jul 93

Identification key — Hilsenhoff (1993)

A. sylvanus Hilsenhoff

Specimens collected — 4 ♀, 6 ♂ adults

Location — E. of Chaney Woods Rd., ? km, ? of Wells, York Co., USGS Quad. Map - North Berwick, UTMs ?

Habitat — Vernal pool; pH 5.3, specific conductance, 40 µmhos cm^{-1}; water depth (at deepest point in pool) 55 cm; vegetation, ?

Date collected — 08 July 1994

Identification key — Hilsenhoff (1993)

AGABUS Leach

A. erichsoni Gemminger and Harold

Specimens collected — 6 ♀, 3 ♂ adults

Location — Intersection of Moore Brook and Hardison Road, Caribou, Aroostook Co., USGS Quad. Map - Goodwin, UTMs; x580500, y518475

Habitat — Vernal pool; eqpH 8.04; specific conductance, 275 µmhos cm^{-1}; water depths, 13-17 cm; vegetation, 85% ash (*Fraximus* sp.) canopy with 15% emergent grass (Gramineae)

Dates collected — 16 Jun 93, 8 Jul 93

Identification key — Larson (1989)

A. phaeopterus (Kirby)

Specimens collected — 13 ♀, 15 ♂ adults

Location — Throughout a 2,500Km^2 area around Presque Isle, Aroostook Co.

Habitats — a) Beaver flowages; eqpH 6.49- 8.54; specific conductance, 19.7- 337 µmhos cm^{-1}; water depths, 13- 30 cm; vegetation, *Sphagnum* spp., *Scirpus* spp., *Carex* spp., and b) vernal pool; eqpH 8.04; specific conductance, 275 µmhos cm^{-1}; water depths, 13-17 cm; vegetation, 85% ash (*Fraxinus* sp.) canopy with 15% emergent grass (Gramineae)

Dates collected — a) 16 Jun 93, 8 Jul 93; b) 8 Jul 93

Identification key — Larson (1989)

A. semipunctatus (Kirby)

Specimens collected — 2 ♀, 1 ♂ adults

Locations — a) Ashland, Aroostook Co., USGS Quad. Maps - York Ridge, UTMs; x547900, y517480; and b) Bridgewater, Aroostook Co., USGS Quad. Maps - Echo Lake. UTMs; x576775, y515050

Habitats — a) Beaver flowage, eqpH 8.02; specific conductance, 63.3 µmhos cm^{-1}; water depth. 19 cm; vegetation, 40% sedge (Cyperaeeae) with 15% *.Spiraea latifolia*; and b) beaver flowage; eqpH 7.71, specific conductance, 40.6 µmhos cm^{-1}; water depth, 42 cm, vegetation, 60% rush (Juncaceae) with 10% sedge (Cyperaceae)

Dates collected — a) 8 Jul 93; b) 27 May 93

Identification key — Larson (1989)

GRAPHODERUS Dejean

G. perplexus Sharp

Specimens collected — 2 ♂ adults

Locations — a) Ginn Brook 6.5 km w. of Fort Fairfield following Marshall Currier Rd., Aroostook Co., USGS Quad. Map - Goodwin, UTMs; x581400, y517865; and b) Hammond Brook 6.5 km s. of Van Buren, Aroostook Co., USGS Quad. Map - Doyle Ridge, UTMs; x579500, y521250

Habitats — a) Beaver flowage; eqpH 8.56; specific conductance, 309 µmhos cm^{-1}, water depth, 45 cm vegetation, 60% *Typha latifolia;* and b) sedge meadow; eqpH 5.93; specific conductance, 13.1 µmhos cm^{-1}; water depth, 73 cm; vegetation, 10-60% *Scirpus cyperinus* and *Carex rostrata*

Dates collected — 8 Jul 93, 22 Jun 94

Identification key — Hilsenhoff (1993)

HYDATICUS Leach

H. aruspex Clark

Specimens collected — 23 ♀, 20 ♂ adults

Location — Throughout a 2,500 km^2 area around Presque Isle, Aroostook Co.

Habitats — a) Beaver flowages; eqpH 6.49-8.56; specific conductance, 19 7-337 µmhos cm^{-1}; water depths, 13-37 cm; vegetation, *Sphagnum* spp., *Scirpus* spp., *Carex* spp.; and b) vernal pool; eqpH 8.04; specific conductance, 275 µmhos cm^{-1}; water depths, 13-17 cm; vegetation, 85% Ash (*Fraxinus* sp.) canopy with 15% emergent grass (Gramineae)

Dates collected — a) 27 May 93 - 8 Jul 93; b) 8 Jul 93

Identification key — Roughley and Pengelly (1982)

HYDROVATUS Motschulsky

H. pustulatus (Melsheimer)

Specimen collected — 1 ♀ adult
Location — Norway, Oxford Co.; USGS Quad. Map ?, UTMs ?
Habitat — ?
Date collected — 3 Sep 69
Identification key — Young (1963)

MATUS Aubé

M. ovatus ovatus Leech

Specimens collected — 1 ♀, 5 ♂ adults
Locations — a) Upland forest w. of Old County Rd. between Chicks Brook and Ogunquit River, South Berwick, York Co., USGS Quad. Map - York Harbor, UTMs ?, and b) upland forest of Cutts Island, Kittery, York Co., USGS Quad. Map - Kittery, UTMs ?
Habitats — a) Vernal pool; pH 4.7; specific conductance, 37 µmhos cm^{-1}; water depth (at deepest point in pool) 34 cm; vegetation, ?; and b) vernal pools; pH 5.6-5.9; specific conductance, 67 µmhos cm^{-1}; water depths (at deepest point in pools) 35-87 cm; vegetation, ?
Dates collected — a) (6 Jul 94; b) 14 Jun 94, 9 Jul 94
Identification key — Young (1953)

NEOSCUTOPTERUS Balfour-Browne

N. angustus (LeConte)

Specimen collected — 1 ♂ adult
Location — Moosehead Lake, Piscataquis Co.; USGS Quad. Map ?, UTMs ?
Habitat — ?
Date collected — ? Sep 68
Identification key — Larson (1975)

RHANTUS Dejean

R. consimilis Motschulskv

Specimens collected - 1 ♀, 3 ♂ adults
Location — Intersection of Moore Brook and Hardison Road, Caribou, Aroostook Co., USGS Quad. Map - Goodwin, UTMs; x580500, y518475
Habitat — Vernal pool; eqpH 8.04; specific conductance, 275 µmhos cm^{-1}, water depths, 20-48 cm, vegetation, 15-60% grass (Gramineae), *Scirpus* spp., *Carex* spp. and horsetail *(Equisetum* sp.); one half of the sites contained 10 to 15% sweetgale *(Myrica gale)*
Dates collected — 27 May 93, 8 Jul 93
Identification key — Zimmerman and Smith (1975)

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FIRST RECORD OF *PTEROMALUS MICROPS* (HYMENOPTERA: PTEROMALIDAE) IN THE NEW WORLD[1]

Dean S. Volenberg[2], Steven J. Krauth[3]

ABSTRACT: The parasitoid *Pteromalus microps* (Hymenoptera: Pteromalidae), reared from *Gymnetron antirrhini* (Coleoptera: Curculionidae) on *Linaria vulgaris* (Magnoliopsida: Scrophulariaceae), is recorded for the first time in the New World.

In North America, *Linaria vulgaris* Mill. was introduced from Eurasia as an ornamental perennial in the mid-1600's (Darlington 1859). Commonly called yellow toadflax or "butter and eggs", the plant competes with native species and interferes with low-till agricultural practices (Darwent *et al.* 1975). Yellow toadflax has become a serious weed problem in *Mentha* spp. L. and has infested over 7,000 acres in Wisconsin (Eagan *et al.* 1992). Peppermint *Mentha piperita* L. and spearmint *Mentha cardiaca* Gerde. or *Mentha spicata* L. are grown for oils. Weeds impart off-flavors and colors to the oil upon steam distillation of weed contaminated mint hay (Ellis *et al.* 1941; Schmidt and Binning 1996). Laboratory studies of an exotic root mining lepidopteran as a potential biological control agent are being conducted. In conjunction, established areas of high density of yellow toadflax in Columbia, Dane, and Waukesha counties, Wisconsin were surveyed for insects. Yellow toadflax was swept with an insect net and seed pods were collected for possible facultative natural enemies. Sweep sample collections were identified using the available literature (Kissinger 1964; Buchanan 1937) and proved to be predominantly *Gymnetron antirrhini* Paykull 1800 (Coleoptera: Curculionidae) (O'Brien and Wibmer 1982) and *Brachypterolus pulicarius* (Linnaeus) (Coleoptera: Nitidulidae). Insect rearings from seed pods also yielded *G. antirrhini. Gymnetron antirrhini* adults fed on yellow toadflax shoot tips. Females deposit eggs singly into the pericarp of newly opened flowers. This causes the formation of a small conical protrusion on the plant ovary (Smith 1959). The larvae feed within the ovary consuming ovules (seeds) which are inactivated during oviposition (Smith 1959). Rearings from yellow toadflax seed pods collected in Columbia and Waukesha counties in Wisconsin yielded several pteromalid wasps as well as *G. antirrhini.* The wasps were identified as *Pteromalus* sp.

Specimens submitted to the Taxonomic Services Unit, Systematic Entomology Laboratory, U.S.D.A., A.R.S., Beltsville, MD were identified as

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Pteromalus microps (Graham). This is the first New World record for this Palearctic species. *Pteromalus microps* was described in 1969 from specimens taken in Ireland and Britain (unlocalized) from the same curculionid host. It would appear that it was accidentally introduced along with the weevil which was released for purposes of biological control of *Linaria* (E.E. Grissell, pers. comm.). Species of *P. microps* are metallic-green with or without reflections of blue. The coxae and femora, except their tips, are concolorous with the thorax; trochanters partly dark; rest of legs testaceous with tips of tarsi fuscous: the fore tarsi mainly brownish. Wings hyaline; venation yellowish or testaceous. Length 2.6 to 3mm. Males are easily recognized by the characters of the oral fossa, mandibles, ocelli, antennae and propodeum (Graham 1969). Members of the genus attack the egg, larval and pupal stages of hosts in the orders Lepidoptera, Coleoptera and Diptera. One member of the genus is a hyperparasite of *Bruchophagus* (Hymenoptera: Eurytomidae).

Voucher specimens from these collections are deposited in the Insect Research Collection of the Department of Entomology, University of Wisconsin-Madison. More recently, *P. microps* has been reared from *Mecinus janthinus* (Coleoptera: Curculionidae: Gymnetrinae) in Alberta (Alec McClay, pers. comm.).

MATERIAL EXAMINED: WI: Columbia Co., University of Wisconsin Madison, Arlington Experimental Farms, Coll: 4-VIII-1995, emerged from pods of *Linaria vulgaris*, Coll: D. Volenberg, six females. Waukesha Co., Kettle Moraine State Forest, Coll:25-VIII-1994, Emerged:26-IX-1994, from seed pods of *Linaria vulgaris*, Coll: D. Volenberg, two males, one female. Waukesha Co., Kettle Moraine State Forest, Coll:26-IX-1994, sweep samples, Coll: D. Volenberg, three males, two females.

ACKNOWLEDGMENTS

We acknowledge with thanks the species level identification of *P. micros* by Eric Grissell of the Systematic Entomology Laboratory, USDA, ARS, Beltsville, MD. All other identifications were performed by the junior author. Funding for this study was provided by Hatch Funds #142D672 directed by H. J. Hopen, Department of Horticulture, College of Agricultural and Life Sciences, University of Wisconsin-Madison. We thank H. J. Hopen and D.L. Mahr, Department of Entomology, Wisconsin for reviewing the manuscript.

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BOOK REVIEW

INSECTS OF THE GREAT LAKES REGION. Gary A. Dunn. 1996. University of Michigan Press. 324 pp. $42.50 Cloth, $17.50 ppbk.

In this book, the author has done an excellent job of presenting an overview of the insects of the Great Lakes Region. Although intended for localized, Great Lakes Region readership in its introductory background information and in species selection throughout, much of the subject matter is readily applicable to anywhere in northeastern and north middle America and south central Canada.

Introductory material includes a chapter on the geological and biological history of the Great Lakes Region covering subjects such as formation of the Great Lakes, landforms and soils of the region, climatic factors, pre- and post-glacial plant and insect biology and dispersal, and the current environment of the region. Another chapter covers the entomological history of the region, including introduced and endangered insects while a third introductory chapter presents a comprehensive review of distributional patterns of insects in the Great Lakes Region.

Following introductory information on insect classification and a key to the orders of adult insects in the region, the main text consists of descriptive writing, with marginal illustrations, of each of the major orders and families of common insects to be found in the region. For each order, the text presents a short introduction followed by sections on over-all descriptions, life cycles, habits and habitats, ecological and economic status, and distribution. For each family, selected specific insects are identified by both common and scientific names followed by a brief, identifying description. For most families there is a final paragraph citing sources for additional information on identifications and life histories that are included in the bibliography.

A unique feature of this book is a number (9) of "Quick Guides to Identification" in the form of tables organized by diagnostic characteristics that provide ready assistance to more easily separate the orders, and the families in the major orders. Completing the book is a glossary, an extensive bibliography, an index, and several appendixes listing entomological organizations, periodicals, institutional collections, zoos and butterfly houses, and collecting regulations, all dealing with insects of the Great Lakes Region. Overall, this book would seem to be an introductory MUST for amateur entomologists and insect enthusiasts as well as the general public throughout the Great Lakes Region.

H.P.B.

SCIENTIFIC NOTE

PREDATION BY *ENALLAGMA CIVILE* (ODONATA: COENAGRIONIDAE) ON ADULT SWEETPOTATO WHITEFLY, *BEMISIA TABACI* (HOMOPTERA: ALEYRODIDAE)[1]

Paul W. Schaefer[2], Susan E Barth[2], Harold B White, III[3]

During a search for natural enemies of sweetpotato whitefly, *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae), on September 1, 1995, PWS and SEB observed a female damselfly, *Enallagma civile* (Hager) (Odonata: Coenagrionidae), actively searching whitefly- infested leaves of soybean plants in a field, 3 km south of Sudlersville, Queen Anne's County, Maryland. The female patrolled a limited area among the plant rows near the edge of a large soybean field on the north side of Racetrack Road. Patrolling behavior suggested that this damselfly was feeding on the only observable potential prey species present, the sweetpotato whitefly. After several minutes, we noted a series of behaviors as the female alighted on an exposed soybean leaf and rested for up to 20 seconds before moving to another vantage point. Then in the midst of this ongoing, repetitive behavior, a predatory search was performed in which a hovering flight appeared to focus on the generally vertical upper surface of a drooping leaf of a soybean plant, made particularly limp by a continuing drought. The female hovered nearly perpendicular to the plane of the leaf and approximately 1-2 cm from the surface. In this position, we twice observed the female move over a target adult whitefly and pounce by quickly flying close enough to the surface to grab the adult whitefly, apparently using a combination of legs and mandibles to secure a hold on the prey and then move again to alight on another leaf. There it appeared to complete feeding on the catch and continue to rest as before. Within about 3 minutes, we observed this routine twice before we intervened by catching the female with a quick swipe of the hand, although not without missing twice previously. Following the misses, the female flew only a short distance before settling promptly on another leaf. This was repeated until we collected it and HBW subsequently identified it and incorporated the specimen into his collection.

According to Byers (1930), who provides a description of this species, *E. civile* is relatively small, measures ca. 30 mm in length, and is widespread in North America. We find no records of acceptable prey of *E. civile*. Although we generally expect Odonata to feed on the wing, Corbet (1962) notes that these insects also cruise over surfaces and will take stationary prey. He cites a number of examples, including one of a congener, *E. cyathigerum* Charpentier, recorded as feeding by hovering over a bush and removing beetle larvae from the leaves. Furthermore, Corbet states that this method of feeding appears more frequently in the Zygoptera than in the Anisoptera.

Mound and Halsey (1978) listed the natural enemies of sweetpotato whitefly, but they do not record any Odonata as predators. Although we cannot envision predation by *E. civile* having much biological control impact on a flourishing population of sweetpotato whitefly, our observations suggest that this damselfly has readily adapted to a new prey species under typical agricultural conditions present on the eastern shore of Maryland. We can only suggest that this predation has more of an impact than imagined, particularly at low whitefly population levels. Clearly, *E. civile* is an opportunistic predator that has behaviorally adapted to feeding on a stationary and previously unavailable prey.

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SCIENTIFIC NOTE

DISCOVERY OF THE MILLIPED *CONOTYLA BLAKEI*, IN CANADA (CHORDEUMATIDA: CONOTYLIDAE)[1]

Rowland M. Shelley[2], Laurent LeSage[3]

The conotylid diplopod, *Conotyla blakei* (Verhoeff), occurs in caves and epigean environments in West Virginia, Maryland, Pennsylvania, New York, Massachusetts, Vermont, and New Hampshire (Shear 1971). Kevan (1983) added Maine and reported questionable Canadian occurrence in southern Québec based on unpublished material. The location of his material is unknown, so the citation is not verifiable. Shelley (1988) could only list the milliped as potential for the province because of proximate records in the adjacent United States, but he included it in the second half of couplet 12 in a key to east Canadian species. We now confirm *C. blakei* from Canada and Québec based on an adult male from Parc de la Gaspésie on the Gaspé Peninsula; its gonopods conform closely to the illustrations by Shear (1971, figs. 17-18). The specimen was collected by F. Landry, 25-28 September 1991, from a pitfall trap in a conifer forest near Lake Caribou and is housed at the Centre for Lands and Biological Resources, Ottawa. While *Conotyla* is known from eastern Canada based on a juvenile female from Algona County, Ontario (Shelley 1988), this discovery adds a new species, genus, and family to the provincial fauna and represents a new species for the country. The genus and family are also well known from western Canada, as *C. atrolineata* (Bollman), *C. albertana* Chamberlin and *Austrotyla borealis* Shear occur widely in the Rocky Mountains of Alberta and British Columbia (Shear 1971, Shelley 1990).

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RELEASES OF *DINORHYNCHUS DYBOWSKYI* IN U.S.A. (HETEROPTERA: PENTATOMIDAE) AND APPARENT FAILURE TO ESTABLISH[1]

Paul W. Schaefer[2]

ABSTRACT: During the period of 1979-1981, nymphs of *Dinorhynchus dybowskyi* were released at 4 sites in three states. At Wethersfield, CT, one egg mass (containing 48 eggs) was found indicating successful reproduction had occurred in at least one pair of released individuals. Those eggs successfully overwintered but only 15% hatched due to high mortality, including 21% parasitism by *Anastatus japonicus (=disparis)*. Field surveys in 1982, 1983 and 1995 at former release sites all failed to reveal any evidence of *D. dybowskyi* establishment.

Dinorhynchus dybowskyi Jakovlev (Heteroptera: Pentatomidae: Asopinae) is an arboreal predator of lepidopteran and coleopteran larvae in eastern Asia. Biological details were previously published (Schaefer *et al.* 1979), in anticipation of D. *dybowskyi* being released in the U.S. as a potential natural enemy of the gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Lymantridae). Culminating efforts to introduce *D. dybowskyi* as a beneficial predator of larvae, pupae, and adults of the gypsy moth, I report herein on the releases made and the eventual outcome — the apparent failure of *D. dybowskyi* to establish.

METHODS

All rearing methods employed have appeared previously (Schaefer *et al.* 1979), except egg masses collected in Japan that were held in outdoor screen cages until early spring and subsequently sent under permit to the Beneficial Insects Introduction Research quarantine facility at Newark, Delaware. There, eggs were held in periodically moistened petri dishes with screen vents in the lids. Upon hatching, nymphs were provided only with distilled water in cotton wicks. After first molt, nymphs were provided *ad libitum* with early instar gypsy moth larvae. When the majority of nymphs were in the 2nd and 3rd stadia, they were prepared for release.

Releases: At the time of field release, the standard paper shipping containers were opened and active *D. dybowskyi* nymphs were allowed to crawl from the container onto the bark of oaks *(Quercus* spp.) or other trees known to be infested with gypsy moth. To distribute nymphs over a wider area, only 12 - 14 nymphs were placed on each mature tree, but selected trees were generally those with contiguous crowns to provide easy access to nearby trees should food become scarce.

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Recovery Attempts: At each release site, during fall after leaves had fallen, at least one egg mass search was made. Searches consisted of carefully looking for the double rows of vertical eggs characteristic of *D. dybowskyi* (see Schaefer *et al.* 1979, Fig. 1). Tree boles (especially on smooth barked trees) were searched for eggs, as suggested by previous experience and observations made in northern Japan.

Final Survey: In the early spring of 1995, a final follow-up survey was made at each of the 1981-82 release sites to determine if any evidence existed that *D. dybowskyi* had survived and established. Because egg masses adhere to tree boles for years, it was believed these egg mass remains could be found to confirm establishment.

RESULTS

Releases: In spring during the years 1979 - 1981, 1,704 nymphs of *D. dybowskyi* were released at 4 sites in 3 states as indicated (Table 1). These releases constitute the only attempt at establishment of this predator in the U.S. to date.

Recovery Evidence and Egg Survival: During 2 to 15 search hours spent per site in the fall of 1980, only one egg mass was found. On December 27, 1980, at Wethersfield, Conn., one *D. dybowskyi* egg mass containing 48 eggs was found on the trunk of a red maple, (*Acer rubrum* L.) tree (dbh 12.7 cm), located 160 cm above ground on the southeast aspect. At this time, a coarse

Table 1. Intentional releases of *Dinorhynchus dybowskyi* in U.S.A., 1979 - 1981.

Location	Date	No. Nymphs Released
Pennsylvania,		
Wayne Co., Lake Henry	May 31-June 5, 1979	65
Cumberland Co.,		
Col. Denning St. Park	May 9, 1980	566
	May 23, 1981	118
Maryland,		
Cecil Co., Belvidere	May 5, 1980	515
	May 19-22, 1981	92
Connecticut,		
Hartford Co., Wethersfield	May 15, 1980	287
	May 25, 1981	61
Total		1,704

grade hardware cloth guard was placed over the egg mass to provide protection during the remainder of the winter. At this time it was noted that seven of the 48 eggs had been damaged by a mandibulate predator.

The *D. dybowskyi* egg mass remained in position until May 25, 1981, when it was ascertained that some eggs had already hatched. The egg mass was removed on a strip of bark, returned to the laboratory, and held for further nymph emergence. This resulted in the emergence of unusually large specimens of *Anastatus disparis* Ashmead (Hymenoptera: Eupelmidae) (Identified by M. Schauff, USDA, SEL, Beltsville, MD) but *A. japonicus* may now be the correct name[a]. These eupelmids emerged from ten eggs, while 17 other eggs were damaged by predators. Fourteen others remained inviable from undetermined causes, and only 7 (15%) *D. dybowskyi* eggs had successfully hatched (based on successful removal of the operculum by hatching nymphs).

Final Survey: During the 1995 final field survey, 4.2, 2.5, and 3.3 hours were spent searching the precise release sites in Pennsylvania, Maryland, and Connecticut respectively. No evidence (old or current egg masses) of the presence of *D. dybowskyi* was found anywhere.

DISCUSSION

Although the possibility remains that establishment has occurred but gone undetected, I regard this unlikely given the apparent suitable conditions under which releases occurred and the collective hours spent in search of eggs. Probably insufficient numbers released at any one site was one cause for failure to establish. Another was certainly the unusual environmental resistance observed based on the predation, parasitism and unknown mortality exhibited in the one egg mass found. The fact that this one egg mass was found in Wethersfield, Connecticut and that some nymphs emerged the following spring, suggests that environmental conditions and habitat were suitable for survival during that season, including winter. Clearly one pair (out of 287 nymphs released at the site that season) survived the season, successfully mated, and the female oviposited (probably during September or October 1980).

Concerning the fate of the entire 48 egg complement, it is evident that severe environmental resistance must be overcome to achieve successful establishment since only 15% of the deposited eggs hatched the following spring. Predation by a mandibulate predator, possibly ants or birds, caused 35% mortality, unknown factors caused 29% mortality, and parasitism caused 21% mortality. It is ironic the gypsy moth egg parasitoid, *A. japonicus,* accepted this novel egg mass as a suitable host.

One of two possible explanations exists: (1) that *A. japonicus* is highly opportunistic since a female readily stung newly encountered exotic eggs, or (2) that a re-establishing of an old host-parasite association occurred since *Anastatus* sp. from gypsy moth was first imported and released from both Japan and Europe in 1908 (at that time this insect was known as *Anastatus bifasciatus,* see Howard & Fiske 1911). This host-parasitoid relationship may simply be the reestablishing of an old association that has been suppressed since 1910 when *A. japonicus* was first established in Massachusetts. Unfortunately, it is uncertain at what levels *A. japonicus* parasitizes eggs of *D. dybowskyi* in eastern Asia (but see footnote[3]).

Although the effort to introduce *D. dybowskyi* into the gypsy moth natural enemy complex in North America apparently failed, I believe the potential for beneficial impact on gypsy moth populations is sufficient to warrant further efforts to introduce *D. dybowskyi* into North America.

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[3] Considerable discussion and uncertainty surrounds the correct use of the specific names, *Anastatus disparis* and *A. japonicus.* The Hymenoptera catalog (Burks 1979) continued to recognize *A. disparis* but several others outside the U.S. accept the name *A. japonicus* (Kalina 1981; Zelinskaya 1981; Hirose *et al.* 1968) and indications are that U.S. chalcidoid specialists are increasingly inclined to accept *A. japonicus* (G. Gordh, pers. comm. dtd 18 XI 1976 and M. Schauff, pers. comm. dtd 9 I 1992). However, definitive supportive biological evidence is still needed since attempted crosses of "*A. japonicus*" from gypsy moth eggs in Japan appeared to remain reproductively isolated from the larger "*A. japonicus*" from *Dinorhynchus dybowskyi* eggs also from Japan (R. Fuester and P. Taylor, USDA, Beneficial Insects Res. Lab., Newark, DE, unpubl. 1980 data). This would continue to suggest that a complex of species may be confused herein, now simply placed under the *A. japonicus* name.

In addition to a known association of *A. japonicus* from *D. dybowskyi* eggs in Japan, a dead specimen of *Telenomus* sp. was removed from these same host eggs in February 1979 (Schaefer, unpubl. record, specimen identified by K. Kamijo, Hokkaido Forest Experiment Station, Bibai, Hokkaido, Japan).

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ADVENTIVE LADY BEETLES (COLEOPTERA: COCCINELLIDAE) IN THE CANADIAN MARITIME PROVINCES, WITH NEW EASTERN U.S. RECORDS OF *HARMONIA QUADRIPUNCTATA*[1]

E. Richard Hoebeke[2], A. G. Wheeler, Jr.[3]

ABSTRACT: New distributional data are given for four Old World aphidophagous lady beetles (Coccinellidae) occurring in the Maritime Provinces of Canada, some of which represent new provincial records. Records are cited for *Scymnus* (*Pullus*) *suturalis* from Nova Scotia, for *Harmonia axyridis* from New Brunswick and Nova Scotia, and for *Propylea quatuordecimpunctata* and *Hippodamia variegata* from New Brunswick, Nova Scotia, and Prince Edward Island. New eastern U. S. records are also given for the immigrant *Harmonia quadripunctata*.

Lady beetles (Coccinellidae) are among the most familiar and important groups of predatory insects, and they have been used extensively in classical biological control (Balduf 1935; Hagen 1962, 1974). Various Old World species have been introduced and released in eastern North America in attempts to suppress populations of pest aphids and other homopterans (Gordon 1985; Gordon and Vandenberg 1991). Several adventive coccinellids have become established in the east since the 1970s, either from intentional releases or accidental introduction with commerce (Schaefer and Dysart 1988; Day *et al.* 1994).

As part of our continuing studies of adventive insects in the Maritime Provinces of Canada (Hoebeke and Wheeler 1996), we collected coccinellids in New Brunswick, Nova Scotia, and Prince Edward Island in June 1993 and July 1994-1995. Sweep-net sampling of herbaceous vegetation was conducted in disturbed sites such as urban lots near ports of entry. We also concentrated on college and university campuses, public gardens, and other areas considered vulnerable to invasion by exotic insects, combining sweep-net sampling of weeds with the beating of branches of trees and shrubs over a shallow net.

Here we report and map new distributional data for four exotic lady beetles occurring in the Canadian Maritime Provinces: the scymnine *Scymnus* (*Pullus*) *suturalis* Thunberg and the coccinellines *Propylea quatuordecimpunctata* (L.), *Hippodamia variegata* (Goeze), and *Harmonia axyridis* (Pallas). Our collecting also confirms the widespread occurrence and abundance of *Coccinella septempunctata* (L.) (C7) throughout the Canadian Maritime Provinces (see Schaefer *et al.* 1987), but these records are not reported here. New eastern U.S. records are also cited and mapped for the adventive *Harmonia quadripunctata* (Pontoppidan). Voucher specimens of all species are deposited in the Cornell University Insect Collection, Ithaca, NY (CUIC), unless noted otherwise.

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Scymnus (Pullus) suturalis Thunberg

Releases and Establishment: This European coccinellid was first reported from North America by Gordon (1976), based on collections from Pennsylvania (cited as *S. coniferarum*); he later added a record from New York (Gordon 1982). Records are now available for Connecticut and Michigan (Hoebeke 1984, Wheeler 1992), Maryland and Virginia (Wheeler 1987), Quebec, Canada (McNamara 1992), and Massachusetts and Rhode Island (Lyon and Montgomery 1995).

Gordon (1982) suggested that *S. suturalis* has been established in North America since the early 1900s and was probably accidentally introduced with shipments of conifer nursery stock prior to plant quarantine laws. In 1961, this

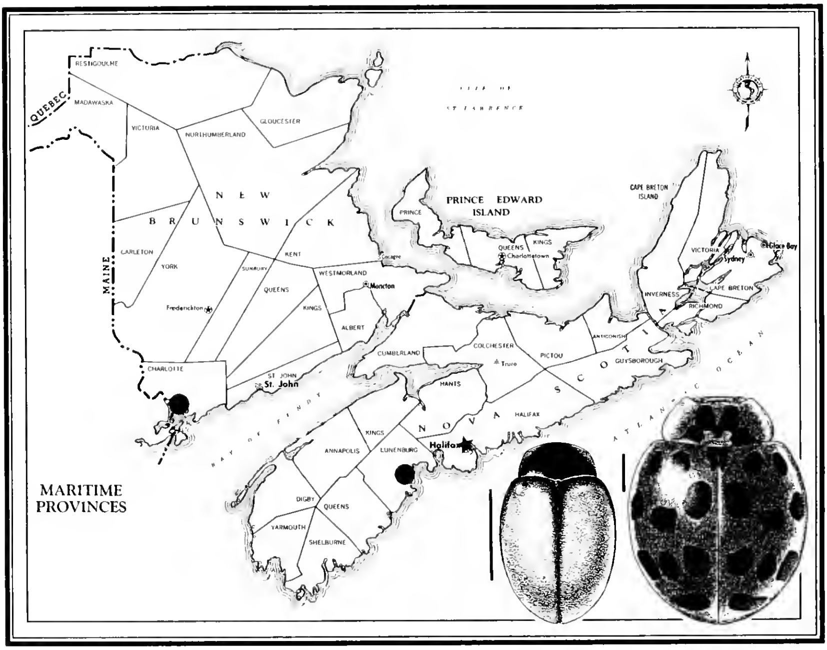

Figure 1. Known distribution of *Scymnus* (*Pullus*) *suturalis* (star) and *Harmonia axyridis* (circle) in the Canadian Maritime Provinces. Habitus illustration (on left) representing *S. suturalis* is from Gordon (1982: fig. 7, p. 253). **Note**: this figure is actually of *S. coniferarum* Crotch, which is nearly identical to *S. suturalis*, except that the body of *S. coniferarum* is more elongate (slightly broader, less elongate in *S. suturalis*), with elytral punctures small, separated by about 2 times diameter of a puncture (elytral punctures coarse, dense, separated by diam. of puncture or less in *S. suturalis*); male and female genitalia of both species are quite different (compare figures 2-6 and 8-12 in Gordon, 1982). Habitus illustration (on right) of *H. axyridis* is from Gordon and Vandenberg (1991: fig. 9, p. 52). Scale lines = 1.0 mm.

aphid and adelgid predator was released at two localities in Michigan (Clinton and Ottawa counties), based on reared stock obtained from Germany (Hoebeke 1984). In North America, this Palearctic species occurs principally on conifers, with most records from *Pinus sylvestris* L., but also *P. resinosa* Ait., *P. strobus* L., *Picea pungens* Engelm., and *Tsuga canadensis* (L.) Carr.

New Maritime Record: The one collection made in Nova Scotia (Fig.1) represents a NEW MARITIMES PROVINCIAL RECORD.

NOVA SCOTIA: Halifax Co., Halifax, Dalhousie University campus, 26 June 1993 (ex *P. sylvestris*).

Propylea quatuordecimpunctata (L.)

Releases and Establishment: This common Palearctic aphid predator, the so-called fourteen-spotted lady beetle (hereafter PQ), was first intentionally introduced into the United States in 1968 to help control greenbugs (*Schizaphis graminum* [Rondani]) in the Great Plains states (Ellis and Adams 1993). It was reared and released in Delaware, New Jersey, and Oklahoma beginning in 1970, but no recoveries of beetles were made at release sites in these states. Between 1987 and 1992, it was propagated and released in 16 western states as a potential control agent of the newly detected Russian wheat aphid, *Diuraphis noxia* (Mordvilko), which was first found in the West beginning in 1986. It was also propagated and released in Georgia, Iowa, Indiana, Maryland, Michigan, Minnesota, Missouri, New Jersey, and Pennsylvania in 1989 and 1990. Although establishment of PQ has been confirmed in the eastern United States (Maine, Massachusetts, Connecticut, New Hampshire, New Jersey, Pennsylvania, Rhode Island, Vermont, and New York (Dysart 1988; Wheeler 1990, 1993; Ellis and Adams 1993; Day *et al.* 1994; Yanega 1996) and in eastern Canada (McNamara 1991), it has not been recovered from any of the 16 western states. PQ was first observed as an established population in eastern North America in 1968 near Quebec City (Ste. Foy), Quebec (Chantal 1972; Ellis and Adams 1993), and in the United States in Grand Isle County, Vermont, in August 1984 (Dysart 1988; Day *et al.* 1994).

It has been suggested that, in spite of repeated attempts to establish PQ through release programs, its establishment may have resulted from an accidental introduction into North America by transoceanic shipping through the St. Lawrence Seaway system (Schaefer and Dysart 1988; Day *et al.* 1994).

Canadian Maritime Records: McNamara (1991) recorded PQ from Ontario, Quebec, and New Brunswick. During late June 1993 and July 1994-1995, we collected PQ from the following localities (Fig. 2); Nova Scotia and Prince Edward Island are NEW PROVINCIAL RECORDS.

NEW BRUNSWICK: Charlotte Co., St. Stephen, 24 June 1993.

NOVA SCOTIA: Colchester Co., Truro, 25 June 1993; Truro, 22 July 1995 (ex *Vicia* sp.). Halifax Co., Dartmouth, 26 June 1993; Halifax, 26 June 1993 (ex *Physocarpus opulifolius*); Halifax, 17 July 1994 (ex *Trifolium pratense*); Halifax, 20 July 1995. Pictou Co., Pictou, 22 July 1994 (ex *Artemisia vulgaris, Arctium minus*); Pictou, 22 July 1995; Rte.104 at Rte. 347, 22 July 1995. Antigonish Co., Antigonish, 22 July 1994 (ex *Trifolium pratense*). (Cape Breton Island) Inverness Co., Port Hawkesbury, 23 July 1995. Richmond Co., Chapel Island, 23 July 1995. Cape Breton Co., Sydney, 23 July 1995.

PRINCE EDWARD ISLAND: Queens Co., Charlottetown, 23 July 1994. Prince Co., Summerside, 26 July 1995 (ex *Trifolium pratense*).

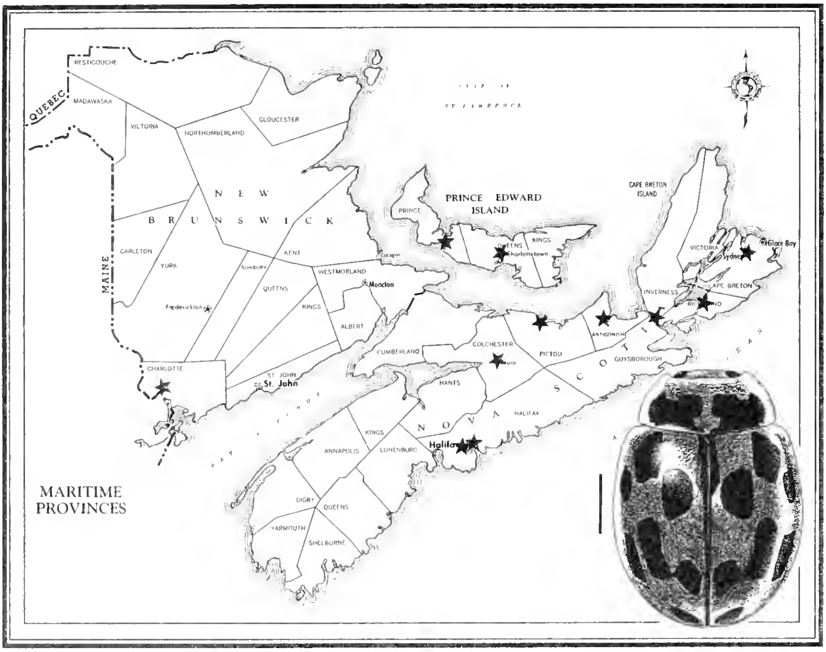

Figure 2. Known distribution of *Propylea quatuordecimpunctata* in the Canadian Maritime Provinces. Habitus illustration is from Gordon and Vandenberg (1991: fig. 3, p. 48). Scale line = 1.0 mm.

Hippodamia variegata (Goeze)

Releases and Establishment: This Old World coccinellid (hereafter HV) was first recorded from North America by Gordon (1987), with established populations found in the vicinity of Montreal, Quebec, in 1984. Beginning in 1957-1958, this aphid predator had been released in the western and southern United States (Arizona, California, Florida, and Georgia), but with no known releases in Canada (Gordon 1985, 1987). Beginning again in 1987, various strains of Eurasian HV were released in several eastern and western states, including Colorado, Kansas, Maryland, Massachusetts, New Mexico, Pennsylvania, and New Jersey (Obrycki and Orr 1990; Flanders *et al.* 1991).

Gordon and Vandenberg (1991) and McNamara (1991) recorded HV from Quebec and Ontario, respectively, while Wheeler (1993) provided new locality records to extend HV's range to the northeastern United States: Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. This species is also known from Maine (Ellis and Adams 1993). Like PQ, HV is thought to have been accidentally introduced into North

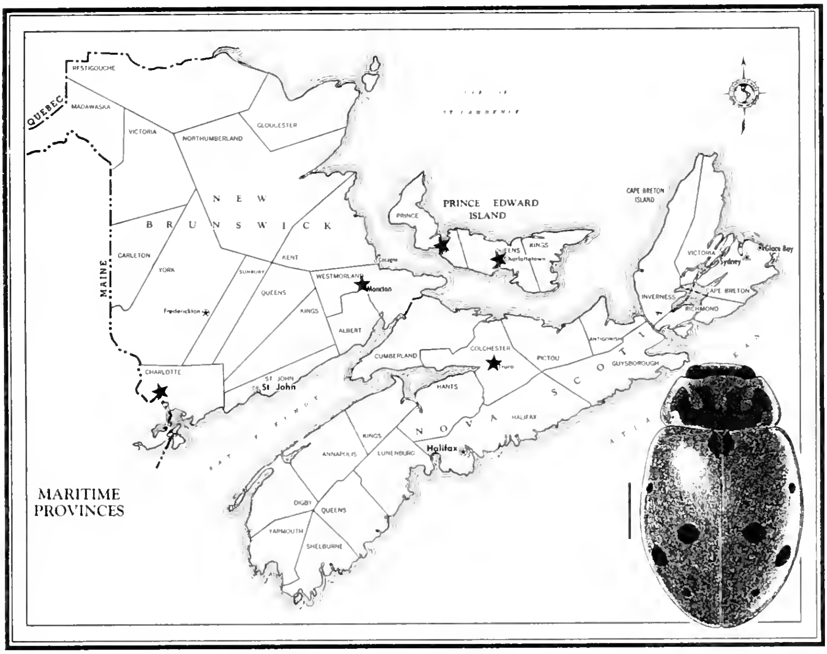

Figure 3. Known distribution of *Hippodamia variegata* in the Canadian Maritime Provinces. Habitus illustration is from Gordon and Vandenberg (1991: fig. 6, p. 50). Scale lines = 1.0 mm.

America by transoceanic shipping through the St. Lawrence Seaway (Schaefer and Dysart 1988; Day *et al.* 1994).

Canadian Maritime Records: The following locality records (Fig. 3) are the first for New Brunswick, Nova Scotia, and Prince Edward Island (NEW PROVINCIAL RECORDS).

NEW BRUNSWICK: Charlotte Co., St. Stephen, 24 June 1993. Westmorland Co., Moncton, 25 June 1993.

NOVA SCOTIA: Colchester Co., Truro, 22 July 1995 (ex *Vicia* sp., *Tanacetum vulgare*).

PRINCE EDWARD ISLAND: Prince Co., Summerside, 26 July 1995 (ex *Trifolium pratense*). Queen Co., Charlottetown, 26 July 1995.

Harmonia axyridis (Pallas)

Releases and Establishment: Several attempts have been made to introduce this exotic lady beetle into North America. Recorded releases include California (in 1916, and again in 1964-1965), Connecticut, Delaware, District of Columbia, Georgia, Louisiana, Maine, Maryland, Mississippi, Ohio, Pennsylvania, Washington, and Nova Scotia (1978-1982), and again Connecticut (1985) (Gordon, 1985; Tedders and Schaefer 1994). An unspecified number of specimens were also released into pine trees in the Kentville area of Nova Scotia in 1983 (H. B. Specht, pers comm.).

Establishment of the multicolored Asian lady beetle was first reported in Louisiana in 1988 and in several counties in Mississippi in 1990 (Chapin and Brou 1991). *Harmonia axyridis* now occurs nearly throughout the eastern United States, with especially large populations recorded in the mid-Atlantic region and New England. It has recently been recorded from Canada in an apple orchard in Quebec (Frelishburg) (Coderre *et al.* 1995) and from the western United States in Vancouver, Washington; western Oregon (LaMana and Miller 1996); and in Yolo and Sacramento counties in California (Dreistadt *et al.* 1995).

Canadian Maritime Records: There are no previous reports in the literature mentioning recovery records or establishment of *H. axyridis* in the Maritime Provinces. In late July 1995, we collected a single specimen from flowers at a roadside parking area south of Halifax, along the coast, and additional specimens were collected in the southwestern corner of New Brunswick in October 1995 (Yves Bousquet, pers. comm.) (Fig. 1). In early August 1995, specimens of *H. axyridis* were observed, but not collected, on potatoes at Barton, Nova Scotia (Digby Co.) (H. B. Specht. pers. comm.).

NEW BRUNSWICK: Charlotte Co., St. Andrews, 7 October 1995, W. Robichaud (deposited in Canadian National Collection, Ottawa).

NOVA SCOTIA: Lunenburg Co., Mahone Bay, 21 July 1995.

Harmonia quadripunctata (Pontoppidan)

North American Records and Establishment: This Old World lady beetle of the tribe Coccinellini was first reported from North America based on eight specimens from New York (Mt. Kisco) and New Jersey (Paterson and Westfield) (Vandenberg 1990). According to Vandenberg, these specimens represent a minimum of 3 separate collection events, spanning > 54 years and a linear distance of about 50 miles (= 80km). The earliest collection was made in 1924

(Paterson, NJ) and the most recent in 1979 (Mt. Kisco, NY). The proximity of the three collection sites led Vandenberg (1990) to suggest that the 8 specimens (with similar color patterns) descended from a single long-established population and that the species probably was accidentally introduced to the east coast of North America with European shipping.

Additional North American localities from specimens in the CUIC extend the known range in eastern North America from Kingston, Rhode Island, to Ithaca, New York.

New Eastern North American Records: The following distributional data are taken from 18 specimens housed in the CUIC. All previously reported locality records and new records given below are mapped in Fig. 4.

NEW JERSEY: Bergen Co., Bergenfield, 1 November 1936, 24 May 1942, 14 June 1944 ("at light"), F. M. Schott (4); Ridgefield Park, 12 January 1927, F. M. Schott, "under bark of sycamore" (1); Teaneck, 18 December 1924, F. M. Schott, "under bark of elm" (3); Wallington, 31 January 1930, F. M. Schott, "under bark in colony of *A[dalia]. bipunctata*," (1). Passaic Co., Paterson, 25 and 27 February 1924, "under bark silver maple" (3).

NEW YORK: Nassau Co., Lynbrook, 26 June 1976, G. C. Eickwort (3). Tompkins Co., Ithaca, Cornell Univ. campus, 15 September 1965, ex "Austrian pine" (2).

RHODE ISLAND: Washington Co., Kingston, Univ. of Rhode Island campus, 29 May 1988, E. R. Hoebeke and A. G. Wheeler, ex "Scotch pine" (1).

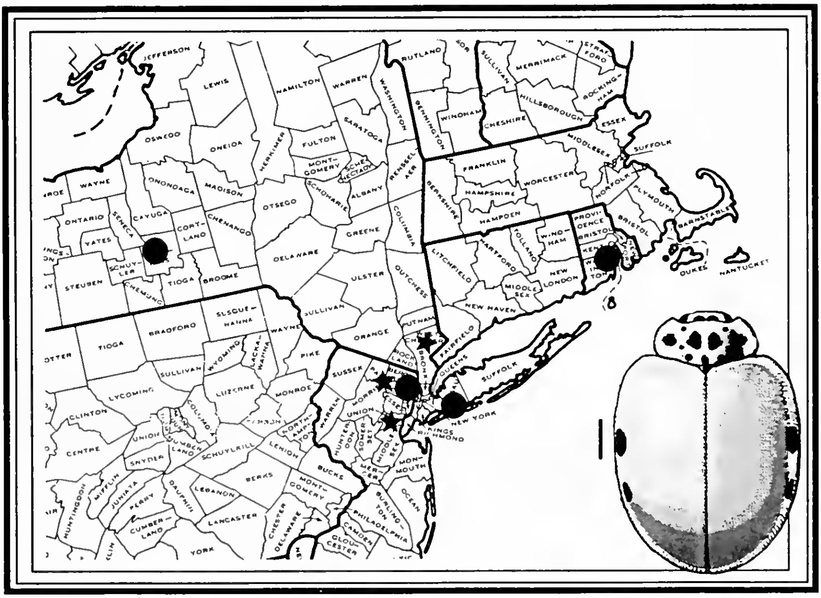

Figure 4. Revised distribution of *Harmonia quadripunctata* in the eastern United States; previous records reported in Vandenberg (1990) denoted by stars (★) and new records by circles (●). Habitus illustration is from Gordon and Vandenberg (1991: fig. 12, p. 52). Scale line = 1.0 mm.

DISCUSSION

Although long-term monitoring of coccinellid populations throughout the growing season is needed, our field work in June or July of three consecutive years in Nova Scotia and two in Prince Edward Island represents more than casual collecting. Intensive sampling along almost the entire coast of Nova Scotia, including repeat collections at several sites, allows us to comment on the status of the four adventive species in the Maritime Provinces.

PQ was the most widely distributed and most numerous species associated with herbaceous weeds in disturbed sites. HV was collected at only two sites in both New Brunswick and Prince Edward Island, and was found only at Truro in Nova Scotia. Its apparent absence from other sites in Nova Scotia and detection in 1995 at a site in Truro where sampling had failed to yield specimens in 1993 and 1994 suggest that this lady beetle is just beginning to become established in the province. *Scymnus suturalis* was taken only at Halifax despite our sampling of Scotch pine at numerous other sites in the Maritime Provinces, suggesting that it has a limited maritime distribution. To our knowledge, adults of *Harmonia axyridis* have been collected at only two sites in the Maritimes: at St. Andrews, New Brunswick, and at Mahone Bay, Nova Scotia, both in 1995. In the 1990s this Asian species has rapidly spread northward from the southern states, its populations exploding in the mid-Atlantic and New England states (Coderre *et al.* 1995; Kidd *et al.* 1995; Hoebeke and Wheeler unpubl. data). It appears to be a very recent arrival in New Brunswick and Nova Scotia.

The origin of most adventive coccinellids in eastern North America is equivocal. Some species may have become established as a result of biological control releases, but most were probably accidentally introduced with maritime commerce: at coastal seaports or inland along the St. Lawrence Seaway (Day *et al.* 1994; DeQuattro 1995). Regardless of their origin, these Old World species are probably permanent members of our fauna, and their further spread should be documented. Their presence in North America should be largely beneficial, helping to suppress populations of injurious aphids and adelgids (Tedders and Schaefer 1994; Lyon and Montgomery 1995; DeQuattro 1995).

Possible adverse effects on humans and the environment (Coderre *et al.* 1995) should also be considered. *Harmonia axyridis* has become a household nuisance because of its tendency to invade houses and other structures in fall (e.g., Lyon 1994), sometimes aggregating by the hundreds or thousands (Hoebeke and Wheeler pers. observ.). The establishment of *Coccinella septempunctata* (C7) may be detrimental to native coccinellids such as *C. novemnotata* Herbst (Wheeler and Hoebeke 1995, and references therein). The presence of several adventive coccinellids in eastern North America affords researchers an opportunity to evaluate interactions between the polyphagous aggressive immigrants C7 and *H. axyridis* and to attempt to assess the effects that these and other adventive coccinellids might have on native lady beetles and on natural and managed systems.

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STATUS AND SPREAD OF THE PALEARCTIC LADY BEETLES *HIPPODAMIA VARIEGATA* AND *PROPYLEA QUATUORDECIMPUNCTATA* (COLEOPTERA: COCCINELLIDAE) IN PENNSYLVANIA, 1993-1995[1]

A. G. Wheeler, Jr.[2], Craig A. Stoops[3]

ABSTRACT: The adventive lady beetles *Hippodamia variegata* and *Propylea quatuordecimpunctata* were detected in Pennsylvania in 1992 and 1993, respectively. Surveys of these aphid predators were conducted during 1993-1996 to document their westward dispersion from counties bordering on the Delaware River; their distribution in eastern Pennsylvania is mapped for the first three seasons. Twelve coccinelline Coccinellidae, both indigenous and nonindigenous species, were collected during the first three seasons; the number of sites at which each was found is recorded. Our surveys document explosive colonization of the state by *Harmonia axyridis*, corroborate evidence of a precipitous decline in numbers of *Coccinella novemnotata* in much of eastern North America, and support the idea that *Hippodamia convergens* is no longer a dominant coccinellid in herbaceous habitats in the northeastern states.

Classical biological control as an effective strategy of insect suppression began with the use of a coccinellid. In the late 1880s the vedalia, *Rodolia cardinalis* (Mulsant), was released to suppress populations of the cottony cushion scale, *Icerya purchasi* Maskell, in California (Essig 1931, DeBach 1964, Hagen and Franz 1973). The project's spectacular results triggered a "ladybird fantasy": a period of inordinate emphasis on exotic coccinellids, characterized by overzealous and generally unsuccessful importation and establishment of additional species (Greathead 1995). Interest in coccinellids for pest suppression eventually gave way to the use of parasitic Hymenoptera and later to synthetic organic insecticides. Ultimately, a more scientific approach to biological control was adopted, the reliance on insecticides lost favor, and interest in coccinellids was revived during the 1960s and 1970s (Gordon 1985, Waage and Greathead 1988, Greathead 1995).

The past 25 years have been marked by changes in the coccinellid fauna of the northeastern United States: establishment of nonindigenous species through either intentional releases for biocontrol purposes or unintentional introductions with commerce, coupled with an apparent decline in numbers of certain native species. Studies on adventive lady beetles during this period have included life histories (e.g., Rogers *et al.* 1972, Michels and Bateman 1986); introduction, evaluation, rearing, release, and redistribution (e.g., Shands *et al.*

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1972, Angalet *et al.* 1979); monitoring of establishment and spread (Schaefer *et al.* 1987, Ellis and Adams 1993, Wheeler 1993, LaMana and Miller 1996, Hoebeke and Wheeler 1996); attempts to determine the origin of North American populations — i.e., deliberate releases or unintentional introductions with commerce (e.g., Schaefer and Dysart 1988, Krafsur *et al.* 1992, Day *et al.* 1994); and taxonomic recognition (Gordon and Vandenberg 1991). Attention has also been given to possible adverse effects of *Coccinella septempunctata* L. and other adventive lady beetles on populations of native coccinellids, and to changes in structure of native lady beetle communities (Day *et al.* 1994, Wheeler and Hoebeke 1995, Elliott *et al.* 1996).

Since the late 1970s, four Old World species of the coccinelline tribe Coccinellini have become established in Pennsylvania: *C. septempunctata, Harmonia axyridis* (Pallas), *Hippodamia variegata* (Goeze), and *Propylea quatuordecimpunctata* (L.) (Hoebeke and Wheeler 1980, Ellis and Adams 1993, Wheeler 1993, 1995, unpubl. data). Pennsylvania participated in the 1993 multistate coccinellid project funded by the USDA Animal and Plant Health Inspection Services' Cooperative Agricultural Pest Survey. The main goal of that project was to determine the distribution of *H. variegata* (HV) and *P. quatuordecimpunctata* (PQ) from Maine to Virginia; information derived from surveys in eastern United States was hoped to enhance biological control efforts against the Russian wheat aphid, *Diuraphis noxia* (Mordvilko), in the western states (Flanders *et al.*, 1993). These two lady beetles — recorded from eastern Canada (Gordon and Vandenberg 1991, McNamara 1991), all New England states, New York, New Jersey, and Pennsylvania— were determined to be extending their range southwesterly (Ellis and Adams 1993).

According to Ellis and Adams, future surveys "should continue to delineate the leading edge of HV and PQ populations." We, therefore, have continued to monitor the westward spread of these species in eastern Pennsylvania, where populations were restricted initially to counties on or near the Delaware River, and present herein the results of surveys during 1993-1996. We also discuss the status of *C. septempunctata* (C7) and *H. axyridis* in Pennsylvania, record the native species of Coccinellini collected during surveys for adventive lady beetles, and comment on the possible decline of certain native lady beetles in the state.

METHODS

Following the detection of HV in Pennsylvania in 1992, more extensive surveys were made in 1993 for both HV and PQ. Three alfalfa fields were surveyed in Monroe, Northampton, and Wayne counties; 1,500 sweeps were taken six times in each field from mid-June to early September (see Ellis and Adams 1993 and Wheeler and Hoebeke 1995 for details). Sweepnet sampling at 52 additional sites was conducted during the same period, emphasizing herbaceous vegetation in disturbed sites such as urban vacant lots and railroad yards and rights-of-way. Aphid-infested plants most often sampled were horseweed, *Conyza canadensis* (L.) Cronq.; spotted knapweed, *Centaurea biebersteinii* DC.; and sweet clover, *Melilotus* spp. The time spent at each site varied, but nearly always included at least 15 minutes of observation and sweepnet sampling (several hundred sweeps). Because the sweepnet sampling of forbs at various ruderal sites proved efficient for detecting adventive lady beetles, similar sampling was conducted in 1994 from mid-June to late August (136 sites in 23 counties), in 1995 from mid-June to mid-August (124 sites in 17 counties), and in 1996 from late June to late August (69 sites in 18 counties). Each season we emphasized areas west of previous detection sites.

Specimens that could not be identified accurately in the field were collected for later verification. Voucher material from our surveys is deposited in the Pennsylvania Department of Agriculture insect collection.

RESULTS

Following the detection of HV in 1992 in three counties that border on the Delaware River, this recent invader was found only in three new counties (Delaware, Monroe, and Northampton) in 1993 (Fig. 1A). Sampling that year failed to yield specimens in 11 counties that lie just west of those along the river; also negative were attempts to collect it in Bucks Co., which borders the river in the southeast. In 1994, HV was found in 14 additional counties; the westernmost collections were from the eastern portions of Bradford, Sullivan, Columbia, Schuylkill, Berks, and Chester counties. By 1995, the western spread of HV reached at least the middle of Tioga Co. in the north, but with the exception of a record from western Columbia Co., all collections south of Tioga Co. were negative. In 1994 and 1995, this species was not found at several sites near localities that were positive the previous season(s). Surveys in 1996 resulted in 11 new county records (not shown in Fig. 1), including five that lie west of the Susquehanna River.

The first records of PQ in Pennsylvania were obtained in 1993 from some of the same sites where HV had been detected the previous year (Fig. 1B). At the end of 1993, PQ had been found in more counties (8) and sites (12) than had HV (6 counties, 10 sites), but its subsequent westward spread has been less than that of HV. Only one new county, Luzerne, was added in 1994, and PQ was not collected in 1995 surveys that included 17 counties lying west of known populations in the state. PQ also was not found in 1996.

In addition to the adventive HV and PQ, two other nonindigenous coccinellids — C7 and *Harmonia axyridis* — were collected. The former species, which was first found in Pennsylvania in 1979 (Hoebeke and Wheeler 1980), now occurs statewide (Flanders *et al.* 1993, A.G.W. unpubl. data). The latter species, known as the multicolored Asian lady beetle, was first collected in Pennsylvania in 1993 (Wheeler 1995). It was not, however, encountered that year during our surveys for HV and PQ, but it was taken at 16 sites in 1994. The following year, it was collected at 52 sites, more than for any of the other coccinellids,

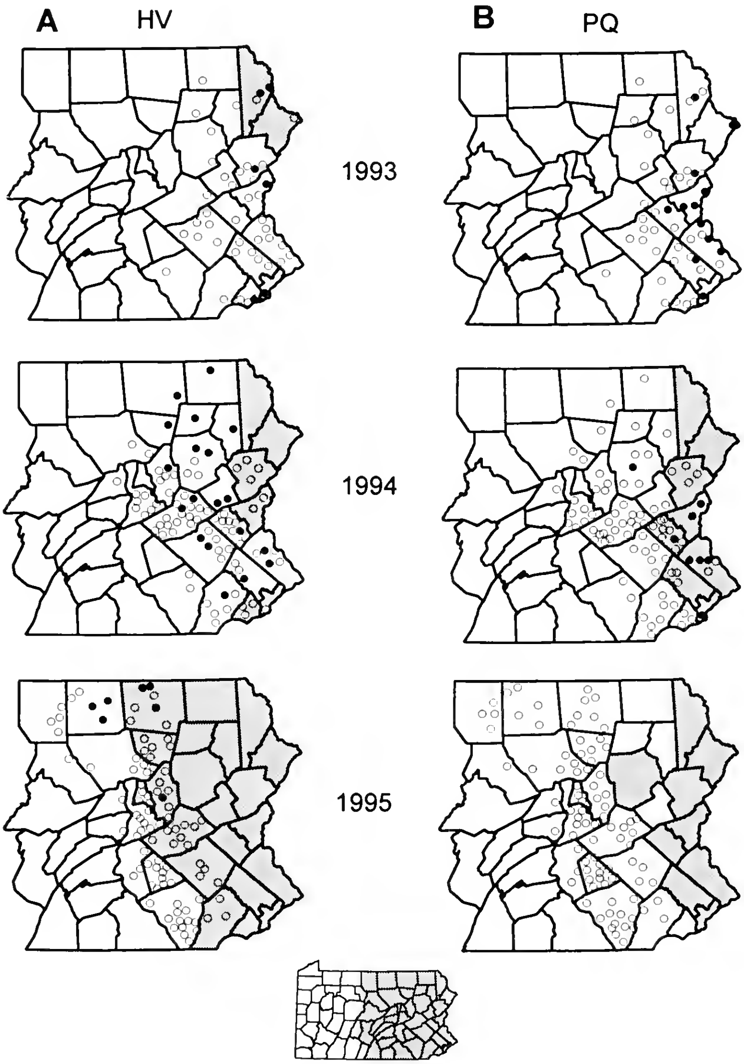

Fig. 1. Occurrence of *Hippodamia variegata* (1A: HV) and *Propylea quatuordecimpunctata* (1B: PQ) in eastern Pennsylvania, 1993-1995. Sites where species were found (●) and were not found (○) are shown; not all sites sampled are mapped because of their proximity. See text for sampling methods. Shading denotes counties positive in previous years. Shaded area of small map at bottom indicates counties surveyed in eastern Pennsylvania.

indigenous or adventive (Table 1). *Harmonia axyridis* has now dispersed throughout the state, occurring not only on forbs in ruderal sites, but also on alfalfa, small grains, and various trees and shrubs (A.G.W. unpubl. data). Among the four adventive coccinellids, C7 occurred at far more sites in 1993-1994 than the other three species, but it was found at only 18 sites (vs. 52 for *H. axyridis*) in 1995.

The most commonly collected native coccinellids during the first three seasons were *Coleomegilla maculata lengi*, *Cycloneda munda*, and *Hippodamia parenthesis* (Table 1). Native species each found at only one site (single individuals) were *Coccinella transversoguttata richardsoni* and *H. glacialis*. *Coccinella trifasciata perplexa* was generally seen only in the more northern counties, and the convergent lady beetle, *H. convergens*, was collected only six times during 1993-1995. *Coccinella novemnotata*, once common in Pennsylvania and the northeast (Wheeler and Hoebeke 1995), was not encountered during our fieldwork.

Table 1. Adult coccinellids (tribe Coccinellini) collected during surveys for *H. variegata* and *P. quatuordecimpunctata* in eastern Pennsylvania, 1993-1995; asterisks indicate adventive species.

Species	No. of Sites		
	1993	1994	1995
Adalia bipunctata L.	6	2	6
**Coccinella septempunctata* L.	57	46	18
C. transversoguttata richardsoni Brown	0	0	1
C. trifasciata perplexa Mulsant	6	0	2
Coleomegilla maculata lengi Timberlake	37	58	51
Cycloneda munda (Say)	14	14	27
**Harmonia axyridis* (Pallas)	0	16	52
Hippodamia convergens Guerin	4	1	1
H. glacialis (F.)	1	0	0
H. parenthesis (Say)	30	27	14
**H. variegata* (Goeze)	10	18	7
**Propylea quatuordecimpunctata* L.	19	8	0

DISCUSSION

Our surveys document the southwestward spread of the adventive coccinellids HV and PQ in Pennsylvania during 1993-1996. The pattern of positive and negative sites is reasonably consistent for both species, with HV's spread exceeding that of PQ. The leading edges of their populations, though, most likely lie somewhat west of those shown in each of the three years. Extremely low densities would have gone undetected at our sample sites, and populations undoubtedly existed in areas not covered by our fieldwork. Our surveys also serve to record the quite recent invasion and explosive colonization of *Harmonia axyridis* in the state.

We would be premature in drawing conclusions regarding a decline in numbers of the convergent lady beetle, *Hippodamia convergens*. This native species was collected at few sites each season, and it was similarly uncommon during surveys for HV and PQ in the northeast during 1992 and 1993 (Ellis and Adams 1993, Wheeler 1993). But coccinellid populations can fluctuate widely between years (see Wheeler and Hoebeke 1995, Elliott *et al.* 1996), and some species probably vary in abundance in different habitats from year to year, depending on availability of aphid prey. Our failure to collect *Coccinella novemnotata* does, however, corroborate a definite trend of declining numbers in the northeast, where this once common native lady beetle may be locally extirpated (Wheeler and Hoebeke 1995).

Among potential factors that could be responsible for declining populations of native coccinellids, adverse effects from C7 have been mentioned most often. As Ehler (1990) noted, it seems likely that this dominant, Old World coccinellid will have some impact on nontarget species in the United States (see also Elliott *et al.* 1996). Yet the causality between increasing dominance of C7 in the northeast and decreasing numbers of native lady beetles has not been established (Wheeler and Hoebeke 1995).

We will refrain from debating the strategies of releasing polyphagous or generalist predators in biological control programs and of redistributing adventive generalists such as C7 that have become established through unintentional introduction with commerce. The compatability of classical biological control and insect conservation, and the possible adverse environmental effects of biocontrol agents have already received attention from Samways (1988), Howarth (1991), Lockwood (1993), Miller and Aplet (1993), Wheeler and Hoebeke (1995), and Elliott *et al.* (1996). Instead, we simply support the philosophy of Ehler (1990) that the presence of C7 in our fauna (and now also that of *H. axyridis*) — whether the result of biocontrol releases or accidental introductions — provides ecologists a unique opportunity to assess the effects of a nonindigenous predator on indigenous lady beetles and other nontarget insects. Workers in different regions of North America are, therefore, encouraged to undertake long-term monitoring of coccinellid populations in managed and unmanaged systems. Such research, ideally coupled with baseline data obtained before establishment of adventive lady beetles, is requisite to reaching sound conclusions about the status of our native coccinellids and evaluating factors that might be contributing to any evident decline in their numbers.

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RANGE OF LACE BUG GENUS *ACALYPTA* (HETEROPTERA: TINGIDAE) EXTENDED SOUTH INTO NEOTROPICS WITH DISCOVERY OF THE NEW SPECIES, *A. EMICATA*, FROM GUATEMALA[1]

Richard C. Froeschner[2]

ABSTRACT: The new species *Acalypta emicata* is described and illustrated from an adult male intercepted on a species of *Tillandsia* being imported into the United States from Guatemala. Included is a key to the seven New World species of *Acalypta* with a single pronotal carina.

A specimen of *Acalypta* Westwood intercepted on an unidentified species of the plant genus *Tillandsia* (family Bromeliaceae) being imported into the United States from Guatemala is interesting not only as a new species but also for extending the range of this genus into the Neotropics, one country farther southward than its previous limiting record from Mexico. As is true for the Mexican record, also based on a specimen intercepted on imported plants of the genus *Tillandsia*, a precise locality of origin for the specimen is not known. The discovery of this specimen, unfortunately, does not answer the question was this, and possibly other members of the moss-feeding genus *Acalypta* intercepted with introduced plants of *Tillandsia*, originally biologically associated with the *Tillandsia* plant or were they actually in moss that may have been used for packing during shipping? The latter is most likely. The cryptic moss-frequenting habit of the *Acalypta* species undoubtedly shields them from being collected more frequently.

Acalypta emicata NEW SPECIES
Figure 1

Diagnosis: Among the New World species of *Acalypta* with only one longitudinal carina (the median) on the pronotum, this species can be recognized by having the combination of the hypocostal lamina uniseriate for its full length and the costal area biseriate for nearly its full length (unevenly so on holotype, see illustration and description below).

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Description: Measurements in millimeters. Brachypterous male holotype: obovate, widest near midlength of hemelytra. Length 2.1. Color black, dorsally with narrow margins of paranota and costal areas distinctly lighter brown; ventrally with anterior margin of propleuron, narrow edge of buccula, and tibiae light brown, sternal carinae almost white.

Head with supraclypeal spines strong, straight, parallel, slightly surpassing midlength of first antennal segment. Antennophore not projecting forward. Antennal segments stout, lengths of segments, I-IV, 0.10 : 0.07 : 0.35 : 0.27; segment III cylindrical, not widened at ends. Labium reaching base of second visible abdominal segment.

Pronotum with anterior margin forming a weakly tectate, bluntly triangular projection extending to anterior margins of eyes. Median carina irregularly uniseriate at middle, lower toward each end. Lateral carinae absent. Paranotum triseriate, almost twice as wide as an eye, lateral margins weakly convex.

Costal area with cells prominent, biseriate for nearly or quite entire length (on holotype the right side wholly biseriate, the left side biseriate with middle third uniseriate, latter apparently a developmental anomaly). Outer limiting veins of discoidal area coarctate in basal third, in lateral view strongly, convexly elevated along basal two-thirds; inner limiting vein weakly elevated, evanescent basally. Hypocostal lamina uniseriate.

Holotype: Brachypterous male, "intercepted on *Tillandsia* sp. from Guatemala; U.S.A - Texas, Houston, Dec. 7, 1993, Q. Johnson." Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

The species name is from the Latin *emico* and means to appear suddenly — that is, it was unexpected.

When Froeschner (1976) discussed the *Acalypta* species of the New World, he treated four as having a single carina on the pronotum. Subsequently three more American species of *Acalypta* with unicarinate pronotum have been discovered: *A. susanae* Allen *et al* (1988) from Arkansas, *A. laurae* Froeschner (1991) from Mexico, and now *A. emicata* from Guatemala, described above. Their morphological characters will not allow them to be fitted into Froeschner's (1976: Fig. 6) diagram and require that it be modified. Such a modification is here offered in the form of the following key:

Key to American species of *Acalypta* with a single pronotal carina

1. Head with a pair of elongate, stout, subhorizontal tubercles arising above base of clypeus .. 2
----- Head without elongate tubercles above base of clypeus .... *mniophila* Drake & Ruboff
2. Antennal segment III black, stout, cylindrical, for full length nearly or quite as wide as segment II .... *emicata* new species
----- Antennal segment III mostly pale, thickening basad or clavately dilating toward apex (not cylindrical) 3
3. Antennal segment III clavate, thickening from base to apex. Hypocosta triseriate .... *susanae* Allen *et al*
----- Antennal segment III thinnest on apical half. Hypocosta uniseriate or biseriate basally and uniseriate apically 4

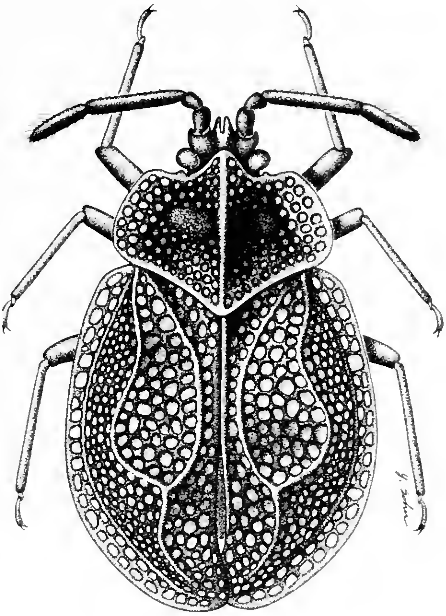

Figure 1. *Acalypta emicata* n. sp., natural length 2.1 mm.

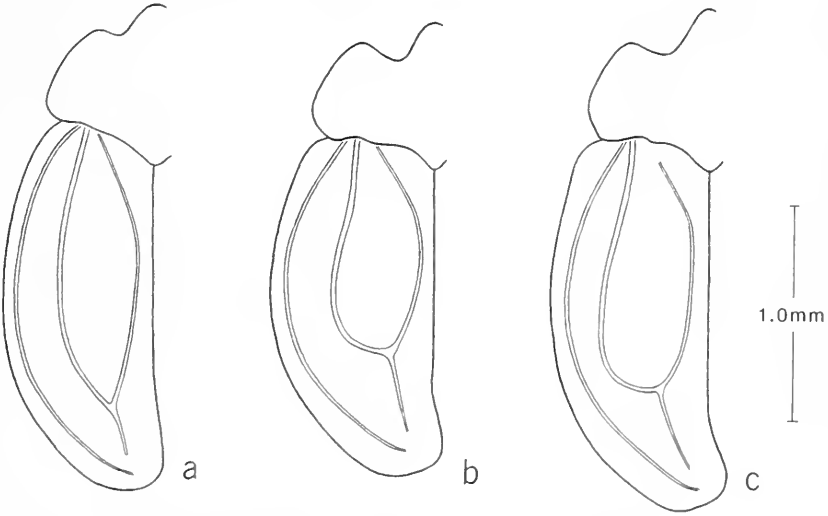

Figure 2. *Acalypta* hemelytra: a) *A. saundersi*; b) *A. laurae*; c) *A. ruhoffae*.

4. Outer and inner limiting veins of discoidal area joining near apical fourth of hemelytron to form an acute angle (Fig. 2a) .... *saundersi* Downes

----- Outer and inner limiting veins of discoidal area joining near apical third of hemelytron and not forming an acute angle 5

5. Discoidal area with limiting veins distinctly embrowned, strongly contrasting with the pallid veins of discoidal and subcostal areas; its outer limiting vein convexly projecting posterolaterally, forming an almost continuous arc with inner limiting vein (Fig.2c) .... *ruboffae* Froeschner

----- Discoidal area with limiting veins light brown, virtually concolorous with other veins of hemelytron; its outer limiting vein less strongly convex posterolaterally, forming a slightly obtuse or right angle with inner limiting vein (Fig. 2b) 6

6. Hypocosta uniseriate for full length .... *laurae* Froeschner

----- Hypocosta biseriate in basal fourth to third, uniseriate posteriorly .... *duryi* Drake

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NEW CENTRAL AMERICAN AND MEXICAN RECORDS OF EPHEMEROPTERA SPECIES[1, 2]

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ABSTRACT: New records of 35 mayfly (Ephemeroptera) species are documented for Belize, Costa Rica, El Salvador, Guatemala, Honduras, Panama and 20 Mexican states. *Acerpenna intermedia* in Mexico and *Baetodes bibranchius in* Tamaulipas represent new country records for Mexico. The Western Hemisphere distribution of each of the species treated is summarized.

The composition of the mayfly (Ephemeroptera) fauna of Mexico and Central America has been historically neglected, but has received considerable attention recently (see, e.g., McCafferty and Waltz 1990; Flowers and Domínguez 1992; McCafferty *et al.* 1992; McCafferty and Lugo-Ortiz 1992, 1994, 1996ab; Lugo-Ortiz and McCafferty 1993, 1994ab, 1995abde, 1996abc; Lugo-Ortiz *et al.* 1994; Domínguez 1995). At this writing, records of 178 nominal species in 43 genera and 11 families have been published from the region, with the families Baetidae (esp. *Baetodes, Callibaetis,* and *Camelobaetidius),* Leptohyphidae (esp. *Leptohyphes* and *Tricorythodes),* and Leptophlebiidae (esp. *Thraulodes)* being the most prevalent (see McCafferty and Lugo-Ortiz 1996b).

We provide new Central American or Mexican state records for 35 species. All new records are given for species arranged in alphabetical order, first by family, then by genus and species. A full accounting of the mayflies of North and Central America, to which the present study will contribute, is kept current on the World Wide Web by Mayfly Central (see McCafferty 1996). Materials examined are housed in: Florida A & M University (FAMU), Tallahassee; the Instituto de Ecología, A. C. (IEAC), Veracruz, México; the Purdue Entomological Research Collection (PERC), West Lafayette, IN; and the Universidad Nacional Autónoma de México (UNAM), México, D. F.

BAETIDAE

Acentrella insignificans (McDunnough) — MEXICO: CHIHUAHUA: Río Gavilán, Los Amarillos, VI-23-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Tomóchic at Tomóchic Rt 16, I-20-1987, B. C. Kondratieff, larvae (PERC); Río Casas Grandes, I-16-1987, B. C. Kondratieff, larvae (PERC); Río Piedras Verdes, Colonia Juárez, I-16-1987, larvae (PERC); Río Piedras Verdes, Colonia Pacheco, I-22-1987, B. C. Kondratieff, larva (PERC); Arroyo Fresas, 3 mi above Río Piedras Verdes, VI-22-1987, larvae (PERC). This species has a widespread distribution in western North America, extending as far north as British Columbia. In Mexico, it was previously reported from Sonora (Allen and Murvosh 1987a).

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Acerpenna intermedia Lugo-Ortiz and McCafferty — GUATEMALA: 10 mi NW of Totonicapán, mountain stream, 10,000 ft, V-7-1972, J. Vandermeer, larvae (PERC); Solala: Ponajachel, 1550 m, VIII-21-1962, G. G. Musser, larvae (PERC). MEXICO: MEXICO: Nanchititila National Park, El Saltito, VIII-23-1994, B. C. Kondratieff, larvae. This species was reported previously from Costa Rica only (Lugo-Ortiz and McCafferty 1994b).

Acerpenna pletura Lugo-Ortiz and McCafferty—MEXICO: NUEVO LEÓN. Río Ramos, XII-20-1939, L. Berner, larvae (PERC); PANAMA: Canal Zone: Río Pedro Miguel, George Green Park on Madden Road, IX-10-1963, W. L. Peters and C. M. Kennan, larvae (PERC). This species was previously reported from Belize, Costa Rica, Honduras, Nicaragua, and Tamaulipas in Mexico (Lugo Ortiz and McCa£ferty 1994b).

Baetis caelestis Allen and Murvosh—MEXICO: CHIHUAHUA: Río Tomóchic at Tomóchic Rt 16, I-20-1987, B. C. Kondratieff, larvae (PERC); small stream 12 mi W of Tomóchic, I-20-1987, B. C. Kondratieff, larvae (PERC); small stream S of Pacheco, I-22-1987, B. C. Kondratieff, larvae (PERC); Río Piedras Verdes, Colonia Pacheco, I-22-1987, B. C. Kondratieff, larvae (PERC). This species also occurs in the southwestern United States and the Baja California peninsula (Allen and Murvosh 1983).

Baetis magnus McCafferty and Waltz — MEXICO: MEXICO, D. F.: Desierto de los Leones, VIII-24-1994, B. C. Kondratieff, larvae (PERC); PUEBLA: 11 mi S of Chignahuapán, VII-26-1965, P. J. Spangler, larva (PERC); Nanchititla National Park, Río Los Barbechos, VIII-23-1994, B. C. Kondratieff, larvae (PERC); Zacatlán, Río San Pedro, VIII-18-1994, B. C. Kondratieff, larvae (PERC); Zacatlán, Río San Isidro, VIII-18-1994, B. C. Kondratieff, larvae (PERC); PANAMA: El Volcán, Palos Santos, 4300 ft, XI-13-1963, W. P. Murdoch, larvae (PERC); Chiriquí: Cerro Punta, 5300 ft, XI-13-1963, larvae (PERC); Cerro Punta, small stream, XII-28-1969. L. T. Nielsen, larvae (PERC). The range of this species includes southwestern United States, as far north as southwestern Nebraska; Mexico; and Central America (Lugo-Ortiz and McCafferty 1993).

Baetis notos Allen and Murvosh — MEXICO: MEXICO: San Diego Cuentla, Hwy 134, VIII-22-1994, B. C. Kondratieff, larvae (PERC). This species is widespread in southwestern United States, and it was previously reported in Mexico from Veracruz only (Lugo-Ortiz and McCafferty 1994a).

Baetis tricaudatus Dodds—MEXICO: MEXICO: Río at El Capulín, VIII 22-1994, B. C. Kondratieff, larvae (PERC); MEXICO, D. F.: Desierto de los Leones, VIII-24-1994, B. C. Kondratieff, larvae (PERC); VERACRUZ: Río La Perla, at La Perla, VIII-26-1994, B. C. Kondratieff, larvae (PERC). This species has a widespread distribution in the United States, and in Mexico it was previously reported only from Baja California Norte (Lugo-Ortiz and McCafferty 1994a).

Baetodes bibranchius, McCafferty and Provonsha—MEXICO: TAMAULIPAS: Río Guayalejo, XII-22-1939, L. Berner, larvae (PERC). This species was previously reported from south-central Texas only (McCafferty and Provonsha 1993).

Baetodes fuscipes Cohen and Allen — BELIZE: Cayo: Teakettle Village, I-22-1993, W. D. Shepard, larva (PERC). This species occurs from northeastern and eastern Mexico south to Honduras (Lugo-Ortiz and McCafferty 1995b).

Baetodes inermis Cohen and Allen — MEXICO: VERACRUZ: Río La Perla at La Perla, VIII-26-1994, B. C. Kondratieff, larvae (PERC). This species has a widespread distribution in Mexico (Cohen and Allen 1978).

Callibaetis floridanus Banks — EL SALVADOR: 15 mi W of La Unión, VII-31-1965, P. J. Spangler, larva (PERC); GUATEMALA: Chimaltenango, VIII-20-1965, P. J. Spangler, larvae (PERC); Chichicastenango, VIII-21-1965, P. J. Spangler, larvae; Estancia Virgen, Finca La Cajeta, VIII-12-1965, P. J. Spangler, larvae (PERC); HONDURAS: La Ceiba, light trap, V-22-1949, E. C. Becker, male adults (PERC); Choluteca: Nacaome bridge on Panamerican Hwy, Río Nacaome, X-10-1964, J. S. Packer, larva (PERC); MEXICO: AGUASCALIENTES: Aguascalientes, VIII-3-5-1963, P. J. Spangler, larvae (PERC); CHIAPAS: San Cristóbal de las Casas, VII-17-21-1964, P. J. Spangler, larva (PERC); CHIHUAHUA: 9 mi N of Meoqui, VI-26-1964, P. J. Spangler, larvae (PERC); DURANGO: San Juan del Río, VI-27-1964, P. J. Spangler, larvae (PERC); Morcillo, VI-28-1964, P. J. Spangler, larvae (PERC); HIDALGO: Ixmiquilpán, VII-1-1965, P. J. Spangler, larvae (PERC); JALISCO: Guadalajara, VII-30-1963, P. J. Spangler, larvae (PERC); 10 mi N of Chalapa, VII-31-1963, P. J. Spangler, larvae (PERC); 15 mi N of Chapala, VIII-1-1963, P. J. Spangler, larvae (PERC); OAXACA: 8 mi N of Oaxaca, VII-14-1964, P. J. Spangler, larvae (PERC); 17 mi E of Juchitán, VII-5-1965, P. J. Spangler, larvae (PERC); TAMAULIPAS: Nuevo Morelos, III-28-1965, P. J. Spangler, larvae (PERC); TLAXCALA: 4 mi N of Apizaco, VIII-26-1965, P. J. Spangler, larvae (PERC); VERACRUZ: 15 mi SE of Tantoyuca, VIII-28-1965, P. J. Spangler, larvae (PERC); Cuitlahuac, VIII-10-12-1964, P. J. Spangler, larvae (PERC). The range of this species extends from southeastern United States south to Costa Rica, and it also occurs in the Antilles (Lugo-Ortiz and McCafferty 1996b).

Callibaetis pictus (Eaton) — HONDURAS: El Paraíso: Escuela Agrícola Panamericana, X-15-1964, J. S. Packer, larvae (PERC); Uyuca, nr Zamorano, small pond, X-27-1964, P. J. Spangler, larva (PERC); MEXICO: BAJA CALIFORNIA SUR: Arroyo San Pedro, 19 mi W of Hwy 1, VI-27-1988, B. C. Kondratieff, larvae (PERC); CHIAPAS: El Chorreadero, Chapa de Corzo, V-5-1979, J. Bueno, larvae (UNAM); San Cristóbal de las Casas, V-5-1979, J. Bueno Soria, male adult (UNAM); Ocosingo, VI-25-1950, C. and M. Goodnight and L. J. Stannard, female adult (PERC); CHIHUAHUA: 18 mi N of Chihuahua, slow shallow stream, VII-22-1952, R. B. and J. M. Selander and Y. Sedman, larvae (PERC); Nuevo Casas Grandes, at light, VIII-26-1986, B. C. Kondratieff, male and female adults (PERC); Arroyo Fresa, 3 mi above jct Río Piedras Verdes, VI-1987, B. C. Kondratieff and R. W. Baumann, male adult (PERC); 25 mi W of Colonia Juárez, Rt 16, small pond, VIII-24-1986, larvae and exuviae (PERC); Riíto, Hwy 16, 10 mi E of Yepachic, VI-28-1987, B. C. Kondratieff and R. W. Baumann, male and female adults (PERC); small stream, 12 mi W of Tomóchic, 1-20-1987, B. C. Kondratieff, larva (PERC); DURANGO: La Michilia, Arroyo Nana Juana, Bosque pino-encino, 2400 m, R. Novelo, IV-15-1988, larvae (IEAC); La Michilia, Arroyo Taray, IV-14-1986, R. Novelo and J. González, larvae (IEAC); GUERRERO: S of Tierra Colorada, I-3 1948, S. Mulaik, larvae (PERC); km 15, Carretera Bejucos, nr Ciudad Altamirano, XI-22-1984, larvae (PERC); HIDALGO: San Miguel, Regla, VIII-19-1994, B. C. Kondratieff, male and female adults (PERC); MEXICO: Chapingo, IV-21-1961, F. Pacheco, female adult (UNAM); Chapingo, X-7-1961, F. Pacheco, female adult (UNAM); Chapingo, Criadero de truchas, III-17-1963, F. Pacheco, female adult (UNAM); Nanchititla National Park, Río Los Barbechos, VIII-23-1994, B. C. Kondratieff, female adults (PERC); MEXICO, D. F.: IX-21-1962, N. Angeles and T. Luz, male and female adults (PERC); OAXACA: 8 mi N of Oaxaca, VII-14-1964, P. J. Spangler, larvae (PERC); El Tule, VI-25-1965, R. B. and J. M. Selander, larva (PERC); MICHOACÁN: Tuxpán, I-15-1955, R. B. and J. M. Selander, female adults (PERC); NUEVO LEÓN: 10 mi N of Monterey, Sabinas Hidalgo, XII-27-1947, S.Mulaik, larvae (PERC); PUEBLA: Puebla, 10 mi NE of Atlixco, VIII-26 1965, P. J. Spangler, larvae (PERC); Zacatlán, VIII-17-1994, B. C. Kondratieff, female adults (PERC); Atequexquitla, VIII-19-1994, B. C. Kondratieff, female adults (PERC); Río San Pedro, Zacatlán, VIII-18-1994, B. C. Kondratieff, larvae (PERC); SINALOA: 7 mi N of Rosario, VII-24-1963, P. J. Spangler, larvae (PERC); SONORA: small stream, 10 mi W of Yécora, VIII-19-1986, B. C. Kondratieff, female adult (PERC); intermittent stream, 11 mi E of Yécora, VIII-22-1986, B. C. Kondratieff, male and female adults (PERC); Hwy 11, SW of Tezopuco, I-18-1988, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Yécora, at lights, VIII-21 1986, B. C. Kondratieff, exuviae and male and female subimagos (PERC); TAMAULIPAS: 44 mi S of Matamoros, VI-28-1965, P. J. Spangler, larvae (PERC). This species is widespread in western United States and Mexico, and is found as far south as Costa Rica (Lugo-Ortiz and McCafferty 1996b).

Camelobaetidius kondratieffi Lugo-Ortiz and McCafferty — BELIZE: Cayo: Teakettle, 1-22-1993, W. D. Shepard, larva (PERC). This species was previously reported from Guatemala only (Lugo-Ortiz and McCafferty 1995d).

Fallceon quilleri (Dodds) — GUATEMALA: Solala: Río Pamajachel, ca 4000 ft, V-15-1972, J. Vandermeer, larvae (PERC); Ponajachel, 1550 m, VIII-21-1962. G. G. Musser, larvae (PERC). MEXICO: PUEBLA: Río San Isidro, Zacatlán, VIII-18-1994, B. C. Kondratieff, larvae and adults (PERC); Río San Pedro, Zacatlán, VIII-18-1994, B. C. Kondratieff, larvae (PERC); VERACRUZ: Río La Perla at La Perla, VIII-26-1994, B. C. Kondratieff, male adults (PERC); Río Pancho Pozas, Altotonga, VIII-25-1994, B. C. Kondratieff, male adults (PERC). This species is widespread in the United States, Mexico, and Central America (Lugo-Ortiz *et al.* 1994).

Moribaetis macaferti Waltz — HONDURAS: Atlantida: 23 mi S of Tela, on Hwy 9, small stream, X-19-1964, J. S. Packer, larvae (PERC); Comayagua: 3 mi N of Taulabe, on Hwy 1, large river, X-20-1964, J. S. Packer, larvae (PERC); El Paraíso: tributary of Río Guayambre, at jct of Hwy 4 and Río Guayambre, 50 km E of Danlí, VIII-29-1964, J. S. Packer, larvae (PERC); small stream nr Santa María, IX-3-1964, J. S. Packer, larvae (PERC); Escuela Agrícola Panamaricana, pond, X-15-1964, J. S. Packer, larvae (PERC); Francisco Morazán: 10 mi E of Guaimaca, on Hwy 3, small stream, XI-6-1964, J. S. Packer, larvae (PERC); Olancho: 45 mi E of jct Hwy 3 and Salama Rd, small stream, XI-6-1964, J. S. Packer, larvae (PERC); 10 mi W of Juticalpa, Río Juticalpa, XI-6-1964, J. S. Packer, larvae (PERC); 1.6 mi W of Campamento Galera turn-off, on Hwy 3, XI-7-1964, J. S. Packer, larva (PERC). MEXICO: PUEBLA: Hwy 106, Pahuatlán, VIII-17-1994, B. C. Kondratieff, larvae (PERC). This species has a range extending from Costa Rica to Chiapas and Veracruz in Mexico (Waltz and McCafferty 1985, Lugo-Ortiz and McCafferty 1994a).

CAENIDAE

Caenis latipennis Banks — MEXICO: NUEVO LEÓN: Anáhuac, Laguna Salinillas, XI-14-1985, H. Rojas, R. Baroa, and S. Tufiño, male adult (UNAM); Ruinas de Tamuín, V-19-1979, J. Bueno, male adults (UNAM). The range of this species extends from central Canada to Chiapas in Mexico (Provonsha 1990).

EPHEMERIDAE

Hexagenia albivitta (Walker) — GUATEMALA: Polochi R, III-22-1906, Schwarz and Barber, male and female adults (PERC). The range of this species extends from southeastern Brazil to Veracruz in Mexico (McCafferty 1970, Lugo-Ortiz and McCafferty 1994a).

Hexagenia limbata (Serville) — MEXICO: NUEVO LEÓN: Anáhuac, Laguna Salinillas, XI-14-1985, male adult (PERC); SAN LUIS POTOSÍ: El Salto Falls, VI-23-24-1965, O. S. Flint, Jr, male and female subimagos (PERC); El Salto, VI-3-1967, O. S. Flint, Jr, male and female subimagos (PERC). This is a widespread species in the United States (McCafferty 1994), and in Mexico it has been reported previously from Tamaulipas and Jalisco (McCafferty 1968).

Hexagenia mexicana Eaton — GUATEMALA: Izabal: Lago Izabal, El Estor, I-5-1988, B. C. Kondratieff, male and female adults (PERC). MEXICO: OAXACA: Tuxtepec. J. Camelo, male adults (PERC). This species was previously reported from Veracruz and Costa Rica only (Eaton 1892, McCafferty 1970).

HEPTAGENIIDAE

Epeorus margarita Edmunds and Allen — MEXICO: CHIHUAHUA: Río Chubuichupa, Chuhuichupa Basin, VI-25-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Piedras Verdes, Colonia Juárez, I-16-1987, B. C. Kondratieff, larvae (PERC); Río Piedras Verdes, Colonia Pacheco, I-22-1987, B. C. Kondratieff, larva (PERC); Río Piedras Verdes, nr Pacheco, VI-22-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Gavilán, Los Amarillos, VI-23-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Tomóchic, at Tomóchic, Rt 16, I-20-1987, B. C. Kondratieff, larvae (PERC). This species is also found in Arizona, New Mexico, and Baja Califomia (Allen and Murvosh 1983, Durfee and Kondatrieff 1995, Lugo-Ortiz and McCafferty 1995c)

Epeorus metlacensis Traver — HONDURAS: El Paraíso: 38 km E of Zancraón, on Hwy 4, X-31-1964, J. S. Packer, larvae (PERC). MEXICO: DURANGO: La Michilia, Arroyo Temazcal, IV-15-1987, R. Novelo, larvae (IEAC); HIDALGO: Zacualtipán, Soyatla, 1800 m, Bosque pino-encino, XI-15-1985, R. Novelo, larvae (IEAC). This species is widespread in Mexico and has been reported as far south as Costa Rica (Allen and Cohen 1977, McCafferty 1985).

Epeorus packeri Allen and Cohen — BELIZE: Cayo: 20 mi SE of Belmopán, Sibún R, I-20-1993, W. D. Shepard, larvae (PERC); 13 mi SE of Belmopán, Caves Branch, I-20-1993, W. D.

Shepard, larva (PERC). This species was previously reported from Honduras and Panama (Allen and Cohen 1977).

ISONYCHIIDAE

Isonychia sicca (Walsh) — BELIZE: Cayo: 13 mi SE of Belmopán, Caves Branch, I-20-1993, W. D. Shepard, larvae (PERC). MEXICO: CHIHUAHUA: small stream at jct with Río Casas Grandes, I-16-1987, larvae (PERC); Río Gavilán, Los Amarillos, VI-23-1987, B. C. Kondratieff and R. W. Baumann, larva (PERC); Río Chihuichupa, Chihuichupa Basin, VI-25-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC). This species occurs from as far north as southwestern Minnesota (Eaton 1892, Allen and Cohen 1977, Kondratieff and Voshell 1984).

LEPTOHYPHIDAE

Leptohyphes brunneus Allen and Brusca — MEXICO: GUERRERO: km 15 Carretera Bejucos, nr Ciudad Altamirano, XI-22-1984, larvae (UNAM); SONORA: Río Chico, above El Chico, I-18-1988, B. C. Kondratieff and R. W. Baumann, larvae (PERC). This species is widespread in Mexico and has also been reported from Guatemala (Allen 1978).

Leptohyphes hispidus Allen and Brusca — MEXICO: CHIHUAHUA: Río Gavilán, Los Amarillos, VI-23-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Arroyo Lalo Varela, tributary of Río Gavilán, VI-22-1987, B. C. Kondratieff and R. W. Baumann, larva (PERC); Río Piedras Verdes nr Pacheco, VI-22-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC). This species is widespread in Mexico and Central America as far south as Costa Rica (Lugo Ortiz and McCafferty 1995e).

Leptohyphes packeri Allen — MEXICO: MORELOS: Jojutla, Vicente Aranda, Río Amacúzac, 800 m, I-15-1983, I. Rocoso, larva (IEAC). This species is known from Arizona and Texas south to Honduras (Lugo-Ortiz and McCafferty 1995e).

LEPTOPHLEBIIDAE

Farrodes texanus Davis — MEXICO: TAMAULIPAS: Río Guayalejo, X-25 1985, J. Bueno, larva (UNAM). This species was previously reported only from southern Texas (Davis 1987).

Neochoroterpes oklahoma (Traver) — MEXICO: CHIAPAS: Río Lacan-Ha, km 22.5 carretera Agua Azul-Ocotzingo, VII-22-1978, J. Bueno and J. Padilla, larvae (UNAM). This species occurs in Colorado, New Mexico, Oklahoma, Texas, and northern Mexico (Henry 1993).

Thraulodes brunneus Koss — MEXICO: DURANGO: La Michilia, Arroyo Nana Juana, bosque seco de pino-encino, IV-15-1988, R. Novelo Gutiérrez and E. González, larvae (IEAC). This species ranges from Arizona and New Mexico through Mexico (Allen and Brusca 1978).

Thraulodes packeri Traver and Edmunds — COSTA RICA: Heredia: Río Sarapiquí, 7 km W of Puerto Viejo, 10.452°N/84.067°W, 50 m, II-11-1986, Morse and Fasth, larvae (FAMU); Limón: Reserva Biol6gica Hitoy-Cerere, Río Cerere, 9.671°N/83.028°W, 90 m, no date, Holzenthal, Hamilton, and Heyn, larvae (FAMU). This species was previously reported from Chiapas in Mexico and Belize and Honduras (Allen and Brusca 1978, McCafferty 1985).

Thraulodes speciosus Traver — GUATEMALA: Izabal: small stream in Río Cahabón, nr Cahaboncito, I-4-1989, B. C. Kondratieff, larva (PERC). MEXICO: CHIHUAHUA: Arroyo Lalo Varela, tributary of Río Gavilán, VI-22-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); small river, jct with Río Casas Grande, I-16-1987, B. C. Kondratieff, larva (PERC); Río Piedras Verdes nr Pacheco, VI-22-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Piedras Verdes, Arroyo Fresas, VI-22-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Gavilán, Los Amarillos, VI-23-1987, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Chihuichupa, Chihuichupa Basin, VI-25-1987, B. C. Kondratieff and R. W. Baumann, larva (PERC); GUERRERO: km 145, Carretera Iguala, nr Ciudad Altamirano, XI-23-1984, larvae (UNAM). This species occurs in Arizona and appears to be widespread in Mexico (Lugo-Ortiz and McCafferty 1995c).

Traverella albertana (McDunnough) — MEXICO: CHIAPAS: Río Lacan-Ha, km 22.5 carretera Agua Azul-Ocotzingo, VII-22-1978, J. Bueno and J. Padilla, larvae (UNAM); GUERRERO: km 15 carretera Bejucos, nr Ciudad Altamirano, XI-22-1984, Brailovsky *et al.*, larvae (UNAM); HIDALGO: Río Venados, IX-10-1979, G. Zapién, larvae (UNAM); Río Venados, X-6-1979, P. Carter, larvae (UNAM); MORELOS: Jojutla, Vicente Aranda, Río Amacúzac, 800 m, XI-12-1983, S. Ibáñez, larvae (IEAC); same data, II-11-1983; same data, I-15-1983, G. Cardoso; San Rafael, Vicente Aranda, Jojutla, II-27-1982, O. Canol, larvae (IEAC). This species is widespread in the western United States and Mexico (Allen and Murvosh 1987b, Lugo-Ortiz and McCafferty 1995c).

POLYMITARCYIDAE

Campsurus cuspidatus Eaton — BELIZE: Burrell Boom, Belize R, VI-18-1974, V. Resh, male adults (PERC). The range of this species extends from northeastern Mexico to Nicaragua (McCafferty and Lugo-Ortiz 1992).

Euthyplocia hecuba (Hagen) — BELIZE: Cayo: 16.6 km SE of Belmopán, Caves Branch, VIII-3-1993, W. D. Shepard, larva (PERC). HONDURAS: Comayagua: Río Humuya, NW of Comayagua, VIII-3-1967, O. S. Flint, Jr, male adults (PERC). This species occurs from northwestern Argentina to Veracruz in Mexico (Hagen 1861, Ulmer 1920).

SIPHLONURIDAE

Siphlonurus occidentalis (Eaton) — MEXICO: HIDALGO: Jacala, XII-31-1947, S. Mulaik, larvae (PERC). This species was known previously from Alberta south to Chihuahua and Sonora (Lugo-Ortiz and McCafferty 1994a).

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ESTABLISHMENT OF AN AES EDUCATIONAL FUND

AN OPPORTUNITY TO SUPPORT

The names Alexander, Cresson, Schmeider, and Wilson have special significance to The American Entomological Society. Each of these entomologists willed part of their estates to support specific activities of the Society. The interests from these bequests provide support for publication of the Society's three journals and enable the Society to purchase and bind entomological books and journals for the Society's library at the Academy of Natural Sciences in Philadelphia. As a consequence of the generosity of these benefactors, membership dues and subscription fees to AES journals are quite reasonable and considerably below those of similar organizations.

The nature of these funds, however, restricts how the interests can be used and thus there are some activities of the Society that are not subsidized. In particular, the AES Executive Council has noted the costs of our educational outreach efforts to encourage interest in entomology. This presently includes the annual Insect Field Day, the Calvert Award, and support of the Young Entomologist's Society. The Executive Council has approved the creation of a new Educational Fund to be built up over the years by contributions to the principal. Members interested in making contributions, large or small, to the Educational Fund should send their tax-exempt donations to the AES Educational Fund, The American Entomological Society, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103-1195.

Harold B. White,
Chair, Educational Committee

ARAMIGUS URUGUAYENSIS (COLEOPTERA: CURCULIONIDAE), A NEW SPECIES BASED ON MITOCHONDRIAL DNA AND MORPHOLOGICAL CHARACTERS[1]

Benjamin B. Normark[2], Analía A. Lanteri[3]

ABSTRACT: *Aramigus uruguayensis,* new species, occurs in Uruguay (Departamentos de Rocha, Canelones, and Maldonado) and includes bisexual populations as well as parthenogenetic lineages. Females are similar to the *pallidus* morphotype of *A. tessellatus,* but they are smaller and have a distinctive spermathecal duct markedly widened in proximal one-third; males have aedeagi that are similar to those of *A. intermedius,* but with shorter apodemes. The mitochondrial DNA haplotypes of *A. uruguayensis* are sharply differentiated (≥ 4.8%) from any other species of *Aramigus.*

Aramigus Horn (Entiminae: Naupactini) currently includes seven species originally distributed in Brazil, Uruguay, and Argentina (Lanteri & Díaz 1994). The genus has been the subject of several taxonomic studies (Lanteri 1986, Lanteri *et al.* 1987), including a recent revision and cladistic analysis based on morphological characters (Lanteri & Díaz 1994), as well as a mitochondrial DNA (mtDNA) study focusing on the relationships of the parthenogenetic lineages within the *A. tessellatus* complex (Normark 1996a). The species *A. tessellatus* (Say) has the largest geographical range and has been introduced in Chile, Mexico, and the United States (Lanteri & Díaz 1994). *Aramigus tessellatus* is a complex of several parthenogenetic lineages and one sexual lineage (Normark 1996a). Most of these are morphologically distinguishable and some were previously described as separate species. These distinct forms have more recently been informally designated as "morphotypes" of *A. tessellatus* (Lanteri & Díaz 1994). The parthenogenetic lineages of *Aramigus* appear to be polyploid (Normark 1996b).

In a recently submitted paper, Normark and Lanteri integrated the two sources of characters — morphological and molecular — to produce the most robust phylogenetic hypothesis for *Aramigus.* As a result of the analysis, they identified a group of specimens from Uruguay that appear to represent the sister species of *A. tessellatus.* This species is not well separated from *A. tessellatus* on the basis of morphological characters of the female, and was initially (Normark 1996a,b) considered to be morphotype of that species, in the sense of Lanteri &

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Díaz (1994). However, we recognize it as a separate species on the following grounds: (1) analysis of mtDNA sequences (Normark 1996a) and genome sizes (Normark 1996b) indicate that it is a distinct monophyletic lineage that includes both sexual and parthenogenetic sublineages, and (2) when both males and females are considered, the new species possesses a unique combination of morphological characters.

The purpose of the present paper is to describe the new species and to discuss the features that allow its separation from other species of *Aramigus.*

Aramigus uruguayensis, NEW SPECIES

Female (Fig. 1). Small (length 5.5-6.5 mm). Vestiture usually gray; elytral scales directed backward; elytral setae pale, coarse, short and recumbent, slightly longer towards elytral declivity. Rostrum strongly truncate-conical ([width of frons]/[width of rostrum] about 1.80); rostral carinae distinct; rostral groove reaching apex of pronotum. Eyes convex; postocular constriction slight. Funicular article 2 longer than article 1. Pronotum lacking lateral depressions; apex and flanks curved; base not constricted and not thickened. Scutellum distinct, glabrous. Elytra moderately elongate ([length of elytra]/[width of elytra]: 1.53-1.66, mean 1.59; [length of elytra]/[length of pronotum]: 2.61- 2.93, mean 2.73); humeral tubercles absent; posthumeral constriction indistinct; apex subacute; elytral striae distinct. Denticles of fore tibiae small; corbel plate of hind tibiae moderately broad. Apex of sternum 5 straight.

Spermatheca (Fig. 2): Ramus moderately differentiated; prominence between nodulus and body moderately developed; about as long as, to longer than spermathecal body. Spermathecal duct long, usually curled, markedly widened in proximal one-third, narrow in distal two-thirds.

Male (Fig. 3). Smaller (length 5.3mm) and narrower than female, with more curved pronotal apex and more distinct posthumeral constriction. Apex of sternum 5 slightly excavated.

Apex of aedeagus acute (Fig. 4), curved upward. Aedeagus curved in lateral view (Fig. 5), about 2x as long as its apodemes. Lateral pieces of internal sac subparallel, more than 2x as long as central piece.

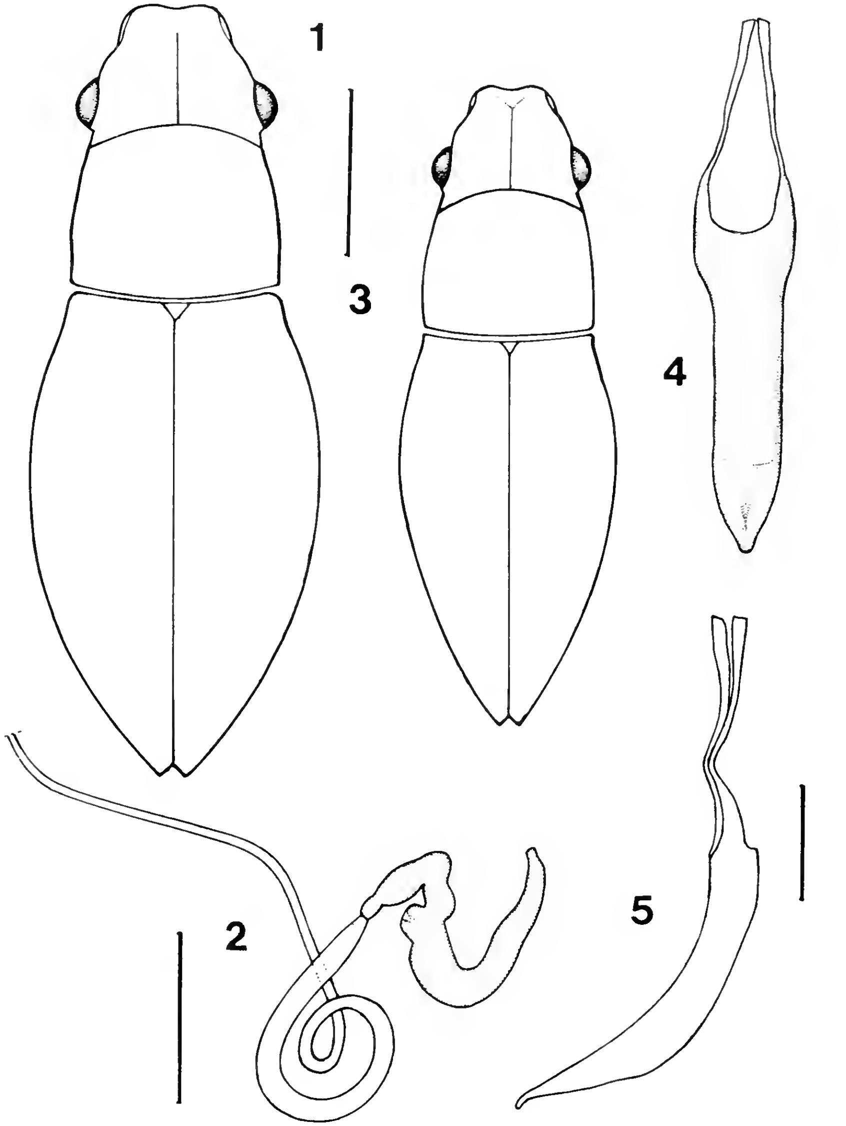
Distribution. The sexual population is known from a single locality, in the department of Rocha, Uruguay. Two other females thought to represent parthenogenetic lineages (Normark 1996a,b) have been found elsewhere in southern Uruguay, in the departments of Canelones and Maldonado. The type locality is Rocha, 8 km S La Coronilla.

DNA. A 762bp fragment of the cytochrome oxidase I gene, mitochondrial genome, was sequenced from 2 males and 2 females of the sexual population (Normark, 1996a). All 4 individuals had identical sequences, which have been submitted to GenBank under the accession numbers U25526-U25529. The sequences of the same fragment from the 2 putatively parthenogenetic females are somewhat different (1.1-1.3% divergent); these have been submitted under the accession numbers U25524, U25525.

Type series. Holotype: 1 female, Uruguay, Rocha, 8 km S La Coronilla, 10-I-1992, B. B. and R. D. Normark coll. 1192. Allotype: 1 male, same data as holotype, 1201. Paratypes: 3 females, same data as holotype, 1191, 1202, and 1193. Holotype and 1 paratype will be deposited in voucher lot #1223 of the Cornell University Insect Collection, Ithaca, New York, USA (CUIC); allotype and remaining paratypes will be deposited at the Museo de La Plata collection, La Plata, Argentina (MLP).

We designated a female as holotype to facilitate comparison with the many parthenogenetic lineages in the genus.

Etymology. The epithet "uruguayensis" refers to the country where the species occurs.



Figures 1-5. *Aramigus uruguayensis:* 1, holotype female, dorsal view of head, pronotum, and elytra; 2, spermatheca and spermatheeal duct; 3, allotype male, dorsal view of head, pronotum, and elytra; 4, aedeagus, ventral view; 5, aedeagus, lateral view. Scales of 1 and 3: 1mm; scales of genitalia (2, 4, 5): 0.5mm.

DISCUSSION

Aramigus uruguayensis was first identified as a distinct group of lineages of *Aramigus* on the basis of mtDNA sequences (Normark 1994). Analysis of 762 bp of the cytochrome oxidase I gene strongly supports the monophyly of this group of lineages (branch support or decay index 8; bootstrap 100%) (Normark 1996a; Normark and Lanteri, unpubl.). The haplotypes of *A. uruguayensis* are 4.8% to 7.8% divergent from those of *A. tessellatus,* and 9.1% to 12.4% divergent from those of other species of *Aramigus* whose mtDNA was examined (Normark 1994).

Based on external morphology, females of *A. uruguayensis* might be confused with some morphotypes of *A. tessellatus* (Lanteri & Díaz 1994), especially with the morphotypes *santafecinus* and *tessellatus,* and with form 1 or the *pallidus* morphotype. They look superficially like small individuals of the *pallidus* morphotype, and are quite variable in both the color of the vestiture and the morphology of the spermatheca and spermathecal duct — characters which are used to separate the different morphotypes of *A. tessellatus.*

The best character for distinguishing females of *A. uruguayensis* from *A. tessellatus* is the markedly widened proximal third of the spermathecal duct (Fig. 2). In the typical forms of the *pallidus* and *santafecinus* morphotypes, spermathecal ducts are not markedly widened at the proximal end and they are not curled (Lanteri & Díaz 1994, p. 140, figs. 56-58, 67). In the *tessellatus* morphotype, the spermathecal duct is narrow throughout its length (p. 139, fig. 44).

There is an atypical form of the *pallidus* morphotype having a curled spermathecal duct (Lanteri & Díaz 1994, p. 140, fig. 59), but it is distinguishable from *A. uruguayensis* by several morphological and mtDNA characters (Normark 1996a, Normark & Lanteri, unpubl.). Lanteri & Díaz (1994) found a few females with sinuous or curled spermathecal ducts markedly widened in the proximal one-third, which they treated as variants of the *santafecinus* morphotype (p. 140, fig. 68) in order to avoid the description of new morphotypes that were not well corroborated. Those specimens previously assigned to the *santafecinus* morphotype were collected in Uruguay, and we now believe that those specimens represent *A. uruguayensis.*

In contrast to the females, which are only weakly differentiated from female *A. tessellatus,* the males of *A. uruguayensis* have aedeagi that differ sharply from those of *A. tessellatus* males. In particular, the body of the aedeagus of *A. uruguayensis is* longer and more slender, and has a more acute apex than that of *A. tessellatus.* The aedeagus is also curved rather than straight in lateral view. The pieces of internal sac are long and subparallel as in *A. intermedius,* and not short and divergent as in *A. tessellatus.* On the whole, the aedeagus of *A. uruguayensis* is similar to that of *A. intermedius* (Lanteri & Díaz 1994, p. 138, figs. 38-40) except that the length of the apodemes is relatively much shorter in *A. uruguayensis* than in any other species of *Aramigus.*

The type series is from the single known sexual population, found in the Department of Rocha, Uruguay. The isolated female from the Department of Maldonado (15 km E San Marcos) was found to be tetraploid by flow cytometry (Normark 1996b) and is hence hypothesized to represent a parthenogenetic lineage. This female, and another with closely related mtDNA haplotype from Canelones, are morphologically similar to females from the sexual population, and have mtDNA haplotypes closely related to (1.1-1.3% divergent from) that of the sexual population. These females may represent parthenogenetic lineages from a diverse *A. uruguayensis* complex that should be a subject of further collections and investigations.

The tribe Naupactini contains many other species that are like *A. uruguayensis* in that they appear to be complexes of sexual and parthenogenetic lineages (Lanteri and Normark 1995). Several of these parthenogenetic lineages have been introduced elsewhere in the world and are widely known as serious agricultural pests (e.g., Eggert *et al.* 1990, Soderstrom *et al.* 1993, Matthiesen & Learmonth 1994). Much less is known about their distribution and biology in their native ranges in southern South America. In the case of *A. tessellatus,* numerous morphologically distinguishable parthenogenetic lineages may co-occur, sometimes along with the sexual lineage (Normark 1994, 1996a). The existence of *A. uruguayensis,* whose range overlaps that of *A. tessellatus,* increases the richness and complexity of potential interactions between related lineages. There may be ecologically (and economically) important differences between parthenogenetic lineages, at least in *A. tessellatus,* since some lineages — and not others — have become agricultural pests (Lanteri 1994). This is potentially a rich system for studies of the ecology and evolutionary biology of sex and parthenogenesis.

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COLLECTIONS OF SAND FLIES (DIPTERA: PSYCHODIDAE) FROM MAMMAL BURROWS IN AN AREA OF CUTANEOUS LEISHMANIASIS IN CAMPECHE, MEXICO[1]

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ABSTRACT: Sand flies were caught from December 1993 to November 1994 in an endemic focus of cutaneous leishmaniasis in the state of Campeche, Mexico. A total of 566 sand flies of seven species were collected using emergence funnel-traps, at openings of several mammal burrows. The main species collected were *Lutzomyia deleoni* and *Brumptomyia hamata.* Population abundance was found bimodal with the first and higher peak from January to March. A small second peak was found from May to October.

Phlebotominae sand flies are small haematophagous insects, well known as vectors of human diseases such as bartonellosis, several arboviruses (mainly Bunyaviridae), and leishmaniases (Young and Duncan 1994). About 700 species of sand flies are known in the world in six genera: *Phlebotomus, Sergentomyia* and *Chinius* in the Old World, and *Lutzomyia, Brumptomyia* and *Warileya* in the New World. Transmission of *Leishmania* spp. (Kinetoplastida: Trypanosomatidae) is restricted to the genera *Phlebotomus* and *Lutzomyia* (Lane 1993).

Sand flies are mainly crepuscular and/or nocturnal. During day-time these phlebotomines rest in a wide variety of shelters such as rock crevices, tree-trunks, caves, underneath dead leaves and animal burrows (Adler and Theodor 1957, Minter 1982, Ward 1985). Such microhabitats might be breeding places.

Little is known in Mexico about the resting/breeding sites of sand flies. The aim of this study was to document the seasonal dynamics of sand flies collected from mammal burrows.

MATERIAL AND METHODS

Study site. The study site was 8 km southeast of the village of La Libertad, Campeche, Mexico. At this site the vegetation is classified as a subperennial tropical forest. In this area the weather is humid-dry with an annual mean tem-

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perature of 27°C and an annual rainfall of 1400 mm (Flores and Espejel 1994).

Sampling of sand flies. Sand flies were caught each month from December 1993 to November 1994, except for September when floods made it impossible to reach the study area. Funnel-traps (Comer and Corn 1991) were placed at the entrance of mammal burrows, mainly armadillo *(Dasypus* sp.) and agouti *(Dasyprocta* sp.). Seventeen traps were set during nine consecutive nights each month. The traps were placed before dusk and checked either the following morning or every other day. Sand flies were manually separated from other insects after each collection using metal tweezers, and then preserved in small vials containing 70% ethanol.

Identification of sand flies. Once in the laboratory, the flies were mounted on microscope slides following the methodology of Young and Perkins (1984). Euparal® (Bioquip Products Co., Gardena CA) was used as mounting medium. Species determination was carried out using the keys of Forattini (1973), Young (1979), Murillo and Zeledon (1985), and Young and Duncan (1994). Gravid females (i.e., females with egg development in IV and/or V Christophers' stages) were easily detected during the identification process. Most mounted slides were kept as voucher specimens at the University of Yucatan (UADY) with some duplicates at the University of Nuevo Leon (UANL).

RESULTS AND DISCUSSION

Overall 566 sand flies, including two genera and seven species, were collected during 87 trapping-nights (Table 1). The most common species was *Lutzomyia deleoni* (Fairchild & Hertig) representing 72.09% of the total trap

Table 1 . Distribution of sand flies collected by funnel traps from mammal burrows in a subperennial tropical forest in the state of Campeche.

	Number of			
Species	Female	Male	Total	%
B. galindoi	10	14	24	4.2
B. hamata	73	13	86	15.2
L. carpenteri	4	14	18	3.2
L. deleoni	220	188	408	72.1
L. o. olmeca	1	17	18	3.2
L. panamensis	2	0	2	0.4
L. shannoni	2	8	10	1.8
Total	312	254	566	100

ping. The test for sex ratio gave an equal proportion of female: male ($Z = 1.56$, $P > 0.05$). *L. deleoni* is mainly suspected to feed on mammals other than human. Williams (1968) reported this sand fly as an abundant species at ground level, being attracted to rodent-baited traps. The non-anthropophilic behavior of this species is supported by the scanty flies caught on human bait catches reported by Williams (1965), Porter *et al.* (1987), and Rowton *et al.* (1991).

The second most numerous species was *Brumptomyia hamata* (Fairchild & Hertig) constituting 15.2% of the total caught. The test for sex ratios indicated that more females were captured than males ($Z = 8.95$, $P < 0.01$). It is suggested that this species (as other members of the genus) might be associated with armadillo burrows from which the sand fly may obtain its blood meal (Young and Duncan 1994).

Other species such as *B. galindoi* (Fairchild & Hertig), *L. carpenteri* (Fairchild & Hertig), *L. o. olmeca* (Vargas & Diaz-Nájera), *L. panamiensis* (Shannon) and *L. shannoni* (Dyar) were also collected from the burrows (Table 1), but their numbers were too low to be considered for further analysis. In fact all these species pooled together represented only 12.7 % of the captures.

The monthly abundance of sand flies was bimodal. The first and the higher peak was found from January to March and it was composed mainly from *L. deleoni* catches. The second peak (May through October) was composed of both *L. deleoni* and *B. hamata*. Numbers of sand flies captured each month seem to be correlated with low levels of rainfall but the abundance of *B. hamata* increased during the period of heaviest rainfall (Fig 1). Reproductive seasons

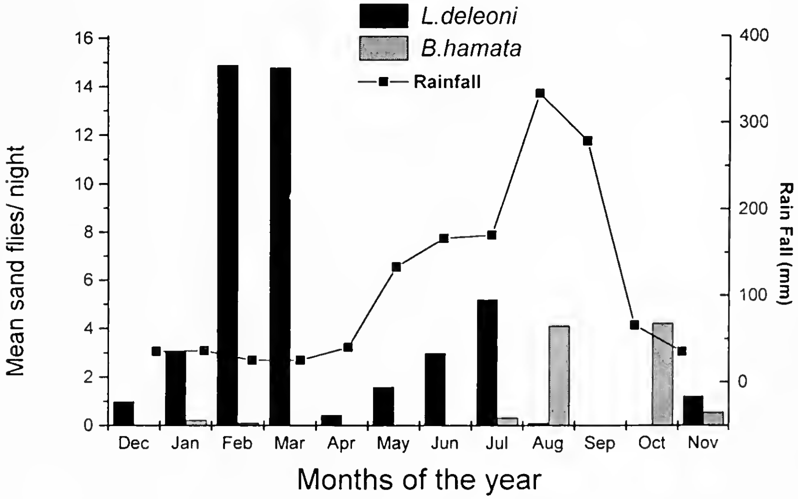

Figure 1. Abundance of sand flies collected in mammal burrows from December 1993 to November 1994 using funnel traps. Campeche state, Mexico.

for the major species may be determined by the number of gravid females caught each month. During the first peak 36 gravid *L. deleoni* females were caught while during the second peak 18 gravid females of the same species were recorded. Other gravid females found were *L. carpenteri* (2), *L. shannoni* (1), *B. hamata* (3), and *B. galindoi* (1).

Other authors (Fairchild and Harwood 1961, Thatcher and Hertig 1966, Chaniotis and Anderson 1968) have reported sand flies inhabiting mammal burrows in the New World, but the importance of such burrows is not yet well understood. We suggest that further studies are needed to determine whether those burrows serve as resting/breeding places or both.

ACKNOWLEDGMENTS

We are indebted to the inhabitants of La Libertad, Campeche, Mexico for their cooperation and to the authorities of the Regional Research Centre, University of Yucatan for providing facilities for field work. This project received financial support from UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases (TDR) ID 900248.

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BOOK REVIEW

CADDISFLIES (TRICHOPTERA) OF THE INTERIOR HIGHLANDS OF NORTH AMERICA. S.R. Moulton II and K.S. Stewart. 1996. Memoirs of the American Entomological Institute, Volume 56, 313 pp.; ISBN: 1-887988-00-9. (Available from American Entomological Institute, 3005 SW 56th Avenue, Gainesville, FL 32608-5047. $40.

The Interior Highlands, a 400,000 km region in parts of Arkansas, Illinois, Missouri and Oklahoma have long been notable for their high numbers of endemic plants, insects and fishes. The first extensive study of aquatic insects in the region, which contains the Ozark, Arbuckle and Wichita Mountains, dates to 1991 with the publication of the monograph by Poulton and Stewart on the Plecoptera of the region. With the publication of this new monographic study by Moulton and Stewart on the Trichoptera of the Interior Highlands, we have a companion volume. Workers concerned with water quality and aquatic resources in the region will have monitoring tasks considerably easier with the coverage of two of three EPT groups. Caddisfly workers will find the book a worthy successor to Ross's classic 1944 survey of the Illinois fauna.

The book is basically divided into two sections; text and taxonomic keys. The text portion is subdivided into an introduction, which includes a summary of regional caddisfly studies, and a description of the geology and hydrology of the Interior Highlands. Following the introduction is a methods section which describes the nearly 500 localities in all 17 physiographic subregions visited between 1990 - 1994. The results section is one of the highlights of the book and contains extensive information on the distribution and emergence dates of the 229 species in 58 genera and 17 families identified from the 250,000 specimens collected during the study. Not too surprisingly, this caddisfly fauna was dominated by Hydroptilidae, Leptoceridae and Hydropsychidae. Detrended Correspondence Analysis was used to determine if species occurrence could be linked to habitat variables, watersheds or geology; the results of which are presented in an expansive table. Patterns of distribution, probable affinities and distribution maps for the 27 caddisflies endemic to the Interior Highlands are included, as is a brief discussion of another 13 species with disjunct distributions occurring in the region.

The second half of the book is devoted to a taxonomic treatment of the caddisflies in the Interior Highlands. Keys are available to family for both larvae and adults. Each family is covered individually with a summary of distinguishing characteristics and distribution. Each genus is then summarized briefly with species keys provided. These keys are primarily for adult males, although there are regional larval keys for 11 genera, including *Helicopsyche*, *Ceratopsyche*, *Hydropsyche*, and *Rhyacophila*. The illustrations accompanying the keys are another of the book's highlights.

(continued on page 326)

A NEW SPECIES OF *MYERSLOPIA* FROM CHILE (HOMOPTERA: CICADELLIDAE)[1]

M. W. Nielson[2]

ABSTRACT: A new species of leafhopper, *Myerslopia chilensis*, from southern Chile is described and illustrated. The genus *Myerslopia* is reviewed and notes are given on this first record of the genus in the New World.

Evans (1947) described *Myerslopia* for two endemic species from New Zealand and created a new tribe Myerslopiini (Evans 1947) for this genus and a related genus, *Pauliniana* Evans, from Madagascar (Evans 1955). Later, Evans (1977) added the first new genus, *Myerslopella*, from Australia to Myerslopiini. Three nymphs of the tribe were reported from Chile and were believed to represent a new, undescribed genus (Evans 1961 [1962]). Knight (1973) in his excellent review of the tribe, described 10 new species and four new subspecies from New Zealand. His work greatly enlarged our understanding of the diversity and peculiar distribution of the group.

Myerslopiini was regarded as a tribe of Ulopinae by Evans (1947, 1955, 1966), Knight (1973) and Oman *et al* (1990). Linnavuori (1972) and Linnavuori & DeLong (1977) elevated the group to subfamily level (Myerslopiinae).

Known myerslopiine leafhoppers have fully developed forewings, lack flying wings and are considered primitive, relict insects derived from ulopine stock during the Mesozoic period (Evans 1966, Knight 1973, Linnavouri 1972). Nymphs of the tribe discovered on the Isla de Chiloe in southern Chile may represent a new genus as reported by Evans (1961 [1962]) or they possibly may be immature forms of the new species described below. Linnavouri & Delong (1977) cited a letter received from Dr. Evans, who mentioned that a new myerslopiine genus (*Myerslopella*) was found in Australia which for the first time gave a tribal connection between it and New Zealand.

The extended distribution of *Myerslopia* into the New World, reported here for the first time, offers additional substantive evidence of faunal and geological connection of southern South America, Australia and New Zealand as part of the historical biogeography of Gondwanaland or "Antarctic" land mass prior to the breakup of Pangeae. The biogeography and proposed origin of the subfamily are given in detail in another paper (Nielson & Knight, in preparation).

In this paper, a new species of *Myerslopia* is described from 1 male and 3 female adult specimens sent to me by Dr. Robert Brooks, Snow Entomological Museum, University of Kansas (UK), for identification.

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[1] Received April 13, 1996. Accepted May 1, 1996.

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Myerslopia Evans

Myerslopia Evans 1947, Type-species, *Myerslopia magna* Evans, by original designation.

The genus was characterized by Knight (1973) in his detailed study of the New Zealand Ulopinae.

Myerslopia chilensis NEW SPECIES

Figs. 1-7

Length male, 5.2 mm., female 5.60-5.90 mm.

General color dark brown, with large ivory spots in basal half of costa, tannish ridge along fused claval suture; scutellum tannish; crown tannish in basolateral area in female.

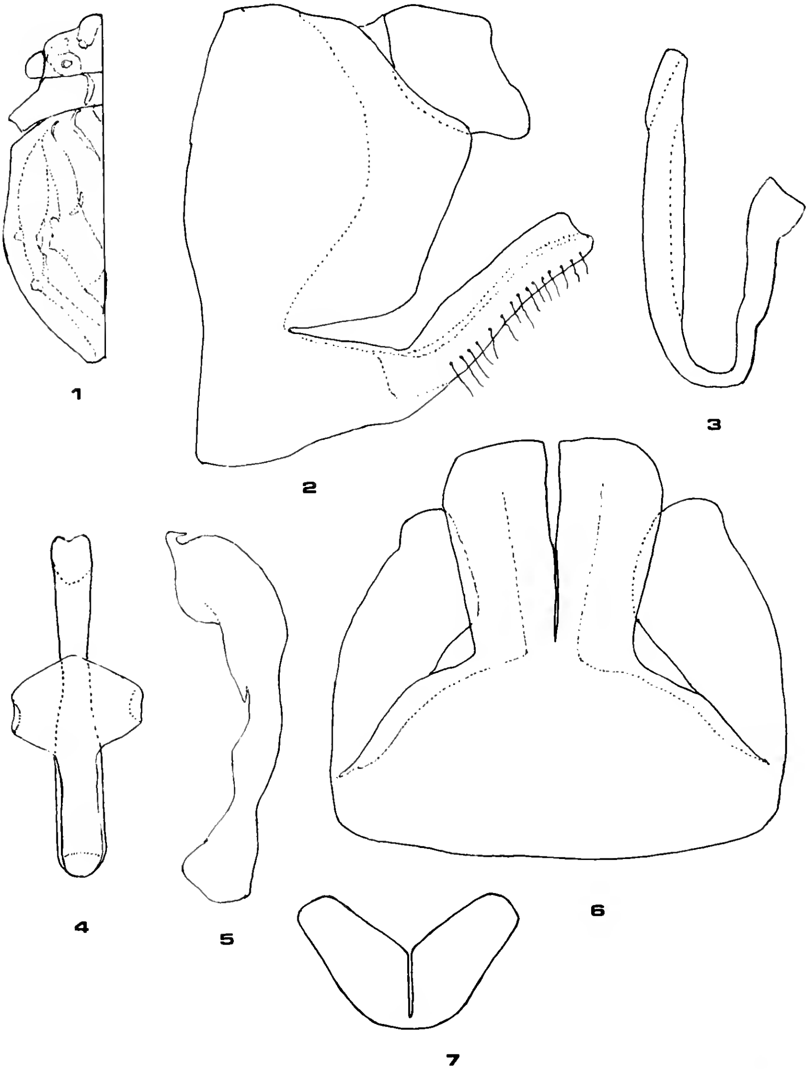
Head broad, narrower than pronotum; eyes small, protuberant laterally; ocelli absent; crown produced medially, anterior margin sinuate, foliaceous, disk with triradial depression, prominent rumulate tubercles basally, one on each side between midline and inner margin of eyes, numerous small bullae on discal surface; pronotum very short, with lateral, triangulate paranota, paired curved, highly elevated ridge medially; scutellum very small, inflated; forewing coriaceous, shielding abdominal pleural region, pitted, highly sculptured with several, irregular shaped protuberances on each side of commissural line, elevated ridge on first claval vein, claval suture fused by elevated curved ridge from base to near commissural line apically, elevated ridge transecting fused claval suture, five protuberances of various configurations in each discal area, large protuberance on joined commissure 1/3 distance from apex, venation obscure, appendix absent (Fig 1); hindwing absent; clypeus swollen distally, protuberant basally on each side of middle, numerous bullae on surface; clypellus swollen; lora distinct, gena large, antennal sockets deep, antennal ridge foliaceous, irregularly cupolate; labium robust, extending beyond posterior coxae.

Male. Pygofer short, without caudal processes, caudal margin produced to a medial lobe (Fig. 2); segment 10 sclerotized (Fig. 2); aedeagus long, tubular, curved dorsad of and fused basally to apex of connective, gonopore terminal on dorsal margin (Fig. 3, 4), configuration similar to *magna* Evans complex (Knight 1973, fig. 10E); connective subquadrate basally (Fig. 4); style nearly straight (not abruptly curved medially as in all New Zealand species), enlarged in distal third with small curved projection apically (Fig. 5); plate fused basally to broad triangulate valve, not fused along entire midline (Fig 6), truncate or nearly so in lateral and ventral views (Fig. 2, fig. 6), microsetae along outer lateral margin (Fig. 2), sclerotized curved ridge along base of plate and extending along caudal margin of valve (Fig. 6).

Female. Seventh sternum large, consisting of two elliptical plates fused narrowly at base on midline, with narrow separation on midline (Fig. 7).

Holotype (male). CHILE: Osorno, 19 km. E. Termas de Puyehue, 40 degrees 40'S., 71 degrees 14'W., 450 m., 30.XI.1994, A. Leschen & C. Carlton, #200, ex:sifting leaf litter (UK). Allotype female, Chiloe, 31.4 km. SW Chonchi, Lago Tepuhueco, 50 m., 42 degrees 51'S., 73 degrees 47'W., 26.XI.1994, R. Leschen & C. Carlton, #122, ex:sifting leaf litter (UK). Paratypes, 1 female, Osorno, 34.5 km. E. Orsono, 40 degrees 38'S., 71 degrees 42'W., 200 m., 1.XII.1994, R. Leschen & C. Carlton, #201, ex: leaf litter *Nothofagus* (UK); 1 female, Osorno, Lago Puyehue, 2 km. W. Termas de Puyehue, 40 degrees 42'S., 72 degrees 22' W., 300 m., 13.XI.1994, R. Leschen & C. Carlton, #172, ex:flight interception trap (UK).

Remarks. This species is related to the *magna* complex in general habitus and male genital characters. It keys to couplet 4 in Knight's key to the species



Figs. 1-7. *Myerslopia chilensis*, n. sp. 1. Dorsum, left dorsal view. 2. Male pygofer and 10th segment, lateral view. 3. Aedeagus and connective, lateral view. 4. Same, ventral view. 5. Style, lateral view. 6. Plate, valve and male pygofer, ventral view. 7. Female seventh sternum, ventral view.

of *Myerslopia* of New Zealand. Distinguishing features of *chilensis* that separate it from *magna* include the following: smaller size, higher number of and different configurations of protuberances on forewings (a major character for species differentiation), different configuration of clypeal protuberances, plates completely separated and truncate distally, and style not curved abruptly at right angle medially with subapical third enlarged.

The hosts of *Myerslopia* species in New Zealand are unknown, and all records point to their habitat in leaf litter and soil debris (Knight 1973). Similarly, the host of *M. chilensis* is unknown and all specimens except one (flight intercept trap) were collected in leaf litter, presumably on a forest floor. A specimen collected in leaf litter of *Nothofagus* is significant because this southern hemisphere beech genus is affiliated with the "Antarctic" flora of Mesozoic origin. It is also interesting to note that one specimen was collected in a flight intercept trap, probably carried by strong winds since the adults cannot fly.

The long, robust labium of *Myerslopia* species which is atypical of leafhoppers and the leaf litter habitat of the group might imply that these species are predaceous. If so, they would be the first record of a nonphytophagous leafhopper. They are primitive insects presumably derived from the base of the ulopine stock. Phytophagy is considered a derived character state from predation in the heteropteran groups (Schuh 1979, Ward *et al.* 1993) and therefore the predaceous groups are now placed along the base of the phylogenetic tree. The correlation between "primitive" groups and predation is implied as far as leafhoppers are concerned. Research on the feeding habits of *Myerslopia* or other primitive groups of leafhoppers in the subfamily Ulopinae is needed to resolve this question.

ACKNOWLEDGMENTS

I wish to extend my heartfelt appreciation to R. W. Brooks, University of Kansas, Lawrence (UK) for loan of the specimens and to W. J. Knight and M. D. Webb for critical review of the manuscript.

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BOOK REVIEW

(continued from page 321)

They are well done and are clearly reproduced. Although many are redrawn from originals, the advantage of having over 600 figures all drawn by the same hand is a plus for caddisfly workers. Many of the species present in the Interior Highlands are common throughout the east, so the figures and keys will be much utilized. Larvae of four species, *Helicopsyche limnella, H. piroa, Polycentropus crassicornis,* and a species of *Marilia* are illustrated for the first time, as is the female of *Helicopsyche piroa*. Each of the 229 species occurring in the Interior Highlands is briefly discussed with notes on distribution in the region and North America, as well as notes on taxonomic and biology.

The book concludes with nearly 300 references as recent as 1994 and a taxonomic index. The book is highly recommended to those concerned with aquatic biology in the Interior Highlands region, as a companion volume to Poulton and Stewart's stoneflies of the Ozark and Ouachita Mountains, and as a general reference book for caddisfly workers throughout North America.

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A NEW SPECIES OF *PILOSANA* FROM COSTA RICA (HOMOPTERA:CICADELLIDAE)[1]

M. W. Nielson[2]

ABSTRACT: A new species of leafhopper, *Pilosana bivirgata*, is described and illustrated. Eighteen species now comprise this Neotropical genus in the tribe Youngolidiini.

The genus *Pilosana* was erected by Nielson (1983) in the tribe Youngolidiini (Coelidiinae) and 13 species, mostly from Brazil, were treated. Four new species from Brazil were subsequently described by Nielson (1992). This paper describes a third species from Costa Rica, which represents the extreme northern range of this Neotropical group.

Pilosana bivirgata, NEW SPECIES

Figs. 1-5

Length male, 7.30 mm.

General color black; forewing with broad yellow longitudinal stripe on clavus, apex and costa tinged with pale markings. Similar to *P. bifurcata* Nielson in male genital characters but a larger species with distinctive lobe on caudoventral margin of pygofer.

Dorsal and ventral features as in description of genus.

Male. Pygofer with single tuft of short setae and large caudoventral lobe (Fig. 1), lobe with small tooth on ventromedial margin (Fig. 2); aedeagus narrow with asymmetrical, bifurcate, subapical process on ventral margin, gonopore subapical on lateral margin (Fig. 3); style typical of genus (Fig. 4); plate long, narrow, with long microsetae subbasally and apically (Fig. 5).

Female. Unknown.

Holotype (male). COSTA RICA: Puntarenas, Monte Verde, 1400 m. 14-16.VII.1989, light intercept trap, Robert E. Beer (UK). Paratype male, same data as holotype, in collection of the author.

Remarks. This species is one of the largest in the genus *Pilosana* and can be distinguished from *bifurcata* by its much larger size, the large dentate caudoventral lobe of the pygofer and by the yellow stripe on the clavus. The species keys to couplet 11 in my 1983 paper.

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[1] Received Februry 10, 1996. Accepted April 30, 1996.

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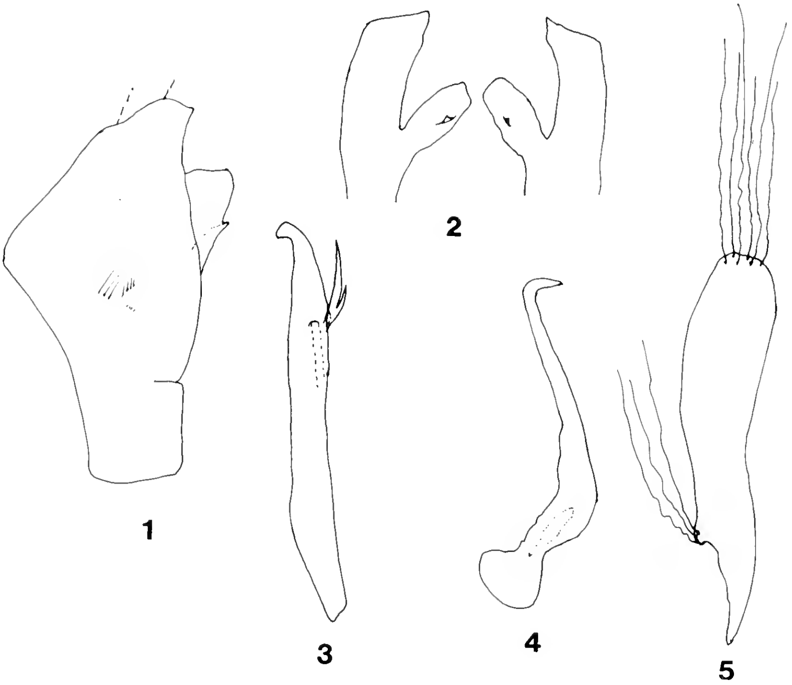

Figs. 1-5. *Pilosana bivirgata*, n. sp. 1. Male pygofer, lateral view. 2. Apex of male pygofer and processes, ventral view. 3. Aedeagus, lateral view. 4. Style, lateral view. 5. Plate, ventral view.

ACKNOWLEDGMENTS

I thank James S. Ashe, Snow Museum, University of Kansas, Lawrence (UK) for loan of material, H. Derrick Blocker, Kansas State University, Manhattan, Chris Dietrich, Illinois Natural History Survey, Champaign, and Stephen W. Wilson, Central Missouri State University, Warrensburg for reviewing the paper.

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KEY TO SPECIES OF *OMADIUS* (COLEOPTERA: CLERIDAE) FROM MANADO, SULAWESI (INDONESIA) WITH NEW RECORDS AND SYSTEMATIC NOTES[1]

Jonathan R. Mawdsley[2]

ABSTRACT: A key is provided to the six species of *Omadius* recorded from Manado, Sulawesi (Indonesia): *O. bivulneratus*; *O. fasciipes* (NEW RECORD); *O. indicus* (NEW RECORD); *O. prioceroides*; *O. mediofasciatus*; and *O. radulifer*. Lectotypes are designated for *Omadius bivulneratus* and *Omadius prioceroides*. *Omadius femoralis* and *O. posticalis* are placed in synonymy with *O. mediofasciatus* (NEW SYNONYMIES).

Four species of the checkered beetle genus *Omadius* were described from specimens collected by Alfred Russel Wallace in the vicinity of Manado, Sulawesi, during Wallace's celebrated voyage through the islands of present-day Indonesia: *O. bivulneratus* Thomson; *O. prioceroides* Thomson; *O. femoralis* Gorham (a synonym of *O. mediofasciatus* Westwood; see below); and *O. radulifer* Gorham. During a recent visit to the Museum National d'Histoire Naturelle (Paris), I examined the holotype or syntype series of all of these species as a part of my ongoing systematic investigations of this genus. These investigations have also enabled me to synonymize *O. femoralis* Gorham and *O. posticalis* Gorham (described from the Philippines) under *O. mediofasciatus* Westwood.

Tropical Indonesia has been greatly altered since Wallace's visit, and therefore Wallace's collection of *Omadius* species serves as a useful benchmark against which more recent collections of these beetles may be compared. Collections made during 1986 by P. M. Hammond (1990) of the Natural History Museum (London) in the Dumoga-Bone National Park near Manado captured only one of Wallace's species (*O. prioceroides* Thomson), as well as the cryptically colored and more inconspicuous *O. fasciipes* Westwood and *O. indicus* Laporte de Castelnau, which were probably overlooked by Wallace. These two species are therefore reported here as NEW RECORDS. I have prepared the following key to species of *Omadius* known to occur on the northern arm of Sulawesi to aid future workers in identifying these large and conspicuous members of the forest clerid fauna.

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[1] Received November 14, 1995. Accepted March 15, 1996.

[2] Department of Entomology, Comstock Hall, Cornell University, Ithaca, NY 14853, USA.

Genus *Omadius* Laporte de Castelnau (1836)

Type Species: *Omadius indicus* Laporte de Castelnau (1836).
(Subsequent designation by Desmarest (1860).

Diagnosis: Body elongate, nearly cylindrical; overall length 10-19 mm; antennae filiform near base, strongly serrate towards apices; eyes finely granulate and very large, frons correspondingly reduced; terminal maxillary palpomeres subulate; terminal labial palpomeres broadened at apices; postgenal processes strongly acuminate and meeting medially above gula; elyural humeri elevated; femora and tibiae elongate, slender; tarsal pads present on protarsomeres 1-4. mesotarsomere 4, and metatarsomere 4; pretarsal claws appendiculate.

Key to species of *Omadius* recorded from Manado, Sulawesi

1.) Elytral bases without rows of small tubercles 2
- Elytral bases with rows of small tubercles 3

2.) Integument nearly glabrous and strongly shining; legs reddish-orange, without black maculae; elytra black with red bases and white transverse fasciae .... *O. prioceroides* Thomson (1860)
- Integument densely pubescent, dull; legs yellow with black maculae; elytra brown with transverse piceous fasciae .... *O. fasciipes* Westwood (1855)

3.) Pronotal arch transversely strigose, at least in part 4
- Pronotal arch not transversely strigose, usually minutely and sparsely punctate 5

4.) Elytra nearly glabrous except for white setae along base of suture and lateral ovate orange patches of pubescence; integumental coloration predominantly metallic blue black; metatibiae planate .... *O. bivulneratus* Thomson (1860)
- Elytra densely pubescent, pattern distinctive: ground color greyish-brown with a broad transverse black band and one or two small black patches at basal and apical third; metatibiae more cylindrical .... *O. mediofasciatus* Westwood (1852)

5.) Elytra yellowish brown with dark brown fasciae; elytra tapering uniformly from humeri to apices; elytral apices sharply acuminate .... *O. indicus* Laporte de Castelnau (1836)
- Elytra black with white fasciae; elytra parallel-sided with apices separately rounded; apices broadly rounded .... *O. radulifer* Gorham (1876)

SPECIMENS EXAMINED

I examined holotype or syntype material of all species described or recorded from Manado, as listed below; all of these specimens are contained either in the collections of the Hope Entomological Department, Oxford University (HCOX), or in the collection of the Museum National d'Histoire Naturelle, Paris (MNHN).

O. bivulneratus Thomson - 2 syntypes, Manado (MNHN), including LECTOTYPE male (here designated).

O. fasciipes Westwood - Holotype, Singapore (HCOX).

O. femoralis Gorham - Holotype, Manado (MNHN).

O. indicus Laporte de Castelnau - 5 syntypes from India (MNHN). I do not plan to designate a lectotype for this variable species until the patterns of variation within the complex "*indicus* group" are better understood, and the relationships of all species in this group can be evaluated simultaneously.

O. mediofasciatus Westwood - Holotype, Khasyah Hills, India (HCOX).

O. prioceroides Thomson - 2 syntypes, Manado (MNHN), including LECTOTYPE male (here designated).

O. radulifer Gorham - Holotype, Manado (MNHN).

I also examined five individuals each of *O. prioceroides*, *O. indicus*, and *O. fasciipes* collected by P. M. Hammond in the Dumoga-Bone National Forest in 1986 (MNHN).

SYSTEMATIC NOTES

I examined the unique holotypes of *O. femoralis* Gorham (1876:104) from Manado and *O. posticalis* Gorham (1876:105) from "Philippines" (both in the H. S. Gorham Collection, Museum National d'Histoire Naturelle, Paris) and concluded that both are conspecific with *O. mediofasciatus* Westwood (1852), a species whose holotype I examined in 1990 (Hope Entomological Collection, Oxford University). Gorham used characters of size and coloration to distinguish these two species from *O. mediofasciatus*; these characters vary considerably in a series of 320 specimens of *O. mediofasciatus* from Laos which I examined in the Bernice P. Bishop Museum, and undoubtedly only a single widespread species is involved. The following new synonymy is thus presented:

Omadius mediofasciatus Westwood, 1852.

O. femoralis Gorham, 1876. NEW SYNONYMY.

O. posticalis Gorham, 1876. NEW SYNONYMY.

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