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(Continued on inside of back cover)

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NEW SPECIES OF *MASTOGENIUS* (COLEOPTERA: BUPRESTIDAE) FROM CENTRAL AMERICA, WITH NOTES AND A KEY TO SPECIES OF CENTRAL AND SOUTH AMERICA[1]

Gary V. Manley[2]

ABSTRACT: Two new species are described from the central mountains of Costa Rica, *Mastogenius pacacua* and *M. cedralensis.* A third new species is described from the Upper Aguan Valley of Honduras, *M. coyolensis. M. bordoni* Cobos is placed as a synonym of *M. cyaneous* Fisher. A key to the species of *Mastogenius* from Central and South America is presented.

The first record of *Mastogenius* from Central America was *M. cyaneous* Fisher from Panama. While several species of the genus are known from Mexico, South America, and the West Indies, no other records have been published from Central America. The collection of an undescribed species from the Aguan Valley in 1977 represented the first record of the genus from Honduras and only the second species from Central America. During 1983 and 1984 two new species were collected from Costa Rica.

Toyoma (1983) separated *Haplostethus* from *Mastogenius* and Nelson (1985) placed the North American species of Mastogeniini in *Haplostethus.* Based on a study of the New World Mastogeniini (Manley, 1986), I believe *Haplostethus* should remain a synonym of *Mastogenius.* Therefore, the name *Mastogenius* is retained, following the synonymy of Cobos (1981). A key to the described species from South and Central America is given.

Mastogenius pacacua Manley, new species
(Figs. 1, 7 & 11)

Holotype, male: Elongate oval, strongly shining, pronotum pubescent, elytra glabrous, dorsal surface uniformly black appearing slightly olive-green in sunlight and occasionally when viewed with incandescent illumination, ventral surface and legs uniformly black with a distinct brown tinge. HEAD slightly convex, with distinctly elongately depressed frons: surface punctate with each puncture having a single short setae, area between punctures smooth; eyes with inner margins slightly converging toward apex; antennae serrate with fourth segment, hairy, extending beyond prosternum. PRONOTUM strongly, uniformly convex, wider than long, distinctly narrower at apex than at base, widest at posterior 1/3, sides broadly arcuately diverging from apical angles to near posterior one-third, then feebly obliquely converging to posterior angles; anterior margin broadly rounded in front, posterior margin truncate, slightly sinuate; marginal and submarginal carina widest apart anterior to middle of pronotum, marginal carina not reaching anterior border of pronotum; surface uniformly densely punctate, and clothed with short recumbent hairs, intervals smooth. SCUTELLUM

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black, triangular and smooth. ELYTRA convex, as wide as pronotum at base; sides nearly parallel from humeral angles to beyond middle, then arcuately converging to broadly rounded apices; oblique transverse depression near bases; surface uniformly irregularly punctate, intervals smooth, sparsely clothed with very short, semierect hairs, hairs arising from bases of elytral punctures. ABDOMEN beneath uniformly black with slight dark brown reflection, convex, punctate, sparsely clothed with short recumbent hairs; last sternite densely punctate, truncate at apex, clothed with scattered long erect hairs. PROSTERNUM, punctate, with scattered recumbent hairs, without antennal grooves. Posterior margin of hind coxal plates sinuate, equally wide at interior and external margins. SIZE: Length, 3.1 mm; width, 1.3 mm.

Allotype, female: No significant differences observed between sexes of this species. Female slightly larger than male.

Types: Holotype, Costa Rica, San Jose province, 2 km east of Colon, March 3, 1984, Gary V. Manley, 1550 meters. Allotype and three male paratypes collected from the same locality as the holotype on April 20, 1984 by Gary V. Manley. Type material currently in G.V. Manley collection but will be deposited in (U.S.) National Museum of Natural History.

Etymology: All specimens collected sweeping along forest margins below the peak of Cerro Pacacua for which this species is named.

Mastogenius cedralensis Manley, new species

(Figs. 2, 8 & 12)

Holotype, male: Elongate oval, shining, pronotum pubescent, elytra pubescent, dorsal surface uniformly black, ventral surface and legs uniformly black, except tarsi which are testaceous. HEAD slightly convex, flat in front, without distinctly depressed frons; surface rather coarsely punctate with each puncture having a single recumbent setae, smooth between punctures; eyes with inner margins converging to each other toward apex; antennae serrate from the fourth segment, hairy, extending beyond the pronotum. PRONOTUM uniformly convex, wider than long, narrower at apex than at base, widest at posterior 1/4, sides broadly arcuately diverging from apical angles to near posterior 1/4, then feebly obliquely converging to posterior angles; anterior margin sinuate, broadly rounded in front, posterior margin truncate; marginal and submarginal carina only slightly wider apart near middle, anterior half nearly parallel, marginal carina not reaching anterior border of pronotum, anterior tip straight; surface uniformly densely punctate, and clothed with recumbent hairs, intervals smooth. SCUTELLUM black triangular, smooth. ELYTRA convex, as wide as pronotum at base; sides nearly parallel from humeral angles to beyond middle, then arcuately converging to broadly rounded apices; with oblique transverse depression near bases; surface uniformly, irregularly densely punctate, uniformly clothed with posterior facing recumbent hairs similar in density and length to those of pronotum. ABDOMEN beneath, convex, punctate, clothed with recumbent hairs; last sternite densely punctate, truncate at apex, clothed with hairs. PROSTERNUM coarsely punctate, with scattered hairs, without antennal grooves. Posterior margin of hind coxal plates sinuate, external margin narrowed, less than one-half the width of interior margin. Size, length 3.1 mm, width 1.2 mm at elytral humeri.

Allotype, female: Differs from the male as follows: pronotum shining aeneous, elytra bicolored, anterior 1/3 and posterior 1/3 strongly shining aeneous with golden reflection, middle 1/3 shining deep blue with violet reflection, apices of elytra concolorous with middle region. Gold and blue regions not sharply defined and may vary depending on viewing angle. When viewed without a microscope elytra appear brassy blue-green and color patterns cannot be separated. Both pronotum and elytra clothed with hairs but hairs less dense and shorter than in male. Antennae shorter, not reaching posterior margin of pronotum. Length 3.2 mm; width (pronotum) 1.4 mm (elytra) 1.3 mm.

Types: Holotype, Costa Rica, San Jose, 2 km. east Colon, April 20, 1984, Gary V. Manley. Collected on the upper slopes of Cerro Pacacua at between 1500-1600 meters. Allotype and one female paratype collected at the same locality and date as the holotype. Type material currently in G.V. Manley collection but will be deposited in (U.S.) National Museum of Natural History.

Etymology: The species is named after Calle Cedral, a trail which follows along the top of the ridge between Colon and Santa Ana on the south edge of the Central Valley west of San Jose. Specimens were collected along this trail in wooded patches.

Mastogenius coyolensis Manley, new species
(Figs. 3 & 9)

Holotype, female. Elongate oval, shining, dorsal surface uniformly deep aeneous brown, ventral surface uniformly black, pronotum and elytra equally pubescent. HEAD slightly convex in front, a distinct but shallow round depression on frons between eyes; surface coarsely irregularly punctate with scattered short white pubescence, intervals smooth; eyes with inner margins slightly converging toward apex; antennae serrate from fourth segment, not extending beyond pronotum when laid along side, triangular segments with scattered hairs. PRONOTUM uniformly convex, wider than long, narrower at apex than at base, widest anterior to middle, side arcuately diverging from apical angles to near middle, then converging to basal angles; anterior and posterior margins straight; marginal and submarginal carinae widest apart just posterior to middle, marginal carina not reaching anterior border of pronotum, sloping toward submarginal carina at anterior termination; surface uniformly densely punctate, intervals smooth, uniformly clothed with short recumbent white hairs. SCUTELLUM black, triangular, smooth except for a few very fine shallow punctations. ELYTRA convex, as wide as pronotum at base; sides subparallel from humeral angles to beyond middle, then arcuately converging to subtruncate apices; oblique transverse depressions near base; surface uniformly irregularly punctate, intervals smooth, sparsely clothed with semi-erect white hairs, hairs arising from elytra punctures. VENTRAL THORAX convex, coarsely and densely punctate with scattered recumbent white hairs; prosternum without antennal grooves; posterior margins of hind coxal plates sinuate, narrowed laterally. ABDOMEN convex, moderately punctate, sparsely clothed with recumbent white hairs and scattered longer hairs near middle of abdominal sternites; last sternite more coarsely punctate with mixture of short and long hairs, truncate at apex. SIZE: length 3.1 mm, width 1.2 mm.

Type material: Holotype, Honduras, Coyoles, upper Aguan Valley, June 20, 1977, Gary V. Manley. Type material currently in G.V. Manley collection but will be deposited in (U.S.) National Museum of Natural History.

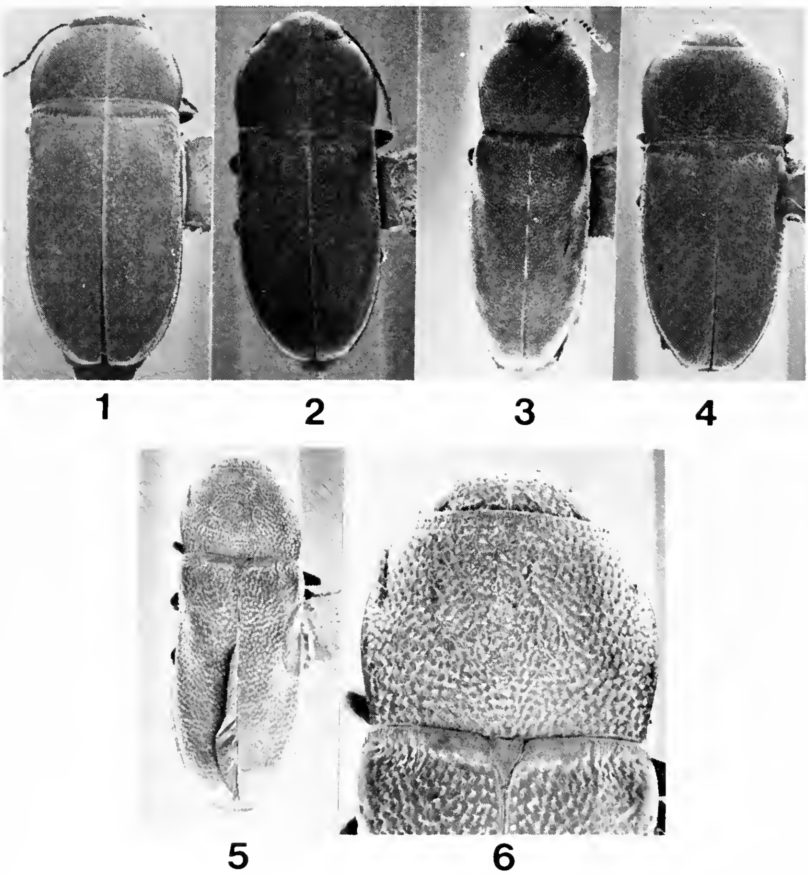
Etymology: This species is named after Coyoles, Honduras. The holotype was collected sweeping scrub brush about 2 miles north of town.

Mastogenius cyaneous Fisher
(Figs. 4, 10 & 13)

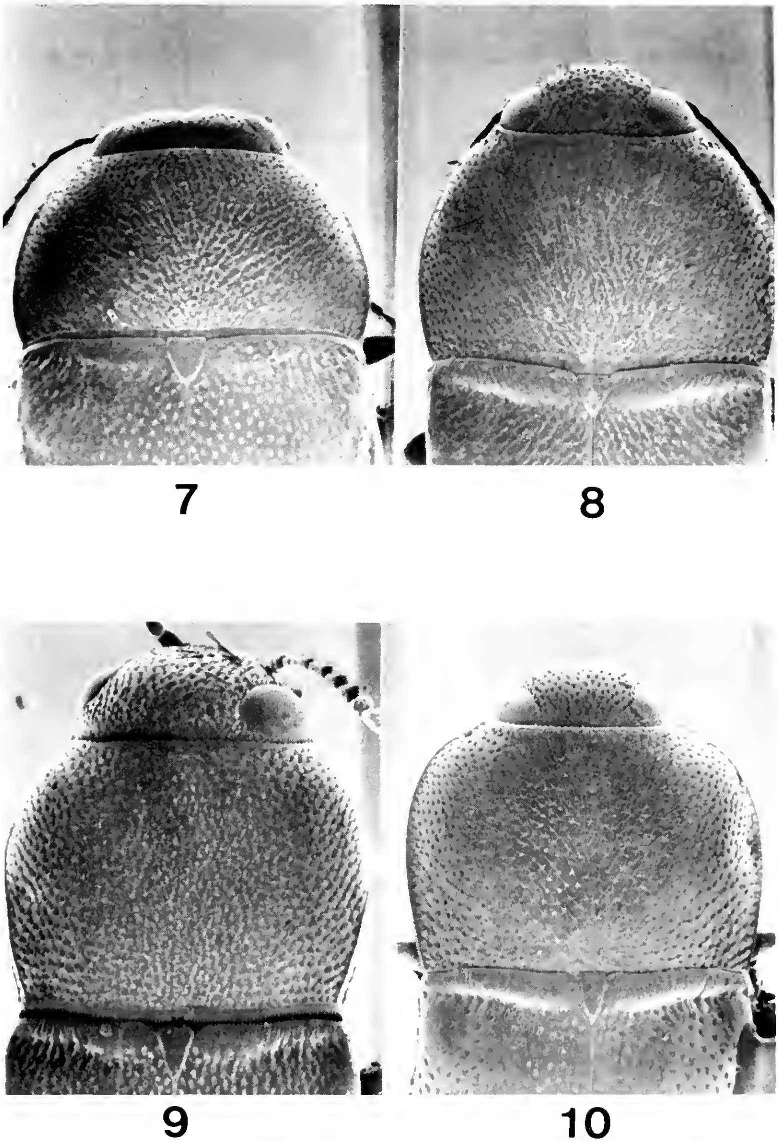
Mastogenius bordoni Cobos, 1981, new synonymy)

Previously only the holotype specimen of *M. cyaneous* from Panama was known from Central America (Fisher 1922). *M. cyaneous*, however, is widespread in both central and northern South America, having been collected by the author from Honduras (10 specimens; Comayagua Valley, VI-2-1978), Costa Rica (2 specimens; 1 San Jose, Santa Ana, VI-24-1983; 1, San Jose, 2 km. east of Colon, VI-17-1983), Colombia (5 specimens; 1 Santa Marta, V-15-1981; 1, Santa Marta, V-18-1981; 3, Santa Marta, VII-6-1982), and a single specimen observed from El Salvador (Tonocatepeque, 20-VI-1958) deposited in the Canadian National Collection in Ottawa.

Comparisons of homotype material from Honduras as well as specimens of *M. cyaneous* from Costa Rica and Colombia with the type of *M. bordoni*



Figs. 1-6. Dorsal view and pronotum. 1. *Mastogenius pacacua* n.sp. 2. *M. cedralensis* n.sp. 3. *M. coyolensis* n.sp. 4. *M. cyaneous* Fisher 5. *M. martinezi* Cobos 6. *M. martinezi* Cobos.



Figs. 7-10. Pronotum. 7. *Mastogenius pacacua* n. sp. 8. *M. cedralensis* n. sp. 9. *M. coyolensis* n. sp. 10. *M. cyaneous* Fisher.

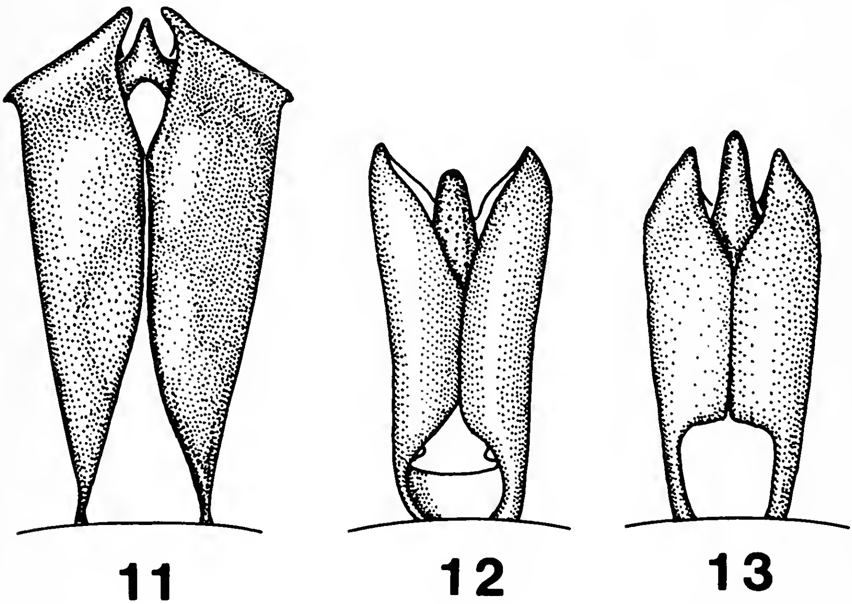
Cobos from Venezuela revealed that they are the same species.

Specimens vary mostly in size with the South American specimens being somewhat smaller but comparisons of the male genitalia from Columbia, Costa Rica, and Honduras show no differences. Other than size, all specimens appear to be identical. Size is also variable in the series of specimens from Honduras.

The holotype would appear to be a female but was not dissected. Figures 4, 10 and 13 were prepared from a homotype male collected from the Comayagua Valley of Honduras and labelled "SEM" in my collection.

Mastogenius martinezi Cobos
(Figs. 5 & 6)

This species was described by Cobos, 1981 from a pair of specimens collected at Cordoba, Argentina. Another female was collected by H. & A. Howden from Cordoba in II- 17-21- 1982, and figures 5 and 6 are based on this specimen.



Figs. 11-13. Dorsal view of male genitalia. 11. *Mastogenius pacacua* n. sp. 12. *M. cedralensis* n. sp. 13. *M. cyaneous* Fisher.

The following key is provided to *Mastogenius* of Central and South America. I have not observed specimens of the following species, and they are placed in the key based on details in the descriptions: *M. solieri, M. reticulicollis, M. laevifrons, M. aeneus, M. simulans,* and *M. sulcicollis.*

Key to *Mastogenius* of Central and South America

1 Form short, compact, less than 2 1/2 times as long as wide at humeri (usually 2.0: 2.5) 2

Form more elongate and slender, equal to or more than 2 1/2 times as long as wide at humeri 10

2 Front of head strongly sulcate or with depression or pit near middle 3

Front of head convex or flat, without any median depression 8

3 Larger species, over 3.0 mm in length; sculpture of pronotum very dense, coarse, and roughened; color blue, blue-green or fusco-bronze 4

Smaller species, under 3.0 mm, usually about 2.5 mm in length; sculpture of pronotum variable, color uniformly brown 5

4 Dorsal color blue or blue-green. Brazil .... *M. solieri* Thomson

Dorsal color fusco-bronze. Brazil .... *M. reticulicollis* Cobos

5 Pronotum widest near middle, narrowed toward anterior angles; front of head shallowly sulcate or with rounded depressed pit but not strongly deeply sulcate to clypeus ... 6

Pronotum margins divergent from base, widest near anterior angles; front of head longitudinally deeply sulcate from upper frons to clypeus 7

6 Elytra blue-black or black; margins of pronotum semi-circularly rounded at middle. Costa Rica .... *M. pacacua* n. sp.

Elytra brown; margins of pronotum subparallel at middle. Ecuador .... *M. manglaraltoensis* Manley

7 Sulcus on front of head wide and deep, widest near clypeus and more or less uniform in depth from top to bottom, wider than width of eye at greatest width. Ecuador .... *M. changonensis* Manley

Sulcus on front of head deep and narrower, sides of sulcus more or less parallel, with a deep pit in upper region, not wider near clypeus, narrower than width of eye at greatest width. Venezuela .... *M. proximus* Cobos

8 Pronotum widest anterior to middle, near anterior angles. Central and South America .... *M. cyaneous* Fisher

Pronotum widest posterior to middle, anterior angles strongly narrowed 9

9 Tarsus testaceous, tibia and femur piceous. Costa Rica .... *M. cedralensis* n. sp.

Tarsus piceous, concolorous with tibia and femur. Ecuador .... *M. elinarae* Manley

10 Pronotum longer than wide, narrower at the base than elytra; body very long, 4 times the width; color bronze, almost black. Length 4.0 mm. Chile ..... *M. laevifrons* Kerremans

Pronotum transverse, at least as wide as long, as wide as the base of elytra; body length not more than 3 times the width 11

11 Legs testaceous, body uniformly metallic brown. Argentina .... *M. martinezi* Cobos

Legs concolorous with ventral surface 12

12 Front of head convex or flat, not sulcate or with a strong median depression 13

Front of head distinctly sulcate or with a median depression or pit.............. 18

13 Posterior lateral margins of elytra finely toothed; length 3.3 mm. Brazil............ .... *M. aeneus* Kerremans

Posterior lateral margins of elytra unarmed.................................. 14

14 Elytra uniformly brown... 15

Elytra steel-blue, piceous-blue, blue or piceous, but not shining brown 16

15 Marginal carina of pronotum turned sharply downward toward submarginal carina near anterior 1/4 of pronotum, nearly touching submarginal carina; elytral surface confluently punctate; ventral surface black-bronze. Honduras .... *M. coyolensis* n. sp.

Marginal carina of pronotum widely separated from submarginal carina toward anterior, nearly reaching anterior margin of pronotum, not turned sharply downward; elytral surface distinctly punctate, interspaces distinct and smooth; ventral surface shining brown. Ecuador .... *M. jipijapa* Manley

16 Marginal and submarginal carina of pronotum widest apart near middle of pronotum, anterior end of marginal carina turned down toward submarginal carina and not reaching anterior margin of pronotum. Ecuador .... *M. guayasensis* Manley

Marginal and submarginal carina of pronotum widest at anterior end of marginal carina, anterior end of marginal carina straight or turned up and away from marginal carina and reaching anterior margin of pronotum.. 17

17 Tarsi pale chestnut colored, tibia piceous. Brazil .... *M. simulans* Cobos

Tarso concolorous with tibia and femur. Central and South America.............. .... *M. cyaneous* Fisher

18 Front of head flat with shallow depression near middle; marginal carina of pronotum turned sharply downward toward submarginal carina near anterior 1/4 of pronotum; disk of elytra slightly flattened; dorsal surface aeneous. Honduras ... *M. coyolensis* n. sp.

Front of head with deep longitudinal sulcus; marginal carina not turned sharply downward near apical 1/4 of pronotum; disk of elytra convex, elytra sometimes slightly longitudinally gibbose; dorsal surface deep brown or fusco-piceous....... 19

19 Sculpture of elytra smooth, distinctly punctate, interspaces smooth, surface glabrous 20

Sculpture of elytra very dense, confluent, and coarsely roughened; surface hairy. Chile.. 21

20 Pronotum divergent from base, widest near anterior angles; dorsal surface fusco-piceous. Venezuela .... *M. proximus* Cobos

Pronotum widest and subparallel near middle, convergent at both base and apices; dorsal surface brownish. Peru .... *M. peruvianus* Fisher

21* Front when viewed from above distinctly sinuate (with a deep median depression), especially in the female. Pronotum narrowed toward the anterior, with the maximum width in the posterior 1/3 .... *M. sulcicollis* Philipi

*from Cobos, 1981

Front when viewed from above flattened in the middle (with a small median depression more elevated and shallow), equal in both sexes. Pronotum narrowed toward the posterior, with the maximum width in the anterior 1/3......... *M. parallelus* Solier

Discussion of Central American Species

The three Costa Rican species are relatively easily separated from each other by a combination of characters. *M. cyaneous* has uniformly deep blue elytra with a piceous pronotum, and is the only species with its pronotum widest anterior to the middle. The pronotum is semi-circularly rounded in the other species, and widest near or posterior to the middle. *M. pacacua* and *M. cedralensis* differ in their elytral pubescence: *M. cedralensis* has abundant, long recumbent setae on the elytral surface; *M. pacacua* is nearly glabrous; *M. pacacua* is longitudinally dome shaped on the elytra; and *M. cedralensis* is slightly flattened on the disk of the elytra.

M. coyolensis from Honduras is rather easily separated from other Central American species by being uniformly brown on the dorsal surface, more elongate, with its elytra twice as long as broad, and coarsely textured. Other species from Central America are either black, blue or have a greenish or blue-green reflection on the dorsal surface, are shorter or broader, with the elytra less than twice as long as broad at humeral angles, and elytra punctate with smooth interspaces.

The following key is provided to *Mastogenius* of Central and South America. I have not observed specimens of the following species, and they are placed in the key based on details in the descriptions: *M. solieri, M. reticulicollis, M. laevifrons, M. aeneus, M. simulans,* and *M. sulcicollis.*

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A NEW SPECIES OF *PELINA* (DIPTERA: EPHYDRIDAE) FROM THE NEOTROPICAL REGION[1,2]

Philip J. Clausen[3]

ABSTRACT: A new species of *Pelina* from Mexico is described. This is the first record of this genus from well within the Neotropical Region.

Since my revision of the genus *Pelina* for the Nearctic Region (Clausen, 1973), I have found only one new species which was from Mexico and I then considered it as being from the southernmost extension of the Nearctic (Clausen, 1985). Now, as a result of a recent collecting trip to southern Mexico, Wayne N. Mathis of the (U.S.) National Museum of Natural History has collected a series of *Pelina* specimens, clearly of a new species, from well within the Neotropical Region. This is the first record of the occurrence of this genus in the neotropics.

I am not including any species key as this is the only distinctly Neotropical species and is easily distinguished from the Nearctic species using the characters in the following diagnosis.

Pelina mathisi Clausen, new species

Diagnosis: Apex of scutellum truncate, apical scutellar tubercles very large and long, length R_{4+5} 1.63 to 1.84 mm, and length M_{1+2} 1.02 to 1.19 mm. Male with short, broad surstyli with short, rounded, apical projection and internally with long, curved, pointed projections which apparently fit into pits on lateral fragments of sternite 5. Female with anterior apex of mesothoracic tibiae with black setae and apical spur, sternites 7 and 8 slightly narrower than sternite 4.

Description: Male. Total body length 2.79 to 3.03 mm; shining black with brassy, coppery, silvery and greyish pruinosity.

Head shining black with brassy pruinosity except as noted; length 0.51 to 0.54 mm; 1 large and 3 or 4 small pairs of orbital setae; vertex with brassy pruninosity above and below; gena black with greyish to silvery pruinosity. Face shining black with dense greyish to silvery pruinosity; parafacial setae in 2 more or less distinct rows, top row with 1 large and 2 small, divergent setae, bottom row with 1 large and 1 or 2 small, convergent setae. Cyepus with silvery to greyish pruinosity, mouthparts with greyish pruinosity. Antenna dark with brassy pruinosity; arista dark brown, very slightly plumose dorsally.

Thorax shining black with coppery pruinosity, brassy to faint greyish pruinosity between acrostichal and dorsocentral setal rows, cuticle beneath stripes with fine, transverse, ripple-like sculpturing; scutum length 0.78 to 0.88 mm; pleura shining black with brassy pruinosity

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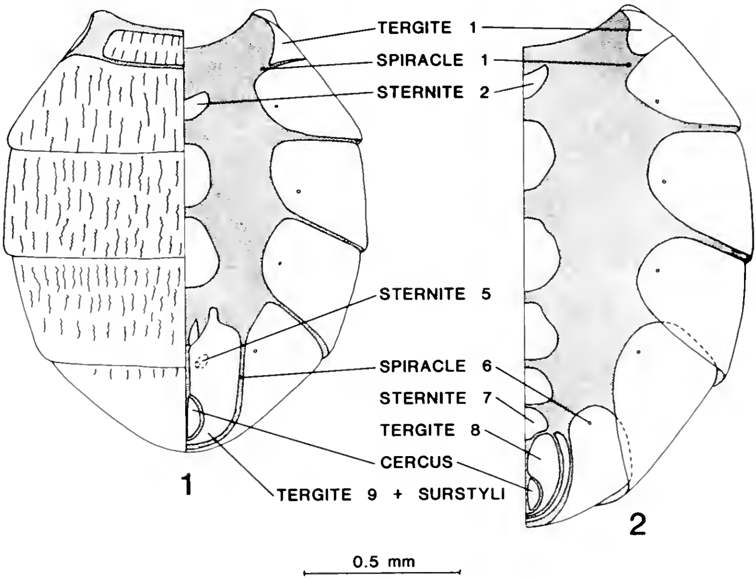
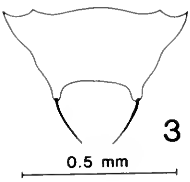
above, becoming greyish anteriorly, posteriorly and below. Scutellum (Fig. 3) shining black with coppery pruinosity, length 0.24 to 0.31 mm, truncate at apex, apical tubercles very large and long, apical and lateral scutellar setae large. Legs black except tarsi reddish, all covered with brassy to greyish pruinosity; prothoracic tibiae with long yellow setae at apex; apex of mesothoracic tibiae each with black spur and 4 small, black, anterior setae; apex of metathoracic tibiae each with yellow anterior setae and yellow posterior comb. Wing length from humeral crossvein 2.41 to 2.55 mm; width 0.85 to 1.02 mm; distance from h to R_1 0.51 to 0.58 mm; R_1 to R_{2+3} 1.26 to 1.43 mm; R_{2+3} to R_{4+5} 0.58 to 0.65 mm. R_{4+5} to M_{1+2} 0.20 to 0.27 mm; length R_{4+5} 1.63 to 1.77 mm; length M_{1+2} 1.02 to 1.09 mm; costal section from R_1 to R_{2+3} 2.2 to 2.6 times distance from h to R_1; R_1 to R_{2+3} 2.2 to 2.5 times distance from R_{2+3} to R_{4+5}; and R_{2+3} to R_{4+5} 2.1 to 3.0 times distance from R_{4+5} to M_{1+2}.

Abdomen as in Fig. 1; shining black with sparse coppery pruinosity; tergites 1 through 4 deeply sculptured dorsally, tergite 5 sculptured only along anterior dorsal margin. Sternite 1





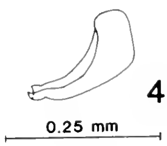


Fig. 1 - Male abdomen - *Pelina mathisi* Clausen. Fig. 2 - Female abdomen - *Pelina mathisi* Clausen. Fig. 3 - Scutellum - *Pelina mathisi* Clausen. Fig. 4 - ventral receptacle - *Pelina mathisi* Clausen.

absent; sternite 5 reduced to 2 small, widely separated, oval, lateral fragments, each bearing a pit, into which the pointed, internal projection of each surstylus apparently fits.

Genitalia (Fig. 5). Note tergite 9 + surstyli with short, rounded, apical projection, internally with long, curved, pointed projections which apparently fit into pits on fragments of sternite 5. Paired gonites, long, somewhat truncate apically with posterior projecting hooks, fused anteriorly to sternite 6; gonal arch absent. Aedeagus large, long, rather slender, cleft anteriorly and posteriorly, laterally each side tapering to a rather blunt apex.

Female: Total body length 2.99 to 3.16 mm. Head, thorax, legs, and wings as in males except as noted.

Head length 0.54 to 0.58 mm.

Thorax with scutum length 0.82 to 0.92 mm; scutellum length 0.27 to 0.31 mm. Wing length from humeral crossvein 2.55 to 2.72 mm; width 0.95 to 1.02 mm; distance from h to R_1 0.61 to 0.65 mm; R_1 to R_{2+3} 1.39 to 1.46 mm; R_{2+3} to R_{4+5} 0.58 to 0.65 mm; R_{4+5} to M_{1+2} 0.24 to 0.27 mm; length R_{4+5} 1.80 to 1.84 mm; length M_{1+2} 1.12 to 1.19 mm; costal section from R_1 to R_{2+3} 2.2 to 2.4 times distance from h to R_1; R_1 to R_{2+3} 2.2 to 2.5 times distance from R_{2+3} to R_{4+5}; and R_{2+3} to R_{4+5} 2.1 to 2.4 times distance from R_{4+5} to M_{1+2}.

Abdomen as in Fig. 2. Ventral receptacle as in Fig. 4.

Distribution. Known only from the type locality.

Types: Holotype ♂ and 16 paratypes (6 ♂♂ and 10 ♀♀) from San Cristobal de las Casas (20 km. E.), 2050 m.,Chiapas, Mexico, 8 May 1985, Wayne N. Mathis. All are deposited in the collection of the National Museum of Natural History, Washington, D.C.

Specimens examined. The holotype ♂ and 16 paratypes as mentioned earlier.

Etymology: It is my pleasure to name this species in honor of my good friend and fellow ephydrid worker, Wayne N. Mathis, who collected the specimens and kindly loaned them to me.

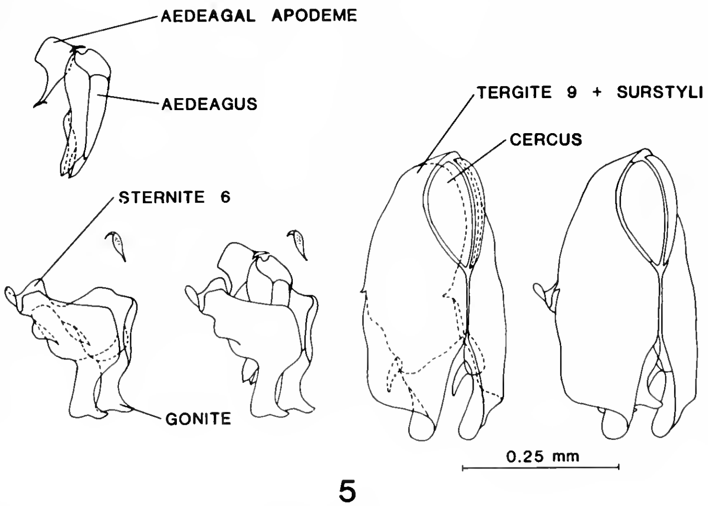


Fig. 5 - Male genitalia - *Pelina mathisi* Clausen.

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TAENIOPTERYX BURKSI (PLECOPTERA: TAENIOPTERYGIDAE) IN COLORADO, WITH NOTES ON AQUATIC INSECTS OF PLAINS STREAMS[1]

Boris C. Kondratieff[2], James V. Ward[3]

ABSTRACT: The winter stonefly, *Taeniopteryx burksi* is recorded for the first time from Colorado. This is only the third species of this predominantly eastern group to be found in the western United States. The remarkable streams of the Great Plains of eastern Colorado have an interesting mix of widespread-eastern, midwestern and western species of aquatic insects. The dominant species of these streams are listed.

Twelve species of *Taeniopteryx* are known from North America (Ricker and Ross 1968; Stewart and Szczytko 1974; Kondratieff and Kirchner 1982, 1984; Baumann and Jacobi 1984). Of these species, only three are known to occur in western North America [according to Baumann's (1976) zoogeographical divisions]: *T. nivalis* (Fitch) from Alberta, California, Oregon, Idaho, Saskatchewan, Utah and Washington, *T. parvula* Banks from Alberta, and *T. pecos* Baumann and Jacobi from New Mexico. Canton et al. (1981) also reported on two collections of nymphs of an unidentified species of *Taeniopteryx* from northern Colorado. These records may pertain to *T. nivalis*.

During a survey of the aquatic insects of eastern Colorado, numbers of mature nymphs and adults of *T. burksi* Ricker and Ross were collected from several streams in Yuma and Kit Carson Counties (Fig. 1). This area, part of the Great Plains physiographic province of Colorado, remains virtually uninvestigated by aquatic entomologists. The streams follow rather straight courses to the east and are characterized by low gradients, sandy bottoms and few instream retention devices (Fig. 2). The woody riparian vegetation of this region consists primarily of occasional Plains Cottonwood trees (*Populus sargentii*). Unfortunately, many of the streams are being seriously perturbed by agricultural practices.

Taeniopteryx burksi is widely distributed throughout eastern North America (Ricker and Ross 1968). Stewart et al. (1974) presented several hypotheses concerning the western dispersal and distribution of *Taeniopteryx* species and other stoneflies during the glacial periods. These remarkable spring-fed streams on the Great Plains of eastern Colorado may be the most western refugia for this species and other typically eastern North American

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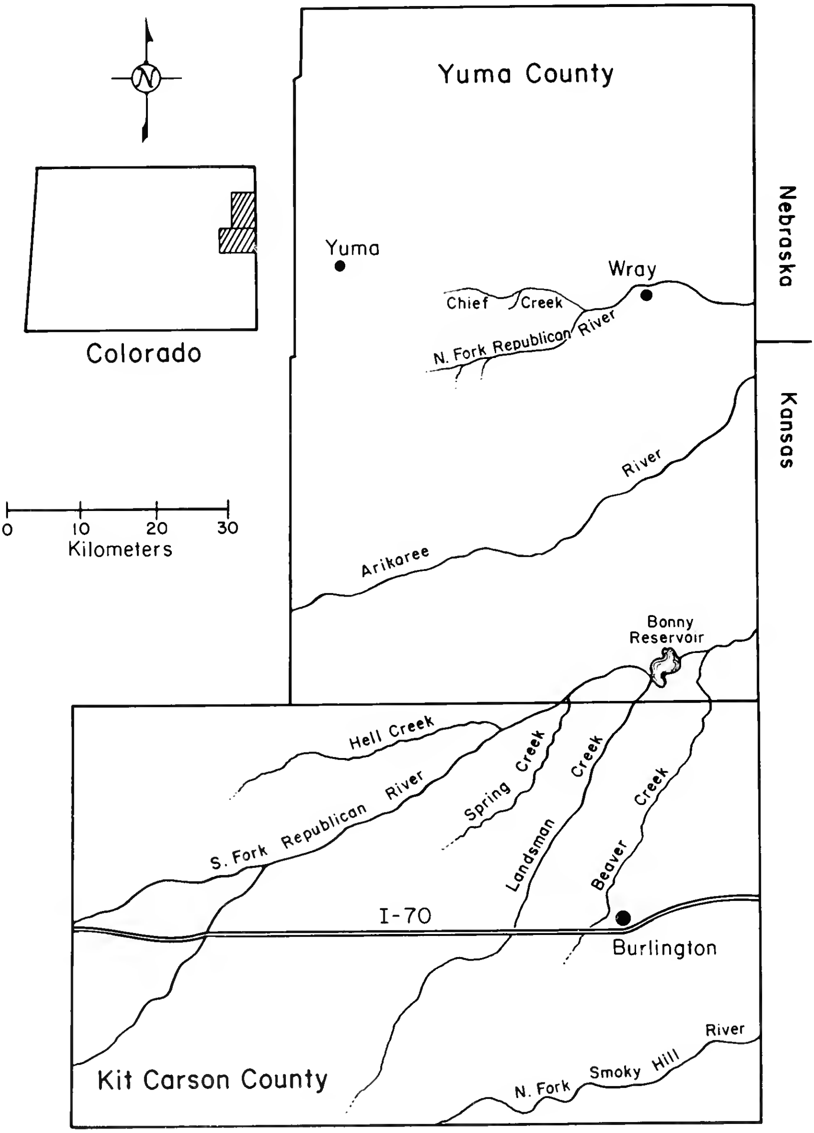

Fig. 1. Collecting sites in Yuma and Kit Carson Counties, Colorado.

Fig. 2. Photograph showing typical plains stream habitat.

groups of aquatic insects. Other examples of predominantly eastern stoneflies found in the West include *Acroneuria abnormis* (Newman), *Parcapnia angulata* Hanson, *Pteronarcys dorsata* (Say), and *Perlesta*. All of these taxa now have been collected in Colorado.

No capniids or other taeniopterygids were found in association with *T. burksi*. The only other stoneflies present in these streams were a species of *Isoperla* (*quinquepunctata* complex of Szczytko and Stewart 1979) and a species of the *Perlesta placida* complex (genus being revised by B.P. Stark).

Other adult and immature aquatic insects collected during preliminary sampling include the dragonflies and damselflies, *Ophiogomphus severus* Hagen, *Calopteryx maculata* (Beauvois), and *Hetaerina americana* (F.); mayflies, *Isonychia rufa* McDunnough, *Baetis insignificans* McDunnough, *Heptagenia diabasia* Burks, *Ephermerella inermis* Eaton, *Hexagenia limbata* Serville, and *Tricorythodes* sp.; the caddisflies *Hydropsyche occidentalis* Banks, *Cheumatopsyche pettiti* (Banks), *Nectopsyche diarina* Ross and *Gumaga griseola* (McLachlan); and the riffle beetles *Stenelmis crenata* (Say) *Microcylloepus pusillus* (LeConte), and *Dubiraphia spp.* The water penny genus *Psephenus* has also been collected from this area (D. Fronk, personal communication). The above faunal assemblage is an interesting mix of widespread-eastern, midwestern, and western species.

Perlesta (Stark *et al.* 1973), *I. rufa* (Kondratieff and Voshell 1984), *H. diabasia, G. griseola* (Ross and Wallace 1974; D. Ruiter personal communication), *S. crenata, M. pusillus,* and *Psephenus* (Brown 1983) also represent new state records for Colorado.

Selected Material Examined: *T. burksi* - Yuma Co., Chief Creek, 31 Jan. 1986, 15 males, 11 females, 1 nymph; North Fork of Republican River, 31 January 1986, 18 males, 17 females, 20 nymphs; Kit Carson County, South Fork Republican River, 31 January 1986, 2 nymphs. *Perlesta placida* - Chief Creek, 25 June 1986, 5 males, 9 females, 7 nymphs; North Fork Republican River, 25 June 1986, 4 females. *I. rufa* - Chief Creek, 25 June 1986, 3 males, 7 females, 4 nymphs; Arikaree River, 25 June 1986, 1 male, 2 females, 1 nymph; Kit Carson County, South Fork Republican River, 25 June 1986, 1 male. *H. diabasia* - Chief Creek, 25 June 1986, 12 males, 15 females, 8 nymphs. *G. griseola* - Chief Creek, 25 June 1986, 3 males; *S. crenata* - Yuma County, North Fork Republican River, 25 June 1986, 4 adults. *M. pusillus* - North Fork Republican River, 25 June 1986, 2 adults. (All material deposited in the Colorado State University Insect Collection.)

ACKNOWLEDGMENTS

We thank Howard E. Evans and Don W. Fronk for their prepublication reviews, and Oliver S. Flint, Jr. for the identification of *Gumaga griseola.* Harley P. Brown confirmed our riffle beetle records.

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CRYPTIC COLORATION IN *SCHIZURA IPOMOEAE* (LEPIDOPTERA: NOTODONTIDAE), WITH A NEW HOST PLANT AND DISTRIBUTION RECORD[1,2]

R.J. Rathman[3]

ABSTRACT: Cryptically colored larvae of *Schizura ipomoeae* were observed feeding on black hawthorn, *Crataequs douglasii*, foliage near Wenatchee, Washington, during July and August, 1985. This represents new distribution and host plant records for *S. ipomoeae.*

The procryptic habits and appearance of twig-like geometrid larvae are well known (Poulton 1890). However, there are few known examples of feeding by cryptically colored lepidopterous larvae, whereby chewed foliage resembles the herbivore. W.G. Müller described the behavior of a South American nymphalid larva, *Anaea* sp., which chews the leaf of its food plant so that a number of rough models of itself remain attached to the leaf midrib. It then positions itself on an adjacent midrib. The deceptive effect is even more remarkable due to coloration of the larva: green dorsally and dark ventrally, the green simulating leaf remnants attached to the midrib (*In* Cott 1966).

On July 18, 1 and 6 August, 1985, 10 mature larvae of *Schizura ipomoeae* Doubleday (Lepidoptera: Notodontidae) were observed feeding on black hawthorn, *Crataegus douglasii* Lindley, foliage on an east-facing slope approximately 16 km south of Wenatchee, Chelan County, Washington, at elevation 670 m. Observations were made for a total of 120 minutes in the late afternoon on 15 plants ranging in height from 1 to 1.5 m.

Chewed leaves on the plants examined comprised approximately 10% of the total number of leaves, and the section of plant "cut out" by larvae resembled late instars in form and coloration. The color pattern of *S. ipomoeae* larvae was remarkably similar to the brown, mottled pattern of foliage being consumed (Fig. 1). Larvae were positioned along intact and chewed leaf edges and initially were very difficult to see, especially because diurnal feeding was slow, and the larvae moved very infrequently. These findings confirm an early report by Packard (1895) that larvae of *S. ipomoeae* resemble foliage. Madsen and Hoyt (1957) also reported protective coloration in *S. ipomoeae* on plum.

Crataegus douglasii is added to the list of host plants mimicked by *S. ipomoeae.* Peterson (1962) lists the following hosts: *Quercus, Acer,*

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Betula, Rubus and *Gleditsia tricanthus* L., honeylocust. Seitz (1924) lists, in addition to the above hosts, *Ulmus, Vaccinium and Ceanothus* in the northern states and *Ipomoeae coccinae* in the Gulf states. In Idaho *S. ipomoeae* has been recorded from prune (Manis 1954). This is the first record of *S. ipomoeae* from Washington. It has been recorded from the eastern states (Packard 1895) and from Idaho (Manis 1954) and California (Madsen and Hoyt 1957).

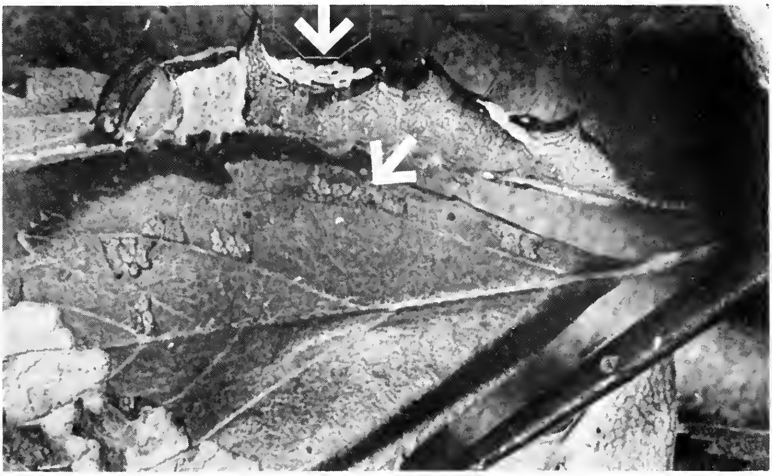

Fig 1. Cryptically colored *Schizura ipomoeae* larva on a new host plant, black hawthorn, *Crataegus douglasii.* Brown, mottled pattern of the larval integument and necrotic areas on the leaf are strikingly similar.

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NEW DISTRIBUTION RECORDS AND SYNONYMY FOR LITTLE-KNOWN DOLICHOPODIDAE (DIPTERA) OF THE PACIFIC NORTHWEST[1,2]

William J. Turner[3]

ABSTRACT: New distribution records from the Pacific Northwest (Washington, Idaho, and Oregon) are reported for 12 dolichopodid species. Observations on their specific habitats and comments about diagnostic features are provided. *Neurigona uinta* is synonymized with *N. flava.*

During 1983-84 I examined and identified the miscellaneous undetermined western dolichopodids in the James Entomological Collection at Washington State University. Among the materials determined were specimens which provided important range extensions into the Pacific Northwest for 12 species of dolichopodids. Represented are mostly smaller and lesser known species, especially those of the subfamily Sympycninae. Most of the material was collected by me over the past 15 years, principally by sweeping and Malaise trapping throughout Washington, northern Idaho and northeastern Oregon. My determinations were compared with type material in the National Museum of Natural History (Washington, D.C.), the California Academy of Sciences (San Francisco), and the Museum of Comparative Zoology, Harvard University. I also borrowed type material from the Canadian National Collection (Ottawa) and Utah State University for study.

Described species of Dolichopodidae that have been identified here as occurring in Washington and/or adjacent areas of Oregon and Idaho include the following;

Achalcus oregonensis (Harmston and Miller), 1966: 91

This small, yellowish brown species with a black abdomen was originally described in *Systenus* and transferred to *Achalcus* by Steyskal (1970). It represents the only western species of the subfamily Xanthochlorinae. I found specimens to be fairly abundant in sweep samples taken within the moist coastal forest areas of western Washington and on the Olympic Peninsula.

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WASHINGTON: Clallam Co.: Dean Creek, 7 mi. S Sequim, 4 Aug 1972. Pacific Co.: Ft. Canby State Park, nr Ilwaco, 16 Jul 1966; 13-15 Jun 1973. Whatcom Co.: Silver Fir Cmpgr., nr Mt. Baker 8-11 Aug 1974.

Achradocera arcuata (Van Duzee), 1924: 48

Widespread throughout the western states, this species has been captured at more arid localities in the Columbia Basin of eastern Washington and the Snake River canyons in the southeastern portion of the state. It was originally described in the *Chrysotus* "barbatus" group, the species of which were subsequently given generic status by Robinson (1975). Specimens of *A. arcuata* may appear similar to *Chrysotus palpiger* (Wheeler), *Diaphorus aldrichi* Van Duzee and *D. triangulatus* Van Duzee occurring in the same sweep samples. Males are easily recognized by their very elongate and tapering antennal flagellum with equally long apical arista and multiseriate postocular setae.

WASHINGTON: Benton Co., Richland, 18 Aug 1975; West Richland, 12 Jun 1974, 4 Jun 1975. Grant Co.: Soda Lake nr O'Sullivan Dam, 10 Jun 1973. Whitman Co.: Steptoe Cyn., 8 mi. SW Colton, 26 Jul 1973, 29 Jul 1976; 10 mi SW Colton, 3 Aug 1974; Pullman, 29 May 1971.

Calyxochaetus insolitus (Van Duzee), 1932: 20

Reported from Colorado and Utah, *C. insolitus* has been collected from one locality along the east side of Lake Coeur d'Alene in Idaho where it occurs with *Sympycnus pugil* Wheeler and *S. cuprinus* Wheeler. Specimens were swept from lush vegetation typical of moist creek margins in an otherwise dry Douglas fir forest. The species is quite unlike most other *Calyxochaetus* in that the first tarsomere of the male foreleg is subequal to the second rather than shorter. The arista gradually expands to the tip. Females appear metallic or gun metal blue on the upper front.

IDAHO: Kootenai Co.: Carlin Bay, 10 mi. N Harrison, 14-28 Jul 1977; 18-24 Jul 1982.

Lamprochromus canadensis (Van Duzee), 1917: 339

This species has been variously placed in *Diaphorus, Sympycnus* and *Telmaturgus* (Robinson, 1967). In the Catalog of Nearctic Diptera (Foote, *et al.,* 1965) it was recorded from several eastern states (New York and North Carolina) and Canada (Ontario) with one questionable record from Utah. Our specimens were collected in sweep samples taken from grassy riparian vegetation bordering slow moving side channels of Asotin Creek which drains into the Snake River above Clarkston, Washington. They occur with *Teuchophorus utahensis* Harmston and Knowlton and *Peloropeodes cornutus* (Van Duzee) at the Asotin Creek site. The species is recognized among similar appearing ones by the broad, deep violet median band of the mesoscutum and paired velvety black spots just anterior to the wing bases.

WASHINGTON: Asotin Co.: 6 mi. W Asotin, along Asotin Creek, 15 Jun 1985; 22 Jun and 8 Jul 1986.

Neoparentia caudata (Van Duzee), 1917: 338

Described originally in *Sympycnus,* this species was known previously from northern California (Wildcat Creek, Contra Costa Co.). It was transferred by Robinson (1967) to *Neoparentia.* Our specimens are from several diverse locations in eastern Washington. The males are easily recognized from other sympycnines by their rather elongate, thread-like caudal filaments that are nearly as long as the abdomen, and setate midventral tubercle on the fifth abdominal segment.

WASHINGTON: Asotin Co., Fields' Spring State Park, 4 mi. S Anatone, 5 Jul 1984. Grant Co.: Soda Lake, nr O'Sullivan Dam, 18 Sept 1979. Whitman Co.: Lyle Grove Biological Area, 8 mi. SW Pullman, 27 Jul 1985. Yakima Co.: Bear Creek, nr Tieton Ranger Station, 7-9 Jun 1983.

Sympycnus tertianus Loew, 1864: 187

This species is fairly common throughout the coastal areas and at higher elevations (above 640 m) of Washington and Idaho, but specimens often go unrecognized in collections. It frequently occurs with other *Sympycnus* species, especially *S. cuprinus* and *S. pugil.* Unlike the others, the lower thoracic pleuron and abdominal sterna appear pale yellow, concolorous with the legs.

WASHINGTON: King Co., 4 mi. E Skykomish, 18 Jul 1977. Pacific Co.: Ft. Canby State Park, nr Ilwaco, 16 Jul 1977. Whitman Co.: 3 mi. W Colton, 16 Jun 1979. Yakima Co.: Chinook Pass, 12 Jul 1977. IDAHO: Latah Co.: Lost Creek, 12 mi. ENE Potlatch, 22 Jul 1979, 9-12 Jul 1980. Strychnine Creek 15 mi. ENE Potlatch, 2900 ft., 23 Jul 1980.

Sympycnus marcidus Wheeler, 1899: 48

This species is evidently widely distributed in the west as it has been reported from Alberta, Utah and California. It was described from

Wyoming. Our specimens are from extreme northeastern Oregon, in the Wallowa Lake area. All were collected by sweeping stream-side grasses. In males of this species, the third tarsomere of the hind leg bears a series of long bristles, the distal-most appearing stronger and distinctly geniculate.

OREGON: Wallowa Co.: Wallowa Lake, 4,000 ft. 28-30 Aug 1973.

Teuchophorus utahensis Harmston and Knowlton, 1942b: 20

Until now this species was known only from Utah. Our specimens were collected in southeastern Washington along with *Lamprochromus canadensis* and *Peloropeodes cornutus*. This species is unusual in that the costal vein is noticeably thickened at mid wing beyond the subcosta, similar to the venation of *Teuchophorus clavigerellus* Wheeler. The male hind tibia bears an erect but flattened, spur-like appendage ventrally, one-third from its base. In our material the mid and hind coxae are not black as in the type series, but slightly darkened. Otherwise, they compare well with paratypes examined.

WASHINGTON: Asotin Co.: 6 mi. W Asotin, along Asotin Creek, 13 Jul to 10 Aug 1985, 22 Jun and 8 Jul 1986.

Peloropeodes cornutus (Van Duzee), 1926: 42

Recorded from California, Oregon, Idaho and Michigan (Foote, Coulson and Robinson, 1965), this species can now be reported from Washington. It is not an uncommon species in several moist canyons draining into the Snake River of eastern Washington. The antenna of males is characteristic for this species in that the flagellum is elongate, nearly as long as the head height, not short and triangular as in females and other species. The arista is inserted near the flagellar base.

WASHINGTON: Asotin Co.: along Asotin Creek, 6 mi. W Asotin, 22 Jun 1986. Whitman Co.: Almota, 25 Jun 1973; 6 mi. S Wawawai, 2 Jun 1977 (Malaise trap); Yakawawa Canyon, 7 mi. WNW Colton, 25-27 Jun 1977; Steptoe Cyn., 8 mi. SW Colton, 26 Jul 1973; 10 mi. SW Colton, 3 Aug 1974.

Hercostomus cachae Harmston and Knowlton, 1941a: 131

Another species known previously only from Utah, *H. cachae* was collected in two seep areas along or above the otherwise arid Grande Ronde River valley of southeastern Washington and northeastern Oregon. The male has a characteristic hypopygium with the inner process (or paramere) like the bacilliform sclerites of the genitalia in muscoid Diptera. In both sexes, the hind femur is pale basally and dark on the apical half.

WASHINGTON: Asotin Co.: 17 mi. S Anatone, 10 August 1976. OREGON: Wallowa Co.: 39 mi. N Enterprise, 28 June 1976.

Diostracus mchughi Harmston, 1966: 224

Described from Latourele Falls, Oregon, this species has been collected at waterfalls in two locations within Mt. Rainier National Park, Washington. Dissimilar to *D. olga* Aldrich, the wing in this species is tipped with an apical black spot.

WASHINGTON: Lewis Co.: Stevens Creek at Stevens Canyon Road, 4,000-4,500 ft., 24 August 1973; Pierce Co.: West End Road, nr Puyallup River, 3,500 ft., 12 August 1977.

Neurigona flava Van Duzee, 1913: 40, NEW SYNONYMY

Neurigona unita Harmston and Knowlton 1942a: 80

Neurigona flava was originally described from a single female from Lewiston, Idaho. We have specimens from sites in Oregon and Washington. At each of these localities the small females of *N. flava* were collected simultaneously with similar-sized males identified as *N. uinta* Harmston and Knowlton. This latter species was previously known only from the type series of 16 males from White Rocks (Uinta Co.), Utah (Harmston and Knowlton, 1942a). Our specimens were compared by Fred Harmston with his type material for *N. uinta* and found to be conspecific. Only the larger *Neurigona albospinosa* Van Duzee regularly occurs at the same localities as *N. flava* so that confusing the association of sexes is minimized. Also, at the Yakawawa Canyon and Goose Creek sites, the Malaise traps were in place for several weeks and should have produced any other *Neurigona* species had they been present. On the strength of their associations at several different localities, I believe the two sexes are conspecific and should be recognized under the older name, *N. flava*.

WASHINGTON: Asotin Co.: Fields' Spring St. Prk. 31 Jul 1971, 15 Jun 1972; 4 mi. S Anatone, 3600 ft., 12 Aug 1980. Jefferson Co.: Gold Creek, 5 mi. W Carlton, 19 Jul 1972. Stevens Co.: 2 mi. SE Deer Lake, 27-28 Jul 1973. Whitman Co.: Yakawawa Cyn., 7 mi. NW Colton, 25-27 Jun 1977. Yakima Co.: Naches River, 3 mi. W Naches, 16 Jul 1972. OREGON: Baker Co.: Upper Goose Crk., 34 mi. SE Union, 4160 ft., 20-26 Jul 1975; Lower Goose Crk., 36 mi. SE Union, 4000 ft., 13-19 Jul 1975; Lower Lick Crk., 26 mi. SE Union, 4000 ft., 20-26 Jul 1975. All captured in Malaise traps.

DISCUSSION

Most of the above species share one or more features in common worth noting. For the most part, they are smaller forms that may be overlooked among other specimens in sweep or Malaise trap samples. Frequently they resemble the more numerous and similar appearing species with which they occur. Others, such as *Achalcus oregonensis* and *Neurigona flava*, are yellowish or brown and not at all metallic green like most dolichopodids. Finally, several are captured in isolated and less obvious habitats that may be dismissed by the general Diptera collector: roadside seeps, deep coastal forests and verdant vegetation narrowly bordering streams in otherwise arid locations.

It would seem that many dolichopodid species are not limited in their distributions, but likely occur over much broader geographic ranges throughout the western states as suggested here. Many species were described from limited series in states further east, especially Utah. The dolichopodid fauna of Utah has been extensively sampled by Fred Harmston and George Knowlton, probably explaining the great number of species described by my colleagues from that state. I anticipate that the ranges of these and other dolichopodids will be expanded even further when the habitats mentioned here (e.g., seeps, waterfalls and riparian vegetation in otherwise arid areas) are sampled elsewhere. Interesting distribution patterns for these and other invertebrates will emerge when these areas are more completely known throughout the region.

ACKNOWLEDGMENTS

To the following individuals, I am most appreciative for allowing me to study specimens in their care: F.C. Thompson, Systematic Entomology Laboratory, USDA, ARS, Washington, D.C. and P.H. Arnaud, Jr., California Academy of Sciences, San Francisco. J.F. McAlpine, Canadian National Collection, Agriculture Canada, Ottawa and W.J. Hanson, Utah State University, kindly lent me material as well. Also I wish to thank F.C. Harmston for making important comparisons and reviewing this manuscript. P.H. Arnaud, Jr., J.B. Johnson and K.S. Pike also read the manuscript and their assistance is appreciated.

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A.E.S. FIELD DAY FOR YOUNG ENTOMOLOGISTS

The education committee of our society is planning an entomological field day on Saturday, June 6, 1987. It will be held at the Myrick Conservation Center of the Brandywine Valley Association located about five miles west of West Chester, Penn. Entomologists young and old are invited to participate. Please contact Hal White, Dep't. of Chemistry, Univ. of Delaware, Newark, DE 19716 if you would like to come or wish more information. Additional information will be published in the March-April issue of ENTOMOLOGICAL NEWS.

SOME ECTOPARASITIC MITES FROM MAMMALS FROM SULAWESI UTARA, INDONESIA[1]

John O. Whitaker, Jr.[2], Lance A. Durden[3]

ABSTRACT: Several species of ectoparasites were found on small mammal hosts from Sulawesi Utara, Indonesia, as follows: TROMBICULIDAE: *Schoengastia* n.sp., *Leptotrombidium deliense, Gahrliepia* (*Walchia*) *turmalis, Walchiella oudemansi, Siseca tara,* ATOPOMELIDAE: *Listrophoroides postsquamatus* and *L. kinabaluensis, LISTROPHORIDAE: Afrolistrophorus maculatus*, and MYOBIIDAE: *Radfordia selangorensis.* All are new records for Indonesia except for *Leptotrombidium deliense.*

Several authors have reported on larger ectoparasites (fleas, lice, ticks and larger mites) from mammals from Indonesia (Hadi et al., 1981 from West Sumatra; Hadi et al., 1983, from the Mt. Bromo area, East Java, Lewis and Jones, 1985, fleas from Sulawesi Selatan; Van Peenen et al., 1974, from the Gumbasa Valley, central Sulawesi). Fain (1981b) reported the atopomelid mite, *Listrophoroides* (*Marquesania*) *cucullatus,* from *Rattus hoffmanni* from Indonesia, and Fain and Lukoschus (1983) described five new rosensteiniids from Indonesia. Otherwise, with the exception of chiggers (Trombiculidae), there are almost no reports of smaller parasitic mites of mammals of Indonesia.

There are several reports of chiggers from Indonesia. Specifically from Sulawesi (formerly Celebes), Van Peenen et al. (1974) reported *Ascoschoengastia indica* (from *Rattus hoffmanni*), *Blankaartia acuscutellaris* (from *R. rattus, Suncus murinus*), *Eutrombicula wichmanni* (from *R. hoffmanni, R. rattus*), *Gahrliepia* (*Walchia*) *isonychia* (from *R. rattus*), *G.* (*Walchia*) sp. X (from *R. hoffmanni, R. rattus, Maxomys hellwaldi*), *G.* (*Walchia*) sp. Y (from *Maxomys hellwaldi*), *Leptotrombidium deliense* (from *R. hoffmanni, R. rattus, Maxomys hellwaldi*), and *Schoutedenichia* sp. (from *Rattus hoffmanni, Maxomys hellwaldi*).

Some of these and also *Gahrliepia disparunguis, Heaslipia gateri, Leptotrombidium arenicola, L. fletcheri, L. hazatoi, L. keukenshrijveri, L. pilosum, L. scutellare* and *Trombicula domrowi* have also been reported (Hadi et al., 1979, 1981, 1983; Hadi and Sarbini, 1985).

Thirty-eight mammals of eight species from Dumoga-Bone National Park, Sulawesi Utara, Indonesia were examined for smaller mites, including chiggers. The mammals were collected in February, 1985, mostly at about

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220-450 meters elevation. Due to the high level of endemism and the paucity of previous collections, it was hypothesized that this material would prove exceedingly interesting. Larger mites are being studied by Nixon A. Wilson. The purpose of this paper is to present the results of examinations for smaller ectoparasitic and phoretic mites.

METHODS

The fur of the mammals was searched in the field by manipulation while viewing it under a dissecting microscope. Mites were put into vials of 70% alcohol, cleared and stained in Nesbitts solution, mounted in Hoyers solution, and ringed with Euparal. Voucher specimens are being deposited in The National Museum of Natural History, whereas other specimens are in the collections of the senior author, of A. Fain (Institut de Medecine Tropicale Prince Leopold, Antwerpen, Belgium), and of M. Lee Goff (Department of Entomology, University of Hawaii at Manoa, Honolulu).

RESULTS

Most mites found on these animals were Trombiculidae (chiggers), Histiostomatidae, and Atopomelidae. In addition, a few myobiids and miscellaneous mites were found. Data are summarized below by species. It is of special interest that all of the host species, except *Rattus exulans,* are endemic to Sulawesi.

INSECTIVORA (Soricidae)

Crocidura nigripes Miller & Hollister, 1921 (n = 1)

The only mites found on the one shrew determined as this species were 12 chiggers, *Schoengastia sulawesiensis* Goff, Durden and Whitaker (1986).

RODENTIA

Maxomys hellwaldi (Jentink, 1878) (n = 6)

On the six individuals of this species were found the following:

Atopomelidae

Listophoroides postsquamatus Fain, 1976
4 on 2 host individuals

Trombiculidae (chiggers)

Schoengastia sulawesiensis Goff, Durden & Whitaker, 1986
8 on 3 host individuals

Gahrliepia (*Walchia*) *turmalis* Gater, 1932
2 on 2 host individuals

Walchiella oudemansi (Walch, 1922)
1 on 1 host individual

Siseca tara (Walch, 1923)
1 on 1 host individual

Histiostomatidae

Histiostoma sp.
3 on 1 host individual

Maxomys musschenbroeki (Jentink, 1878) (n = 18)
Atopomelidae
Listrophoroides kinabaluensis Fain, 1976
72 on 16 host individuals
Listrophoridae
Afrolistrophorus maculatus Fain, 1976
1 on 1 individual
Myobiidae
Radfordia (*Rattimyobia*) *selangorensis* Fain, Lukoschus & Nadchatram, 1980
2 on 2 host individuals (1 adult female, one juvenile)
Trombiculidae (chiggers)
Schoengastia sulawesiensis Goff, Durden & Whitaker, 1986
6 on 3 host individuals
Histiostomatidae
Histiostoma sp.
909 on 16 host individuals
Bunomys chrysocomus (Hoffman, 1887) (n = 6)
Trombiculidae
Walchiella oudemansi (Walch, 1922)
156 on 5 host individuals
Histiostomatidae
Histiostoma sp.
10 on 3 host individuals
Bunomys fratrorum (Thomas, 1896) (n = 2)
Trombiculidae (chiggers)
Walchiella oudemansi (Walch, 1922)
5 on 1 host individual
Schoengastia sulawesiensis Goff, Durden & Whitaker, 1986
2 on 1 host individual
Rattus exulans (Peale, 1848) (n = 1)
Trombiculidae (chiggers)
Walchiella oudemansi (Walch, 1922)
1 on 1 host individual
Rattus hoffmanni (Matschie 1901)
Histiostomatidae
Histiostoma sp.
41 on 1 host individual
Atopomelidae
Listrophoroides postsquamatus Fain, 1967
1 on 1 host individual

DISCUSSION

Five species of chiggers are included in this material. One is new, *Schoengastia sulawesiensis* Goff, Durden & Whitaker, 1986, whereas the rest had been described previously. Also included in this material are 2 species of *Listrophoroides* (Atopomelidae), one species of *Afrolistrophorus* (Listrophoridae), one species of histiostomatid, and one species of *Radfordia* (Myobiidae).

As is often the case, chiggers showed little host specificity, *Walchiella* *oudemansi* and *Schoengastia sulawesiensis* each occurred on four of the nine hosts; *Gahrliepia* (*Walchia*) *turmalis* and *Siseca tara* occurred on two, whereas *Leptotrombidium deliense* occurred on only one.

Listrophoroides (*Listrophoroides*) *kinabaluensis* Fain, 1976 was described from *Maxomys whiteheadi* from Mont Kinabalu, Borneo and has also been taken from the same host from Sarawak, from Baru Jumpa, "au sud de Tenom, au nord de Borneo," from Mont Brinchang, Pahana, Malaysia, and also from *Rattus xanthurus* from north of the Celebes (Fain 1981b).

Listrophorides postsquamatus Fain, 1976 was described from *Rattus everetti* from the Philippines (Fain, 1981b).

Radfordia selangorensis was described from *Rattus whiteheadi* from Selangor, Malaysia by Fain, Lukoschus and Nadchatram (1980).

Afrolistrophorus maculatus was originally described by Fain (1976) from *Rattus sabanus* from Malaysia.

The histiostomatids were attached to the body of laelapid mites, *Echinolaelaps* sp.

Species apparently not previously taken in Indonesia are all chiggers except *L. deliense,* the atopomelids, *Listrophoroides kinabaluensis,* and *L. postsquamatus*, the listrophorid, *Afrolistrophorus maculatus,* and the myobiid, *Radfordia selangorensis.*

Specimens of many of the species are being deposited in the Institut Royal des Sciences, Brussels, Belgium; The University of Hawaii at Manoa (chiggers), and The National Museum of Natural History, Washington, D.C.

ACKNOWLEDGMENTS

This paper is based on material collected during Project Wallace, sponsored by the Royal Entomological Society of London and the Indonesian Institute of Sciences (Results of Project Wallace No. 04). Research was supported in part by grant No 2946-84 from the Committee for Research and Exploration of the National Geographic Society. Guy Musser (Dept. of Mammalogy, Amer. Mus. Nat. Hist., N.Y.) confirmed the identities of voucher host specimens. Representative samples of Atopomelidae, Listrophoridae, Myobiidae and Histiostomatidae were identified by A. Fain (Institut Royal des Sciences Naturelles de Belgique, Rue Vautier, 31 B-1040, Brussels, Belgium). Chiggers (Trombiculidae) were identified by M. Lee Goff (Dept. of Entomology, Univ. Hawaii at Manoa, Honolulu, Hawaii).

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SECOND CONFERENCE ON PARASITIC HYMENOPTERA

Gainesville, Florida, April 15-17, 1987

A conference on the taxonomy and biology of parasitic Hymenoptera will be held in Gainesville, Florida from April 15 to 17, 1987 under the sponsorship of the University of Florida and the American Entomological Institute.

Papers may be presented in the following sessions: Systematics: Phylogeny, distribution, classification, faunistics, literature resources. Biology: Behavior, host associations, sex-ratios, rearing techniques. Biological Control: Utilization of parasitoids in biological control.

It is expected that there will be some invitational lectures covering broader aspects of the taxonomy and biology of parasitic Hymenoptera. For further information, write to V.K. Gupta, Convener, Center for Parasitic Hymenoptera, University of Florida, Gainesville, FL 32608.

NOTES ON THE REPRODUCTIVE SYSTEM IN CTENOPHTHALMUS (SIPHONAPTERA: CTENOPHTHALMIDAE)[1,2]

Tom Cheetham, Robert Lewis[3]

ABSTRACT: The structures of the ovary and sperm of *Ctenophthalmus p. pseudagyrtes* were examined. The anatomy is compared with that of other fleas.

Descriptions of the anatomy of fleas are limited mostly to those species that are easily collected, commonly cultured, or are implicated in disease transmission. Much of the published information concerns species of the family Pulicidae. It is generally held that this is a very old family that diverged early from the rest of the Siphonaptera (Hopkins and Rothschild, 1953; Holland, 1964). Reports of the presence of nurse cells in the ovarioles of members of the hystrichopsylloid genera *Hystrichopsylla* (Hystrichopsyllidae) and *Stenoponia* (Ctenophthalmidae) (King and Teasley, 1980; Rothschild, Schlein and Ito, 1986) contradict the common assertion, based on data from pulicid species, that all fleas have panoistic ovarioles and have raised a question as to whether this condition may be widespread in members of the superfamily Hystrichopsylloidea.

Several reports on the ultrastructure of the spermatozoa of fleas have been published, but all these have been of pulicid species (Baccetti, 1968; Baccetti *et al.,* 1969 and 1971; Phillips, 1969; Rothschild, 1969; Rothschild, Ford and Hughes, 1970; Rothschild, Schlein and Ito, 1986). These sperm share several unusual features with those of Mecoptera. In both orders the outer ring of accessory tubules is lacking, the nine remaining outer tubules spiral around the central two, and the axoneme as a whole spirals around the elongate central paracrystalline core. It was thought worthwhile to investigate the structure of the sperm of a nonpulicid species to determine if there are any significant differences between fleas in these two main divisions of the order.

Specimens of *Ctenophthalmus pseudagyrtes pseudagyrtes* Baker (Ctenophthalmidae) were collected from *Microtus pennsylvanicus* in Ames, Iowa, in March 1986. Specimens were dissected in 2.5% glutaraldehyde and 2% paraformaldehyde in 0.1 M phosphate buffer, pH 7.3, and the tissues left in the fixative for 1-2 hrs. After washing in buffer and postfixation in osmium tetroxide for 1 hour the tissues were dehydrated in a

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graded ethanol series and embedded in Medcast® resin. Thick sections were cut on glass knives and stained with toluidine blue. Thin sections were cut with a diamond knife, stained with uranyl acetate and lead citrate, and viewed with a Hitachi HU11E-1 electron microscope operated at 50KV.

Serial sections of the ovaries clearly show them to be panoistic (Figure 1). King and Teasley (1980) have suggested that the nurse cells found in *Stenoponia* may not in fact be derived in the same manner as nurse cells in other insect orders. It was hoped that some intermediate condition might be

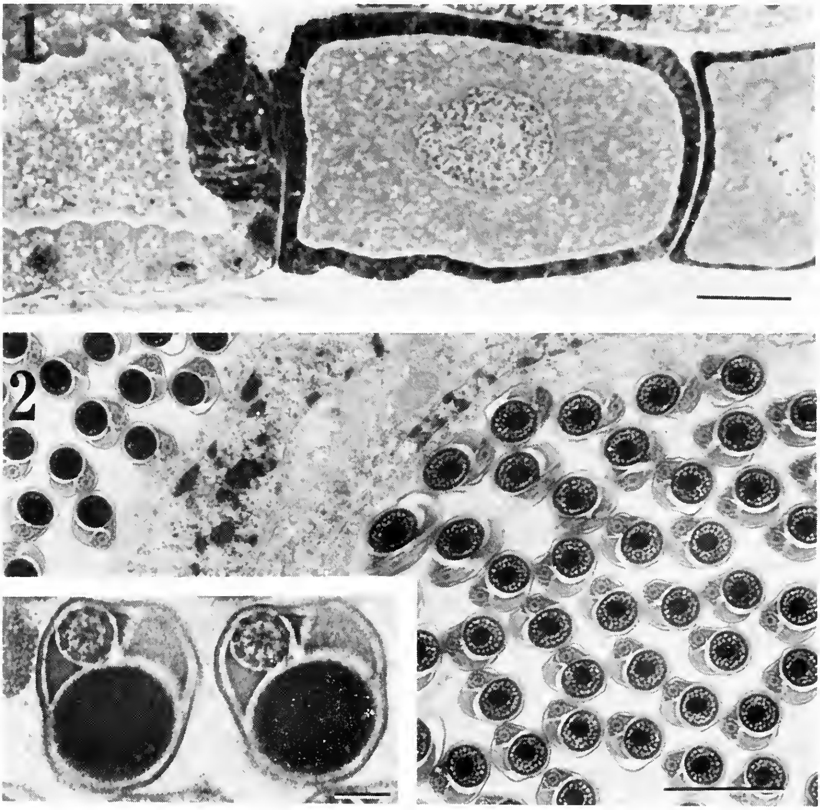

Figure 1: Longitudinal section through ovariole of *Ctenophthalmus p. pseudagyrtes.* Portions of three developing oocytes are visible. The oldest is to the left. Dark tissue surrounding oocyte is follicular epithelium. Line scale = 0.02 mm.

Figure 2: Transverse section through testis of *C. p. pseudayrtes* showing sections through sperm tails at two different levels. Line scale = 2 μ.

Inset: Higher magnification of sperm tails at level seen in upper left of Fig. 2. Wheel-like structures are axonemes, dark body is mitochonrial derivative. Scale line = 0.2 μ.

found in *Ctenophthalmus* that would indicate the nature of the nurse cells in *Stenoponia,* but such is not the case. *Ctenopthalmus* and *Stenoponia* are members of different subfamilies within the Ctenophthalmidae, and the question of the frequency of occurrence of polytrophic ovarioles in this family, and indeed in other families of fleas, remains open. However, it is now known not to be universal within the hystrichopsylloid families.

Transverse sections through the tails of the mature spermatozoa of *C. p. pseudagyrtes* are illustrated in Figure 2 and the inset. Longitudinal sections as well as transverse sections at various levels of the sperm were examined. Although no attempt was made to systematically trace the structure of the entire sperm, the sections seen do reveal most of the anatomy, and it is so nearly identical in form to that of pulicid fleas as illustrated in the literature as to be indistinguishable. Any differences that might be found are expected to be insignificant. For detailed explanation of flea sperm structure the reader is referred especially to Baccetti (1968), Baccetti *et al.* (1969) and Phillips (1969).

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SOCIETY MEETING OF NOVEMBER 19, 1986

Surrounded by dioramas and occasional mynah bird calls, 17 members and 6 guests met in the bird hall of the Academy of Natural Sciences in Philadelphia to hear Dr. James L. Frazier speak on "To eat or not to eat: The bitter-sweet choice of caterpillars." Dr. Frazier is a senior research scientist in the agricultural chemicals department of the duPont Company in Wilmington, Delaware. He described the integrated morphological, molecular, and electrophysiological approaches to studying the feeding behavior of caterpillars that are now used in his laboratory.

Feeding by *Manduca sexta,* the tobacco hornworm, is stimulated by glucose, inositol, and other plant chemicals, and deterred by quinine and other substances. Caterpillars whose mandibular muscles have been connected to electrodes are presented with glass filter disk "leaves" containing various amounts and combinations of test compounds. Their feeding response is monitored simultaneously by the electrodes and a video camera. A sophisticated computer program is then used to analyze the responses of individual taste cells to these same test compounds and allow correlations with the feeding behavior. In combination with these studies Dr. Frazier described electron microscopic studies of the gustatory hairs which contain the taste receptors. These studies are attempting to define what insects taste and how feeding behavior is controlled. The goal is to produce new compounds for controlling insect pests by preventng their feeding on crop plants.

Among the items of local entomological interest were Howard Boyd's report that the buck moth, *Hemileuca maia* was fairly common this October in the New Jersey pine barrens. Eighteen buck moths were sighted on October 20, and forty nine were seen on October 21, between the hours of 10:30 am and 3:30 pm in the dwarf forests of the West Plains. Ken Frank, who sighted his first pipevine swallowtail, *Battus philenor,* in Philadelphia in 1985 after many years of looking (*Ent. News 97*: 65), reported that he obtained many eggs this past summer and reared over 40. He also reported that a gray squirrel tasted and rejected one of the caterpillars. Hal White showed slides of an unusual wasp nest he photographed in early July in Huntingdon County, Pennsylvania. The paper nest, about the size of a baseball, was attached to a small limb six feet off the ground. It had a distinctive finger-sized entrance tube attached below. Charles Mason believes this is the queen nest of the bald-faced hornet, *Dolichovespula maculata.*

Harold B. White,
Corresponding Secretary

EMERGENCE TRAP AND COLLECTING APPARATUS FOR CAPTURE OF INSECTS EMERGING FROM SOIL[1]

Hamdi Akar, Eben A. Osgood[2]

ABSTRACT: Common materials are used to construct an emergence trap and collecting apparatus for studying cecidomyiid emergence. Trap design minimizes temperature, humidity, and photoperiod differences between trap interior and surrounding conditions. Trapped insects are easily retrieved alive with the collecting apparatus described.

To study emergence periods of the balsam gall midge, *Paradiplosis tumifex* Gagné (Diptera: Cecidomyiidae) and its parasites from the soil, we designed and constructed a trap and collecting apparatus which may be left in the field for an extended period of time. Southwood and Siddorn (1965) stressed the need for insect emergence traps that do not create microclimates different from surrounding conditions. Such microclimates may produce inaccurate data on emergence periods. Also, emergence traps must not contain insecticides or insecticide residues from previous attempts to immobilize trapped insects. In this paper we describe a soil emergence trap constructed of common materials that does not create microclimates or utilize insecticides. We also describe a collecting apparatus which permits the efficient retrieval of live insects if desired.

Waede (1960) described a metal emergence trap with a silk gauze top which permitted water penetration and air circulation. A collecting jar fitted with a cone was screwed into one side of the trap. Thirty minutes before taking each collection, the trap was covered with tar paper so positively phototactic insects would move into the jar.

Our wooden trap was modeled from his design. Each trap frame was cut from 1.9 x 19.7 cm (1 x 8 in) pine and measured 64.7 x 30.5 x 19.7 cm in height (Fig. 1). Nylon "no-see-um"® netting[2] covered the top; the bottom was open. The trap was covered with 1.3 cm (1/2 in) hardware cloth to prevent animals or falling objects from damaging the netting. A 7.0 cm hole was drilled in one side of the trap, and a Ball® jar lid band was fastened to the hole perimeter (Fig. 2) with four flat head screws. A wide mouth tapered pint Ball® can-or-freeze® jar was screwed into the attached jar band. No cone was used. The trap frame was inserted in topsoil to a depth of 2.5 cm, and soil was banked against the frame to seal and secure the enclosure.

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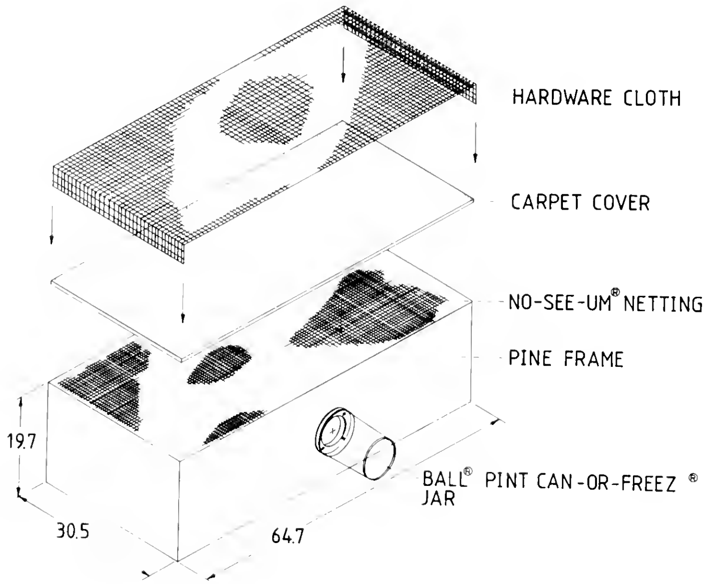

Fig. 1. Emergence trap dimensions (cm) and assembly.

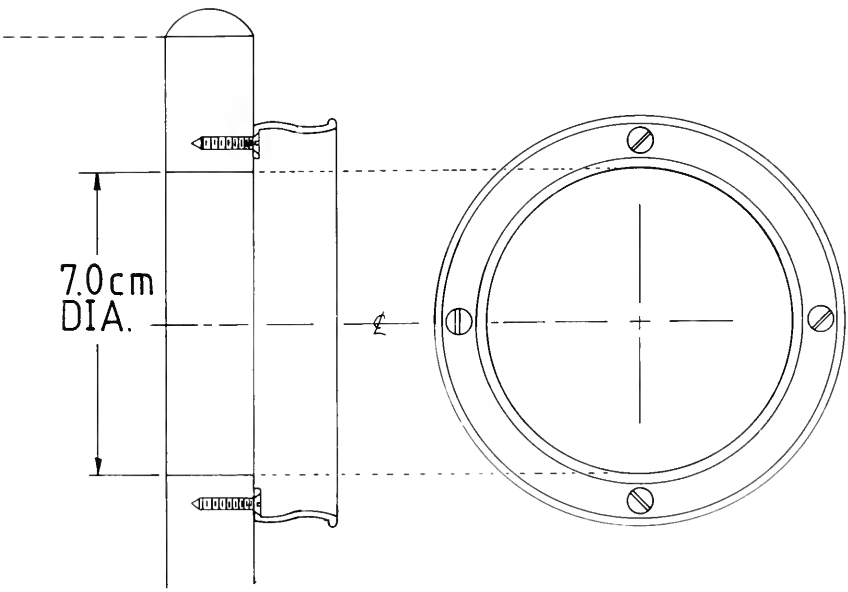

Fig. 2. Flat head screws fasten the jar band to the perimeter of a hole 7.0 cm in diameter.

The collecting apparatus consisted of a Kimble® #54100 plastic funnel and a Ball® jar lid band. The spout of the funnel was shortened to 2.5 cm; its hole was rebored to 0.635 cm. The inner rim of the band was cut in 45° increments, and the resulting sections were bent outward to provide the clearance necessary to secure the funnel to the jar (Fig. 3). These sections must be closely appressed to the funnel to prevent insects from escaping.

Carpet (65 x 31 cm) was used to darken the trap interior prior to taking collections. When we obtained a collection the funnel and band were held together with one hand; with the other hand, the jar was unscrewed from the emergence trap and quickly screwed into the funnel-band apparatus. A finger sealed the spout, but a suitable plug may be employed. Carbon dioxide gas was then released into the jar through tubing (0.95 cm) placed over the spout, which temporarily immobilized the insects. The jar and funnel were then inverted, causing the insects to tumble through the spout into vials.

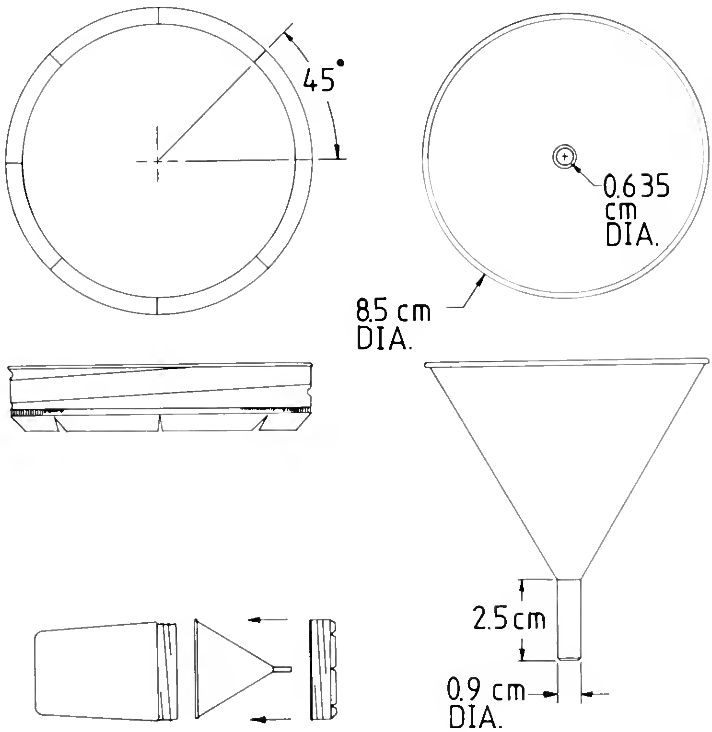

Fig. 3. Components and assembly of collecting apparatus: modified Ball® jar band, modified funnel, and assembly.

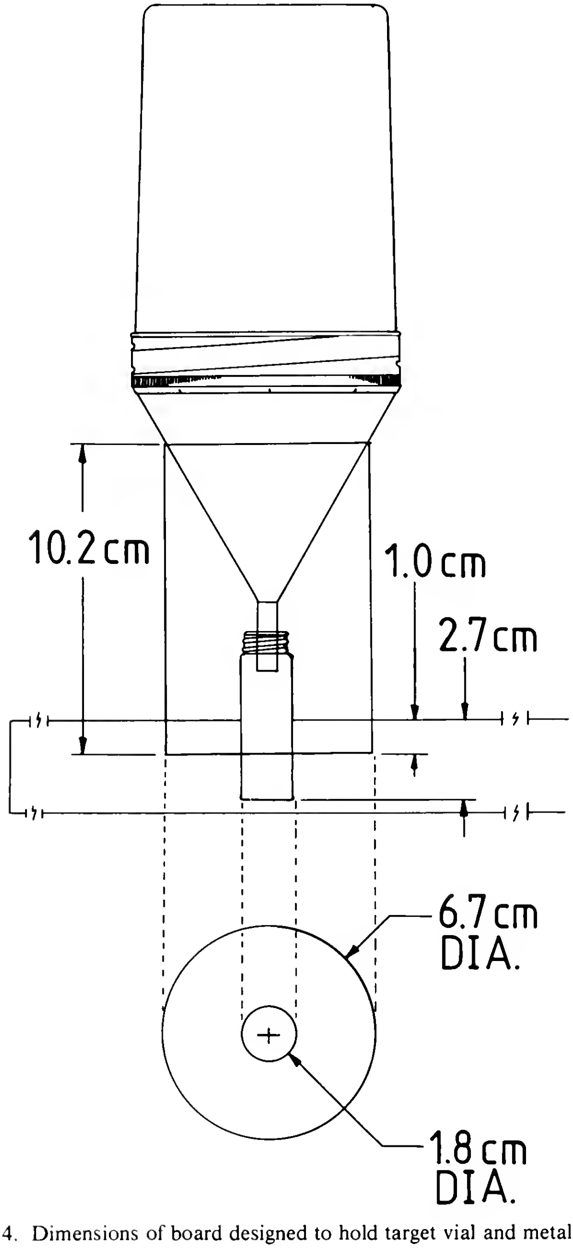

Fig. 4. Dimensions of board designed to hold target vial and metal can.

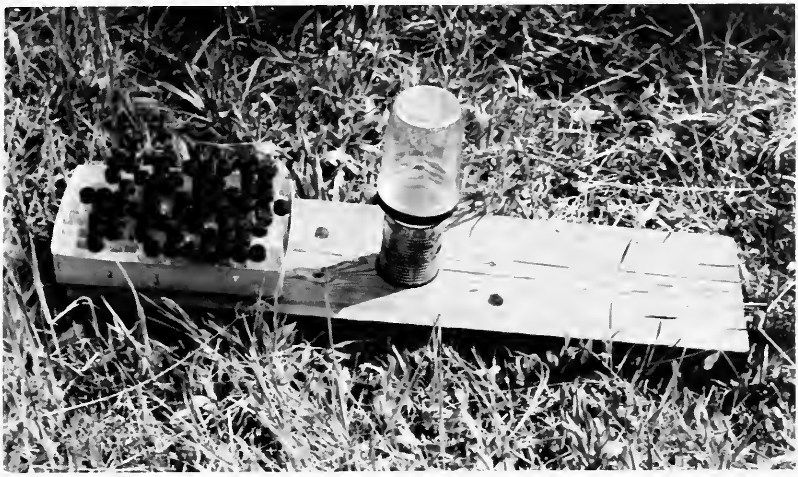

Fig. 5. Board and metal can supporting collecting apparatus.

Small insects have a tendency to adhere to the jar; they may be safely dislodged with the aid of a metal can (6.7 x 10.2 cm) and a board (Figs. 4 & 5). The board is equipped with two concentric recesses. The inner hole cradles the target vial; the outer recess (1.0 cm deep) holds an open-ended can. The depth of each recess must be adjusted so that when the funnel is inserted into the upright can, its tip extends at least 0.5 cm into the vial. The metal can prevents the funnel from being inserted so far as to stress the vial rim. A properly engineered board allows the collector to strike the plastic funnel against the metal can without danger of breaking the jar or vial and with sufficient force to dislodge insects from the jar.

The emergence trap and collecting apparatus described enabled us to obtain accurate data on emergence periods of *P. tumifex* and its parasites. The speed and ease with which trapped insects were transferred to vials make the collecting apparatus pragmatic for other entomological applications.

ACKNOWLEDGMENTS

We thank A.R. Alford and D.T. Jennings for helpful criticisms of the manuscript.

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INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

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ITZN 11/5 8 October 1986

The following applications have been received by the Commission and have been published in volume 43, part 3, of the *Bulletin of Zoological Nomenclature* (6 October, 1986). Comment or advice on them is welcomed and should be sent c/o The British Museum (Natural History), London, England. Comments will be published in the *Bulletin.*

Case No.

2520 *Corixa albifrons* Motschulsky, 1863 (Insecta, Heteroptera): proposed confirmation of neotype designation.

2252 *Dexia* Meigen, 1826 (Insecta, Diptera): proposed designation of *Musca rustica* Fabricius, 1775, as type species.

2565 *Geonemus* Schoenherr, 1833 and *Brachyomus* Lacordaire, 1863 (Insecta, Coleoptera): proposal to maintain current usage by designation of a type species for *Geonemus.*

2524 *Phaulacridium vittatum* (Sjöstedt, 1920) (Insecta, Orthoptera): proposed conservation by suppression of *Acridium ambulans* Erichson, 1842, *Trigoniza manca* Bolivar, 1898 and *Trigoniza australiensis,* Bolivar, 1898.

2528 *Phisis* Stål, 1861 and *Teuthras* Stål, 1874 (Insecta, Orthoptera (Grylloptera)): confirmation of *Listroscelis pectinata* Guerin [-Méneville], 1831 as type species.

ITZN 59 8 October 1986

The following Opinions, rulings of the International Commission on Zoological Nomenclature, have been published in volume 43, part 3, of the *Bulletin of Zoological Nomenclature* (6 October, 1986).

Opinion No.

1401 (p. 231) *Leucaspis* Signoret, 1869 (Insecta, Homoptera): conserved.

1405 (p. 239) *Aphelinus mytilaspidis* LeBaron, 1870 (Insecta, Hymneoptera): conserved.

1406 (p. 241) *Phalaena stagnata* Donovan, 1806 designated as type species of *Nymphula* Schrank, 1802 (Insecta, Lepidoptera).

1407 (p. 243) *Lamia aethiops* Fabricius, 1775 designated as type species of *Ceroplesis* Serville, 1835 (Insecta, Coleoptera).

1408 (p. 245) *Hypocryphalus mangiferae* (Stebbing, 1914) given nomenclatural precedence over *Cryphalus inops* Eichhoff, 1872 and *Hypothenemus griseus* Blackburn, 1885 (Insecta (Coleoptera).

1411 (p. 251) *Drymus ryeii* Douglas & Scott, 1865 (Insecta, Hemiptera): neotype set aside.

1416 (p. 264) *Cnetha* Enderlein, 1921 and *Pseudonevermannia* Baranov, 1926 (Insecta, Diptera): type species designated; *Atractocera latipes* Meigen, 1804: confirmation of holotype.

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THE GENUS *DIPOGON* (HYMENOPTERA: POMPILIDAE) IN THE ROCKY MOUNTAINS[1]

Howard E. Evans[2]

ABSTRACT: The only species of *Dipogon* previously reported from the Rocky Mountains is *D. (Deuteragenia) sayi nigrior* Townes. Two additional species, *D. (Deuteragenia) sericeus* Banks and *D. (Dipogon) lignicolus* new species, are herein recorded from north central Colorado.

Although the pompilid genus *Dipogon* is well represented in the eastern United States, the Southwest, and the Pacific states, only one species has been recorded from the Rocky Mountains. *D. (Deuteragenia) sayi nigrior* Townes has been reported from Montana, Colorado, New Mexico (Townes, 1957) and Wyoming (Evans, 1970). Two additional species are herein reported from north central Colorado, at elevations of 1900-2350 m.

MATERIALS AND METHODS

Species of *Dipogon* are only occasionally collected by routine methods. They are small, rarely visit flowers, largely confined to wooded areas, and nest in hollow twigs or in beetle burrows in dead trees. Of the species treated herein, one *(sericeus)* was collected in a Malaise trap, while the other *(lignicolus* n.sp.) was reared from a wooden trap nest. The male of *sericeus* was previously unknown, and a description is provided below; both sexes of *lignicolus* are described and a photograph of the nest provided. In the descriptions the terminology follows Evans (1950).

Dipogon (Deuteragenia) sericeus Banks

This species was described from Lake Co., Oregon, at 2290 m elevation (Banks, 1944), and has since been recorded from California (Krombein, 1979). I collected four females and one male in Hewlett Gulch, Larimer Co., Colorado (ca. 1900 m elevation) during August and September 1978. They were taken in a Malaise trap set up among tall Asteraceae heavily infested with aphids in open forest along Gordon Creek. Females were compared with the type of *sericeus* in the California Academy of Sciences and found to be conspecific. The previously unknown male will key to couplet 5 in Townes (1957, p. 117) but differs from *sayi* Banks and *calipterus* Say in lacking any clouding along the basal vein of the fore wing and by minor differences in the genitalia. It is also

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smaller (forewing 4 mm, as compared to 4.5-6.3 mm in *sayi* and *calipterus).*

Description of male. - Length 4.5 mm; forewing 4 mm. Black, including antennae and legs to tarsi, which are dusky yellow-brown; wings hyaline, forewing clouded in the marginal and third submarginal cells. Body clothed with fine pubescence which is mostly silvery but grades into golden brown on the mesoscutum. Sparse, short, white hairs also present over much of body, these especially prominent on vertex, temples, pronotum, and first tergite. Antenna weakly crenulate, segment three 2.5 times as long as thick. Head broad, transfacial distance 1.1 times facial distance; front broad, middle interocular distance .65 times transfacial distance; front dull, finely granulate. Vertex evenly arched above eye tops; postocellar line 1.2 times ocello-ocular line. Thoracic dorsum dull, with minute, close punctures; posterior margin of pronotum arcuate; propodeum with a median, linear impression. Second and third submarginal cells approximately equal in width, third submarginal receiving second recurrent vein one fourth distance from base. Hooks on sixth sternite moderately stout; subgenital plate with a strong median keel, not notched apically; genitalia as figured (Fig. 1).

Dipogon (Dipogon) lignicolus Evans, new species

A small series of this species was reared from a trap nest taped to the wooden deck of my home in open ponderosa pine-Douglas fir forest in Larimer Co., Colorado, at 2350 m elevation. The trap nest had a 5 mm bore and, when harvested on 1 September 1985, contained four cells, 12-15 mm long, each containing a white, silken cocoon measuring 3 by 8 mm (Fig. 3). The outer 7 cm of the bore was empty and there was no outer closure. Cells were closed off by thin partitions of a material resembling sticky silk, possibly collected from spider webs. On the inner side of each partition was an accumulation of detritus consisting of small pebbles, 0.2-1.5 mm in diameter, and bits of Douglas fir needles and bark and wood chips. In the detritus there was also one seed, one small dead beetle, and fragments of an ant. Next to the cocoons there were fragments of the spiders that served as prey, but these could not be identified. Three females and a male emerged from the cocoons in April 1986.

Description of holotype female.-Length 5.5 mm; forewing 4.5 mm. Black; legs black except apical half of tarsi light reddish brown; antennae black basally and at extreme apex, segments 4-10 (ventrally 3-11) light reddish brown. Wings hyaline, faintly clouded along basal vein and over a broad area below stigma; microtrichia slightly larger and more crowded in the clouded areas than elsewhere. Body clothed with fine, silvery pubescence that grades into golden brown on mesoscutum; silvery pubescence especially conspicuous on scutellum, coxae, and abdomen. Head, thoracic dorsum, propleura, and coxae with sparse, erect hairs; first tergite with short hairs on basal half; sternites with stiff bristles and apical tergite densely bristly.

Mandibles tridentate, bearing strong bristles; clypeus truncate, 2.5 times as wide as high. Front shining, weakly alutaceous and with minute punctures separated by slightly more than their own diameters. Transfacial distance slightly exceeding facial distance; middle interocular distance .61 times transfacial distance; upper interocular distance .80 times lower interocular distance. Vertex weakly arched above eye tops, postocellar and ocello-ocular lines subequal. Third antennal segment 4.5 times as long as its maximum width. Pronotum broadly angulate behind; mesoscutum minutely punctate, like the front, but punctures slightly more crowded; posterior half of mesopleuron polished and largely impunctate; propodeum shining and with relatively sparse punctures, its midline not impressed. Maximum width of third submarginal cell .80 times that of second submarginal, receiving second recurrent vein .3 distance from base.

Description of allotype male.- Length 5 mm; forewing 3.8 mm. Black, including antennae and legs except tarsi brownish, anterior surface of forefemora and tibiae brownish, and basal antennal segments suffused with brown ventrally. Wings hyaline, without clouding, microtrichia more crowded along basal vein and in area below stigma. Body sparsely clothed with silvery pubescence except pubescence much denser on venter of thorax and coxae; head, prothorax, and basal half of first tergite with a few pale, erect hairs. Antennae crenulate, segment three slightly more than twice as long as thick. Transfacial distance 1.03 times facial distance; middle interocular distance .60 times transfacial distance; upper and lower interocular distances subequal. Vertex strongly elevated above eye tops; postocellar line 1.2 times ocello-ocular line; front angle of ocellar triangle exceeding a right angle. Front as well as thoracic dorsum weakly shining, alutaceous and densely micropunctate. Pronotum arcuate behind; mesopleuron moderately shining, densely punctate; propodeum strongly shining and more sparsely punctate, faintly impressed medially. Venation as in female. Hooks of sixth sternite robust, subtriangular; subgenital plate with a high median keel, acute apically; genitalia as figured (Fig. 2).

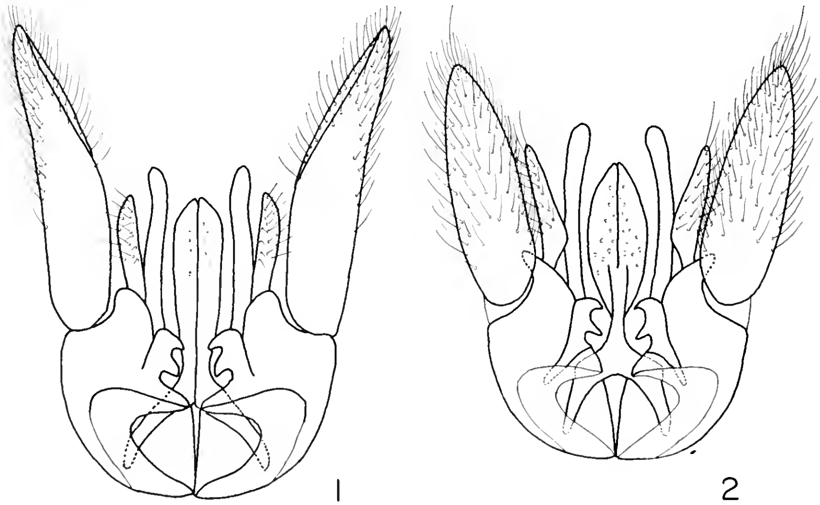
Variation.- One of the paratype females is smaller than the type (forewing 4 mm) but there are no other differences worthy of note.

Holotype.- Female, COLORADO: Larimer Co., Glacier View Meadows [23 km west of Livermore], 2350 m, 25 April 1986 (H.E. Evans, note no. 4031). ***Allotype.***- Male, same data [both Museum of Comparative Zoology, Cambridge, MA]. ***Paratypes.***- Two females, same data [U.S. National Museum, Colorado State University].

DISCUSSION

D. lignicolus belongs to the *graenicheri* group of the subgenus *Dipogon,* as defined by Townes (1957). It differs from *graenicheri* not only in the mostly black coloration but in having the integument less shining, more closely punctate and conspicuously pubescent; the wings are also less strongly banded and the second submarginal cell shorter compared to the third. *D. lignicolus* differs from *diablo* Wasbauer (1960), a California species also belonging to this species-group, in coloration and in its slightly larger size; the female differs further in having the postocellar and ocello-ocular lines subequal and in having erect hairs on the first tergite, while the male differs in having a narrower front and the postocellar line only 1.2 times the ocello-ocular line. The male genitalia differ from those of *diablo,* as figured by Wasbauer (1960), in having more heavily setose digiti and parameres, broader digiti, and other details.

Nests in borings in wood, with cells separated by complex barriers containing bits of soil, wood, and other debris, are the rule rather than the



Figures 1 and 2. Male genitalia of *Dipogon* species, ventral aspect. Fig. 1, *D. (Deuteragenia) sericeus* Banks. Fig. 2, *D. (Dipogon) lignicolus* n.sp.

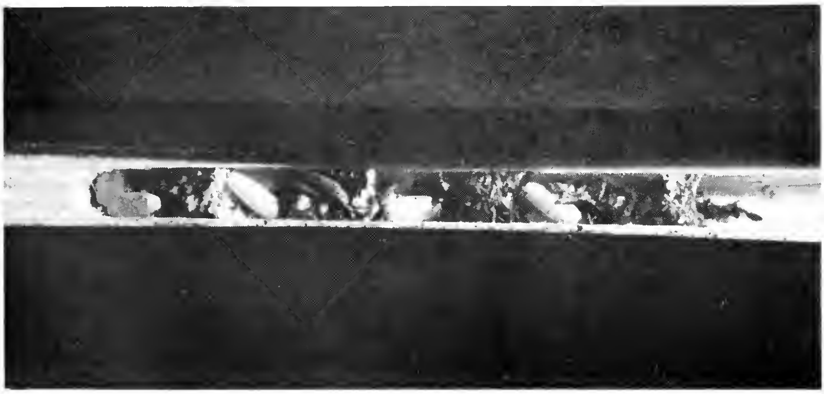


Figure 3. Trap nest showing four cells containing cocoons of *Dipogon (Dipogon) lignicolus* n.sp. Note the mass of detritus on the inner side of each partition.

exception in members of both subgenera of *Dipogon* (Medler and Koerber, 1957; Krombein, 1967). The use of spider webs in cell partitions is well known in some species (Richards and Hamm, 1939). Thus there is nothing particularly distinctive about the nesting behavior of *lignicolus*.

During both 1985 and 1986 I put out between 200 and 300 trap nests near my home 23 km west of Livermore, Colorado, and in 1985 a similar number in Rocky Mountain National Park, at a similar elevation about 50 km further south. I have also used Malaise traps at these and several other localities in Larimer County. Yet the few specimens of *sericeus* and *lignicolus* discussed here represent the only *Dipogon* I have taken. It appears that all species in this genus are extremely rare in the Rocky Mountains.

ACKNOWLEDGMENTS

My thanks to W.J. Pulawski for the loan of type specimens from the collections of the California Academy of Sciences.

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LECTOTYPE DESIGNATIONS FOR THE SPECIES OF COPROMYZINAE (DIPTERA: SPHAEROCERIDAE) DESCRIBED BY HALIDAY[1]

Allen L. Norrbom[2]

ABSTRACT: Lectotypes are designated for *Borborus hamatus* Haliday, (= *Crumomyia nitida* (Meigen)), *B. suillorum* Haliday (= *C. fimetaria* (Meigen)), and *B. longipennis* Haliday, a nominal species of uncertain status. The additional Sphaeroceridae in the Haliday and Curtis Collections are also discussed.

The Irish entomologist Alexander Haliday described 25 nominal species of Sphaeroceridae (Diptera) in two papers (Haliday 1833, 1836). These include four species described in the genus *Borborus* Meigen that are now placed in three different genera within the tribe Copromyzini. As part of a revision of this group, I examined putative Haliday type material from the Haliday and Curtis Collections. In this paper, I designate lectotypes where appropriate and review the status of the four Haliday names. I also briefly discuss the additional Sphaeroceridae in the Haliday and Curtis Collections.

Haliday's descriptions of sphaerocerids were based mainly on material in his own collection, now in the National Museum of Ireland, Dublin. He also examined Francis Walker's sphaerocerid collection, most of which he apparently retained (Haliday 1836: 317). Collin (1914) suggested that some sphaerocerid specimens examined by Haliday might still be in the Walker Collection, and it is clear that Haliday did send other Diptera specimens to Walker (O'Connor and Nash 1982), but according to Brian Pitkin (pers. comm.), there are no Copromyzinae with Haliday labels or otherwise recognizable as Haliday types in the British Museum (Natural History) where the Walker Collection is housed. Haliday also exchanged material with other workers, including John Curtis (O'Connor and Nash 1982), whose collection is now is the Museum of Victoria. I examined only the Copromyzinae in this collection, but there are putative syntypes of many other Haliday sphaerocerid species present. These include specimens on typical Haliday card mounts (see O'Connor and Nash 1982 for a description of such specimens), some of which also have labels in his writing. Among these are specimens labelled with the following Haliday names: *scabricula, crassimana, humida, leucoptera, fuscipennis, lugubris, scutellaris, fungicola, vagans,* and *zosterae* (A. Neboiss, pers. comm.).

[1]Received September 29, 1986. Accepted November 10, 1986.

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Workers revising Haliday species should be aware of these specimens and that putative syntypes of other species may be present in the Curtis Collection.

All of the specimens I examined from Haliday's collection bear machine-printed labels with "Haliday 20.2. '82," which were added when the specimens were incorporated into the National Museum of Ireland general collection. All of them also have light green, machine-printed "Ireland" or white, machine-printed "British" labels. According to O'Connor and Nash (1982), Haliday rarely used locality labels, but his specimens' pin heads were often color coded by country of origin. The above labels were added by museum workers based on type data published by Haliday or to replace the pin heads clipped off to allow the pins to fit into the Museum's drawers.

Not all specimens now found under Haliday names in his collecion should be uncritically accepted as syntypes. Haliday continued to add specimens to his collection after publishing descriptions, sometimes even replacing damaged type material (O'Connor and Nash 1982). Haliday's Diptera collection also underwent considerable rearrangement and mixing when it was incorporated into, and later removed from, the main National Museum collection (O'Connor and Nash 1982). Collin (1914) previously examined Haliday's sphaerocerids, but it is unclear whether he described individual series as he found them or if he sorted the specimens into series based on Haliday's descriptions. There are now more specimens in the collection than Collin (1914) reported, indicating that later museum workers re-sorted some specimens and incorporated overlooked material. For these reasons, only specimens with labels in Haliday's writing or those closely fitting his original descriptions should be regarded as syntypes. In the following section I discuss the status and type material of the four Haliday names currently placed in the Copromyzinae.

Borborus hamatus Haliday, 1833: 17.

From Haliday's original description, especially of the male hind femora as "at the base armed with a strong hooked tooth," *hamatus* is clearly a junior synonym of *Borborus nitidus* Meigen (1830), currently placed in the genus *Crumomyia* Macquart (Norrbom and Kim 1985). Haliday (1836) himself later recognized this synonymy. The type specimens were collected in the area of Holywood, County Down, Ireland.

There are no specimens labelled as *hamatus* in Haliday's collection, but Haliday frequently did not label his specimens, and his species that have been synonymized were often placed under senior synonyms when his collection was incorporated into the Museum's general collection (O'Connor and Nash 1982). Four males of *Crumomyia nitida* in the collection may thus be *hamatus* syntypes. They are double mounted on small pins rather than on the more common card mounts, and they have "Ireland" labels. One also has a "nitidus" label in Collin's writing. A similarly mounted female of *C. nitida,* also with an Ireland label and now placed under *suillorum* Haliday, might also be a *hamatus* syntype.

The Curtis Collection also contains three males and one female of *C. nitida* that are probably *hamatus* types. These specimens, placed above the "hamatus Hal." label in the collection are double mounted similar to the putative syntypes in the Haliday Collection, and one of the males also has a "hamatus" label in Curtis' writing. A similarly mounted female of *Copromyza similis* (Collin) is also in this series, but because of its identity it is a doubtful syntype. The Curtis label and the mounting of these specimens similar to the specimens in the Haliday Collection alone do not justify strongly enought that these specimens came from Haliday and that they should be considered syntypes; there are double pin mounted specimens in the Curtis Collection with locality labels in Curtis' writing that did not come from Haliday. Curtis (1833) remarked that he was "indebted to Mr. Haliday for the species figured" (meaning *hamatus*), however, and because of this statement I have designated the specimen labelled as *hamatus* as lectotype rather than a specimen from the Haliday Collection. The latter specimens are probably also syntypes, but the evidence for this is more circumstantial.

Borborus suillorum Haliday, 1836: 322.

From Haliday's description of the mid tibiae with dorsal bristles, wing crossveins infuscated, male hind femora without a basal spur, only the base of the tibiae rust brown, and size 1.5 lines (= 2.15 mm), *suillorum* has been considered a junior synonym of *Borborus fimetarius* Meigen (1830), currently *Crumomyia fimetaria* (Meigen) (Norrbom and Kim 1985). This is the only copromyzine species occurring in the British Isles having all of the above characters. Haliday (1836) said that *suillorum* "Inhabits fungi in England and Ireland," although he may have included the first country in the range based only on specimens of "Var. B" (probably = *Crumomyia roserii* (Rondani) (Collin 1914), which was "Taken by Mr. F. Walker near London."

Under *suillorum,* the Haliday Collection contains three males of *C. fimetaria* and one female of *C. nitida* double mounted on small pins and with "Ireland" and "Named by J.E. Collin" labels. One male also has a thin label with "suillorum" in Collin's writing. The female of *nitida,* as mentioned above, may be a syntype of *hamatus* Haliday, but the *fimetaria* males are putative *suillorum* syntypes. I have designated the specimen with the hand-written Collin label as lectotype.

Borborus flavipennis Haliday, 1836: 324.

Haliday described *flavipennis* from female specimen(s) "found by Mr. Walker near London". *Alloborborus pallifrons* (Fallen) is the only copromyzine species occurring in England that fits his description of the fore coxae rust yellow, frontal triangle glossy, wing crossveins not infuscated, r-m at first third of cell dm, mid tibiae not setose dorsally, and hind tibiae with an apical spur. The single female of *A. pallifrons* in the Haliday Collection was previously designated as lectotype of *flavipennis* by Norrbom and Kim (1985). It is on a typical Haliday card mount and has a label with "pallifrons, flavipennis Hal" in Collin's writing and "British" and "Named by J.E. Collin" labels.

Borborus longipennis Haliday, 1836: 324.

B. longipennis has been regarded as a junior synonym of *Borborus vitripennis* Meigen (1830) since Duda's (1923) revision of the Palaearctic Copromyzinae. The identity of the true *vitripennis* type in Paris is in doubt however (Richards 1930), and *longipennis* is probably the valid name for the species which is currently known as *Copromyza* (*Borborillus*) *vitripennis* (Meigen) (Papp 1985) (i.e., *vitripennis auct.*). To further complicate matters, this species is not a *Borborillus*; it is probably related to the *saliens* species group of *Metaborborus* Vanschuytbroeck. I will further discuss this relationship in a future paper.

Haliday (1836), from his mention of "the small cross-nerve [=crossvein r-m] usually at the first fifth of the discoidal cell [cell dm]," of the abdomen with "the extremity [terminalia] in the male ... hairy," and that "the spur springs before the extremity of the hind shank [tibia] and is very slender and long," certainly must have based his description on specimens of *vitripennis auct.* He qualified the reference to the location of r-m with "usually," however; thus he may have also included other *Borborillus* species in his concept of *longipennis,* particularly a larger one like *uncinatus* (Duda) which is also found in his collection. Of the collection localities of his specimens, Haliday (1836) stated, "on the sea coast of Ireland; in various parts of England; not rare."

The Haliday Collection contains eight specimens under *longipennis,* all on typical Haliday card mounts and labelled as follows: one male and one female of *vitripennis auct.* with "Ireland" and "Named by J.E. Collin" labels, the male also with a label with "longipenn" in Collin's writing; two males and two females of *vitripennis auct.* with "British" labels, one of the males also with a white label with "longipennis" in Haliday's writing; one female of *unicatus* (Duda) with "Ireland" and "Named by J.E. Collin" labels; and one female of *uncinatus* with a "British" label. The specimens with "British" labels also have small hand-written numbers on the card mount next to the pin. I have designated the male with the *longipennis* label in Haliday's writing as lectotype to maintain the traditional usage of this name. Further resolution of the status of *longipennis* will require reexamination of the type of *Borborus vitripennis* Meigen and determination of the correct usage of that name. The specimens of *uncinatus* (Duda) in the Haliday Collection are probable paralectotypes of *longipennis*, but the specimens of other *Boborillus* species in the collection do not fit Haliday's description and are not syntypes.

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A NEW HOST FOR *BRACHYMERIA OVATA* (HYMENOPTERA: CHALCIDIDAE): *HARRISINA BRILLIANS* (LEPIDOPTERA: ZYGAENIDAE)[1]

Jeffrey A. Halstead[2]

ABSTRACT: A new host record of *Brachymeria ovata* from *Harrisina brillians,* a lepidopterous pest of grapes in the southwestern United States and Mexico, is reported.

The western grapeleaf skeletonizer, *Harrisina brillians* Barnes and McDunnough, is a leaf defoliating pest of backyard, wild, and cultivated grapes (*Vitus* spp.) and two ornamental plants, Boston ivy (*Parthenocissus tricuspidata*) and Virginia creeper (*P. quinquefolia*), in Mexico and the southwestern United States (Stern *et al.* 1981). *Brachymeria ovata* (Say), an unrecorded skeletonizer parasitoid, is recorded as a pupal parasitoid of over 100 species of Lepidoptera which encompass 18 families (Peck 1963, Burks 1979). *Brachymeria ovata* is widely distributed throughout North, Central, and South America (Burks 1979, DeSantis 1979).

Recently, I examined five specimens of *B. ovata* that were reared from skeletonizer pupae by California Department of Food and Agriculture, Biological Control Services Program personnel during skeletonizer natural enemy evaluation surveys in California (pers. comm. Villegas and Esser). Despite the rearing of approximately two hundred-thousand skeletonizer larvae and pupae from 1975 to 1983, only these five specimens were observed.

The rearing data is as follows: 2 ♀, Palo Cedro, Shasta County, California, 15 August 1978, emerged from *H. brillians,* B. Villegas; 3 ♀, Anderson, Shasta County, California, 30 August 1982, emerged from *H. brillians,* T.E. Esser. These specimens reside in the Biological Control Services Program's reference collection.

This data represents a new host record for *B. ovata.* The low level of parasitization indicates that this species is not an important component in the biological control of *H. brillians.*

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INSECT FIELD DAY FOR YOUNG AND AMATEUR ENTOMOLOGISTS

The American Entomological Society, in conjunction with The Young Entomologists Society, and the Brandywine Valley Association, has scheduled an entomological field day to be held, rain or shine, at the Myrick Conservation Center of the Brandywine Valley Association on Saturday, June 6, 1987, from 9 am to 4 pm.

The objective of this event is to promote insect related interests and interactions, particularly among young and amateur entomologists of the greater Philadelphia area. Interested parents and teachers also are invited to participate. Registration is $2.00. A map and additional information will be sent to registrants before May 15.

Please send inquiries to Ann Faulds, Brandywine Valley Association, 1760 Unionville-Wawaset Road, West Chester, PA 19382.

DISCLAIMER NOTICE

At the request of the undersigned, ENTOMOLOGICAL NEWS is publishing the following disclaimer of authorship.

"Because of ethical considerations, I request that my name be removed from co-authorship of the paper '*Acyrthosiphon pisum* (Homoptera: Aphididae), an aphid species biting man' (T.W. Culliney and J.R. Ruberson, Entomol. News 97:225-226)". Signed, "John R. Ruberson".

IS *SIMULIUM TUBEROSUM* (DIPTERA: SIMULIIDAE) A PEST OF HUMANS? A PROBLEM OF INTERPRETATION AND SIBLING SPECIES[1,2]

J.F. Burger, L.A. Pistrang[3]

ABSTRACT: The *Simulium tuberosum* complex is known to consist of at least nine cytospecies throughout its Holarctic range, although some of these may prove to be only chromosomal segregates. The importance of members of this species complex as pests of humans is obscured by contradictory reports in the literature due to misidentification, geographically or seasonally variable biting habits, or the possibility that only certain cytospecies are attracted to humans. A study of the *tuberosum* complex in northern New York and New Hampshire, where high *tuberosum* populations occur, revealed that only 0.3 - 2.9% of adults collected while biting and annoying humans were *tuberosum*. This information, and a critical review of existing literature, demonstrate that adults of the *tuberosum* complex only occasionally bite or annoy humans, and are not major pests. Contradictory reports of annoyance in the southeastern United States cannot be confirmed without additional information.

Simulium tuberosum (Lundström) is a widely-distributed and often abundant Holarctic black fly. Studies of the polytene salivary chromosomes of *S. tuberosum* during the past 25 years by Landau (1962), Mason (1982, 1984), Adler (1986), and Adler and Kim (1986) demonstrated that this "species" is composed of at least nine chromosomally recognizable entities in the known geographic range, and that most of these entities are apparently reproductively isolated, i.e. biological species. Unless otherwise indicated, *S. tuberosum* is used in the broad sense, not in the strict sense This information, and similar studies of other black fly species complexes, make a re-examination of published information on the biology, ecology and taxonomy of familiar, broadly-based morphospecies necessary. This is particularly important for those species considered to be pests of humans and livestock, since control efforts usually are directed at those species.

Contradictory published information about *Simulium tuberosum* as a pest of humans prompted a review of published information, and a study, reported here, conducted in New Hampshire and in northern New York, to determine if *S. tuberosum* was a major pest of humans. We also speculate on the possible causes for contradictory reports of *S. tuberosum* as a human pest species.

Simulium tuberosum occurs from Norway, Finland and Scotland to

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Greenland and Alaska south to California, Texas and Florida. The AB cytospecies is considered to be "true" *tuberosum* (Rothfels 1981) since it is the only one occurring in the type locality in northern Finland [Finnish Lapland]. It is also widely distributed in North America, from Alaska to Quebec, south to Alberta, Wisconsin and Virginia. The other sibling species described to date have a more limited distribution.

Reports on the habits of *S. tuberosum* vary from not attracted to or biting humans to being severe, persistent and important pests of humans. Contradictory information sometimes comes from the same geographic area, partly because some studies do not discriminate clearly between biting versus annoying [swarming, non-biting] flies, or do so in a manner difficult to interpret.

Some studies reported that *S. tuberosum* did not feed on humans (Smart, 1936 [Scotland]; Downe and Morrison, 1957 [Quebec]; Kuusela, 1971 [Finland]), or was not attracted to humans (Jenkins, 1948 [Alaska]; Zahar, 1951 [Scotland]). Raastad (personal communication) stated that *S. tuberosum* did not feed on humans in Norway.

Most authors stated that *S. tuberosum* was only occasionally attracted to or fed on humans, and was not a major pest species (Davies, 1952 [Ontario]; Hocking and Richards, 1952 [Labrador]; Wolfe & Peterson, 1960 [Quebec]; Anderson and DeFoliart, 1961 [Wisconsin]; Lewis & Bennett, 1973 [Newfoundland]; Lewis and Bennett, 1979 [Maritime Provinces of Canada]; Adler and Kim, 1986 [Pennsylvania].

Several studies reported moderate biting or annoyance by *S. tuberosum* (Twinn, 1950 [as *S. perissum* Dyar & Shannon, northern Canada]; Davies *et al.,* 1962 [Scotland, 33% of *S. tuberosum* collected were positive for human blood]; Davies and Williams, 1962 [Scotland]; Davies, 1966 [Scotland]; Amrine, 1971 [Ohio]).

Some authors reported that *S. tuberosum* is a pest of humans only at certain times or in certain places (Stone and Jamnback, 1955 [New York, only until early July]; Peterson, 1956 [Utah]; Peterson, 1959 [Utah, above 7,000 ft (2,134 m)]; Abdelnur, 1968 [Alberta]).

Four studies listed *S. tuberosum* as a severe or major pest of humans (Edwards, 1915 [England]; DeFoliart, 1951 [New York, 1-15 bites per minute]; Stone and Snoddy, 1969 [Alabama]; Snoddy and Noblet, 1976 [southeastern U.S.A.]).

Several authors reported that *S. tuberosum* was annoying but did not bite (Jamnback, 1952 [New York]; Sailer, 1953 [Alaska]; Peterson, 1959 [Utah, below 2,500 ft. (762 m)]; Cupp & Gordon, 1983 [northeastern U.S.A.]. Others reported that *S. tuberosum* was attracted to but did not feed on humans (Sommerman *et al.,* 1955 [Alaska]; Jamnback and Collins, 1955 [New York, but mixed with *S. venustum s. lat.*]; Davies and Peterson, 1956 [Ontario]; Snow *et al.,* 1958 [Tennessee, Alabama, Mississippi, Georgia, North Carolina]; Magnarelli and Cupp, 1977 [New York]).

Two authors, Carlsson (1962) in Scandinavia and Fallis (1964) for Europe and North America indicated that *S. tuberosum* fed on mammals, with no specific mention of humans. Stone (1964) stated that the feeding habits of *S. tuberosum* could not be precisely determined in Connecticut since females could not be reliably separated from *S. venustum* Say and *S. verecundum* Stone & Jamnback.

MATERIALS AND METHODS

To determine if *Simulium tuberosum* is a major pest of humans in northern New York, as reported in the literature, or in northern New Hampshire, where the immature stages are abundant in streams, we sampled 12 sites in New York on 14-16 June and 13-15 July 1982, and 10 sites in New Hampshire during spring and summer, 1982. In New York, we sampled 5 sites in Hamilton County (Blue Mountain to Long Lake, Newcomb, Minerva, and Tahawus), 6 sites in Essex County (Blue Ridge, New Russia, and Keene Valley), and 1 site in Clinton County (Ausable). We also examined 1,000 adult black flies selected from 44,800 adults collected during 1982 by Daniel Molloy and his colleagues at their Onchiota (Franklin County) study site. These samples were collected on 9-10 June, 5-6 July, 13 July, and 24-29 July, with no distinction made between flies attracted to collectors and those collected biting.

The principal sampling area in New Hampshire was Waterville Valley (Grafton County), where a concurrent study of the seasonal distribution and abundance of *S. tuberosum* sibling species in the Waterville Valley watershed was in progress, and where larval populations in streams were high. Additional collections were made from June through August at 9 sites in Coos County, New Hampshire.

Adult black flies were sampled by overhead net sweeps, 4 sets of 10 sweeps each, separated by 30 second intervals, during the morning and afternoon activity peaks. Biting flies were collected only after beginning to feed.

RESULTS

In New Hampshire, 31 of 1,508 flies attracted to humans (Table 1) were *S. tuberosum* (2.3%), a percentage similar to that reported by Davies (1952) in Ontario, and Wolfe and Peterson (1960) in Quebec. Of 159 flies collected biting humans, 4 (2.5%) were *S. tuberosum.*

In New York, 5 of 1,433 flies swarming around humans in our collections (0.3%) were *S. tuberosum* (Table 2). Of 69 adults collected biting humans, 2 (2.9%) were *S. tuberosum.* For the Onchiota study site (Table 3), 19 of 1,000 adults (1.9%) examined from all dates were *S. tuberosum.* At least 1 *S. tuberosum* adult was identified for each of the 4 dates examined, but more than half (11 of 19) were collected during the 5-6 July sampling period.

At no time did *S. tuberosum* exceed 2.9% of the flies attracted to or biting humans at any sampling station in New York and New Hampshire. We conclude, therefore, that *S. tuberosum* is not a major pest of humans in New York or New Hampshire, despite its abundance in small streams and larger rivers throughout the study areas, and need not be targeted for control in black fly abatement programs. The feeding habits of this reportedly anautogenous species group remain obscure in the northeastern United States.

Table 1. Adult black flies attracted to and biting humans in New Hampshire, May — September, 1982.

Species	Biting	Swarming	Total
Prosimulium spp. (3)	119	630	749
Simulium venustum and *verecundum* complexes	34	561	595
S. jenningsi group	0	41	41
S. tuberosum cpx. (5 cytospecies)	4	31	35
S. n. sp. nr. *luggeri*	0	33	33
S. parnassum Malloch	1	23	24
Stegopterna mutata (Malloch)	0	15	15
S. decorum Walker	0	8	8
S. corbis Twinn	1	4	5
S. aureum cpx.	0	2	2
S. vittatum cpx.	0	1	1
TOTAL:	159	1,349	1,508

Table 2. Adult black flies attracted to and biting humans in the Adirondack Mountains, New York, June — July, 1982.

Species	Biting	Swarming	Total
Simulium venustum cpx.	34	782	816
S. verecundum cpx.	29	520	549
S. jenningsi group	0	141	141
S. tuberosum cpx.	2	5	7
Prosimulium mixtum Syme & Davies	0	4	4
S. decorum Walker	2	0	2
Stegopterna mutata (Malloch)	0	1	1
S. longistylatum Shewell	1	0	1
S. aureum cpx.	1	0	1
TOTAL:	69	1,453	1,522

Table 3. Adult black flies attracted to a human host, Onchiota, Hamilton County, New York, 1982.

Species	9-10 Jun	5-6 Jul	13 Jul	24-29 Jul	Total
S. venustum cpx.					
S. verecundum cpx.					
S. jenningsi grp.	413	187	90	176	866
Prosimulium spp.	49	0	1	1	51
S. vittatum cpx.	20	3	3	2	28
S. parnassum Mall.	0	2	5	15	22
S. tuberosum cpx.	5	11	1	2	19
S. pugetense cpx.	8	0	0	0	8
S. corbis Twinn	1	0	0	1	2
S. rugglesi Nicholson & Mickel	0	1	0	0	1
S. decorum Walker	0	0	0	1	1
S. aureum cpx.	0	0	0	1	1
S. impar Davies, Peterson & Wood	1	0	0	0	1
TOTAL:	497	204	100	199	1,000

DISCUSSION

The results of our study agree with many other studies on the habits of adult black flies: that *S. tuberosum* only occasionally is attracted to or bites humans. How can we explain reports in the literature that *S. tuberosum* can be a serious pest of humans? This question is important because *S. tuberosum* larvae can be very abundant in streams and may be targeted for control efforts because they are purported to be pests of humans. If they are not major pests of humans, control may be unwarranted, at least until pest status can be established, with concomitant reduced control costs.

Reports on *S. tuberosum* as a human pest are contradictory not only throughout the range of this species complex, but also in the same geographic area. In Alaska, Jenkins (1948) reported that *S. tuberosum* was not attracted to humans. Sailer (1953), however, stated that it was annoying but did not bite humans, and Sommerman et al. (1955) stated that it was attracted to but did not feed on humans.

In the southeastern U.S.A., Stone and Snoddy (1969) and Snoddy and Noblet (1976) reported that *S. tuberosum* was a serious biting pest of humans, while Snow *et al.* (1958) stated that it was attracted to but did not bite humans.

In Scotland, Smart (1936) and Zahar (1951) reported that *S. tuberosum* was not attracted to humans, while Davies *et al.,* (1962), Davies and

Williams (1962) and Davies (1966) stated that it caused moderate annoyance to humans. Edwards (1915) stated that it was a severe pest of humans in England.

Lewis Davies (personal communication) provided additional comments on the *S. tuberosum* group in the Skey Valley of the Central Scottish Highlands. Five black fly adults collected after feeding on a human in August, 1956, were *S. tuberosum,* but other records of human annoyance attributed to *tuberosum* may apply instead to *Simulium reptans* Meigen or perhaps to species in the *Simulium ornatum* group. *Simulium reptans* prefers to feed on cattle, rather than humans, while the reverse is true for *tuberosum. Simulium reptans* inhabits the lower reaches of streams where human habitation is more common, while *S. tuberosum* is found more commonly upstream where it is less likely to encounter humans. However, it seems clear that *S. tuberosum* in Scotland can be at least an occasional pest of humans.

Apart from imprecise definitions of *S. tuberosum* as a pest of humans, how can discrepancies in reports of this species group as a pest of humans be explained? Three explanations are possible.

First, other anthropophilic species (i.e. *S. venustum* and *S. verecundum* complexes) were misidentified as *S. tuberosum.* This could occur in several ways. Characters not suitable for reliable species distinction may be used, especially if they are variable. Use of inaccurate keys and figures may lead to misidentification. Reliable characters, such as features of the external genitalia, may be ignored because they are perceived as difficult to use. Misidentified reference specimens may be used to identify pest black flies. Reference in the literature to the difficulty of distinguishing *S. tuberosum* from other common pest species, such as *S. venustum* and *S. verecundum* (Stone, 1964), may discourage accurate identification of *S. tuberosum,* and encourage authors to "lump" it with other pest species. Reference in the recent literature to the *"venustum/verecundum"* complexes or the [*Prosimulium*] *"mixtum/fuscum"* complexes incorrectly implies that these complexes cannot be separated satisfactorily, and reflects the disinclination ot certain workers to take the time necessary to examine genitalic and other characters.

Simulium tuberosum females are easily distinguished from *S. venustum* and *S. verecundum* females by the narrower fore tibiae bearing a pale streak on the anterior surface not extending across the entire width of the segment, and not forming a broad white patch, the narrow pale basal areas on the mid- and hind tibiae, and by the distinctive shape of the anal lobes.

Second, the biting habits of *S. tuberosum* may vary geographically, seasonally, or may be affected by local environmental conditions. It is well known that black fly biting intensity tends to increase as low pressure fronts approach, prior to storms, but whether this occurs in all mammalophilic species is unknown. It is also possible that larval nutrition or environmental factors in streams may influence biting behavior of adult flies. It is difficult to assess the importance of geographic variation in biting/annoying habits of black flies without additional information.

Finally, some sibling species or chromosomal segregates in the *Simulium tuberosum* complex may be human pests, while others are not. Much of the information generated on the habits of *S. tuberosum* was published prior to definition of the sibling species (cytospecies) now known to comprise the *tuberosum* complex (Landau, 1962; Mason, 1982, 1984), or was not considered in discussion of *S. tuberosum* as a pest of humans.

Three cytospecies are known to occur in Europe: AB in Finland, and FGI and Y_2 in Norway. Only in Scotland has *S. tuberosum* been recorded as a pest of humans, but since its cytogenetics has not been studied there, these biting records cannot be definitely associated with any of the known European cytospecies. Because the AB cytospecies is known to be widely distributed geographically and seasonally, it is possible that this cytospecies is associated with human annoyance in the Scottish Highlands. No records of human annoyance are published from the Scandinavian countries where FGI and Y^2 occur.

In North America, human nuisance records are best known from Alaska, Alberta, Utah, eastern Canada, Wisconsin, New York, New Hampshire, Pennsylvania, and the southeastern United States. Three cytospecies are known to occur in Alaska: FGI, FG and AB. These also occur in Alberta, along with a fourth cytospecies, FGH. The cytogenetics of the *tuberosum* group has not been studied in Utah, but possibly the three widely distributed cytospecies occurring in Alaska occur there as well.

Seven cytospecies in the *S. tuberosum* complex are known from eastern North America (Table 4), although some of these may prove to be only

Table 4. Cytospecies of the *S. tuberosum* complex in Eastern North America.

Ont.	Que.	Wis.	N.Y.	N.H.	Penn.	Va.	S.C.
AB	AB	AB	AB	AB	AB	AB	—
A	—	—	A	A	A	A	A
CDE	—	—	CDE	CDE	CDE	CDE	—
—	CDEM	—	CDEM	—	CDEM	CDEM	CDEM
—	—	—	—	—	CKL	CKL	CKL
FG	FG	—	—	FG	FG	—	FG
FGH	—	—	FGH	FGH	FGH	—	FGH

chromosomal segregates within different populations and not biological species. Six of the seven cytospecies occur in the present New York-New Hampshire study area, and the seventh, CKL, is abundant in Pennsylvania, where Peter Adler's detailed studies on the ecology of black flies have greatly increased our knowledge of the *tuberosum* complex.

In New Hampshire, the FGH, FG and CDE cytospecies are abundant in montane streams, but since adults rarely were found biting or annoying humans during the past 10 years, these cytospecies cannot be considered important human pests. The A and AB cytospecies were collected less frequently, so their status as human pests is less certain.

In Pennsylvania, where all described eastern cytospecies occur, Adler and Kim (1986) stated that the complex was not a pest of humans, and that only a few instances of biting were recorded. This eliminates all the described eastern cytospecies as important human pests. How, then, can one explain the observation by Stone and Snoddy (1969) that *S. tuberosum* is the most persistent pest of humans and livestock in Alabama? Five cytospecies, A, CDEM, CKL, FG and FGH are known to occcur as far south as South Carolina (Adler, personal communication) but none of these seems to be a human pest in northern localities. If their statement is correctly applied to *S. tuberosum,* the pest populations may be an undescribed cytospecies or based on misidentified material. Resolution of this problem must await analysis of the *tuberosum* complex in Alabama.

A final question is whether the occasional human nuisance or biting records cited throughout the geographical range of *S. tuberosum s. lat.* can be ascribed to one or two cytospecies, or whether several of them are involved. Only the AB cytospecies is common to areas where annoyance has been documented (except in the southeastern U.S.A.), and thus is likely to be at least an occasional human biter. Since it is not yet possible to positively identify adult female black flies by cytospecies, implication of *Simulium tuberosum* in human annoyance is not possible, except where only one cytospecies occurs.

In summary, *Simulium tuberosum* is not proven to be a major human pest species, and only rarely annoys or bites humans. In localities where biting records are carefully documented, none of the known *S. tuberosum* cytospecies can be considered a major human pest, in proportion to the large larval populations observed in streams. The pest status of the *S. tuberosum* complex in the southeastern United States, however, remains unresolved.

To clearly define the pest status of anthropophilic black flies, future studies should include careful identification of species and species complexes, clear reference to numbers of biting and swarming black flies, and a combination of cytotaxonomic and electrophoretic analysis of adults, when possible, to associate biting or annoying activity with a particular cytospecies.

ACKNOWLEDGMENTS

We wish to thank R.W. Crosskey, Department of Entomology, British Museum (Natural History), L. Davies, Department of Zoology, University of Durham, J. Raastad, Zoological Museum, University of Oslo, and J.W. Amrine, Jr., Department of Entomology, West Virginia University for their generous contributions of information about the *Simulium tuberosum* group in England, Scotland and in Ohio, U.S.A., respectively. We also thank P.H. Adler, Department of Entomology, Clemson University for his valuable comments and for allowing us to use unpublished information about *tuberosum* in the southeastern United States, and P.C. Johnson and D.S. Chandler, Department of Entomology, University of New Hampshire for their reviews of this manuscript.

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A FOSSIL SIRICIDAE (HYMENOPTERA) FROM ARGENTINA[1]

Patricio Fidalgo[2], David R. Smith[3]

ABSTRACT: *Urocerus patagonicus*, n. sp., is described from Paleocene shales from Patagonia, Argentina. No living native Siricidae are known from South America, and this is the first fossil Siricidae discovered from this continent.

The discovery of an impression of a specimen of Siricidae in Paleocene shales in Patagonia, Argentina, is unusual because no living Siricidae are native to South America. The southernmost occurrence of living, native Siricidae in the Western Hemisphere is northern Central America which coincides with the southern extent of the northern lineages of conifers. One species, *Urocerus gigas gigas* (L.), has been accidentally introduced into Chile and is apparently established. The Siricidae are practically absent in the Southern Hemisphere except for two species of *Afrotremex* from central Africa and one species of *Eriotremex* from New Guinea, all of which belong in the subfamily Tremecinae. This fossil, however, belongs in the Siricinae, a group that has no living native representatives in the Southern Hemisphere but are associated only with the northern coniferous forests. This discovery indicates that the Siricinae were once much more widespread than they are now.

The impression (Fig. 1) shows part of the head, thorax, base of the abdomen, and most of the forewings. The forewing venation is most consistent with current day species of *Urocerus*.

Urocerus patagonicus Fidalgo and Smith, new species

Adult. — Forewing and dorsum of head, thorax, and base of abdomen as in Figs. 1-3. Two apparent anomalies occur, a double anal crossvein (a) in the left forewing and a partial stub of another vein (Rs) in the same wing. These are apparently aberrations since we have seen such irregularities in living species. Important features of the forewing as follows: crossvein 2r-m present; basal stub of vein Cu_1 absent (between $M+Cu_1$ and 1A); veins Rs and M meet at same point; cell $1R_1$ about 2/3 length of cell $2R_1$; basal stub of vein 3A absent; crossvein 2r-m meets Rs far apical to where 2r meets Rs; crossvein 2m-cu meets M apical to where crossvein 2r-m meets M.

Holotype. — No. 13320, Paleocene, Patagonia, Argentina; Chubut, Laguna del Hunco, J. Powell coll. Deposited in the collections of Paleontologia Invertebrados Lillo, Instituto M. Lillo, Tucumán, Argentina.

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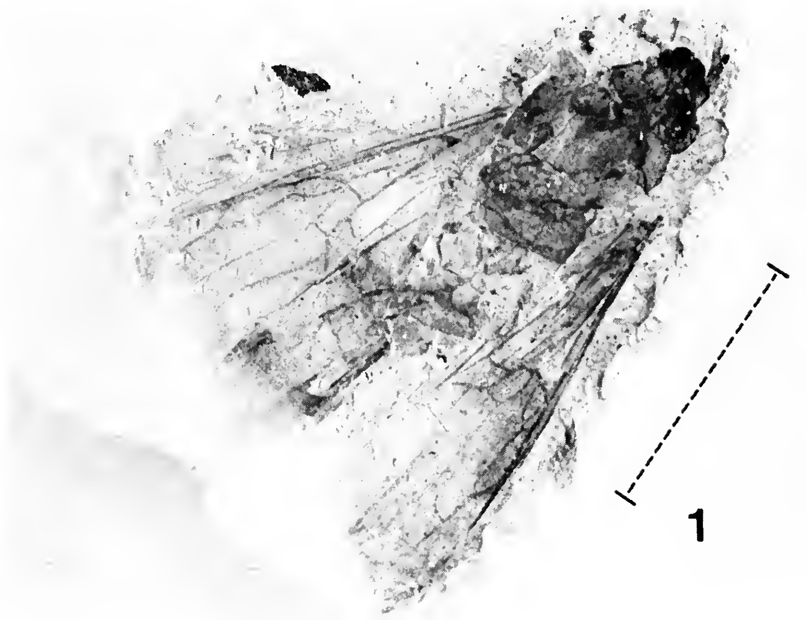
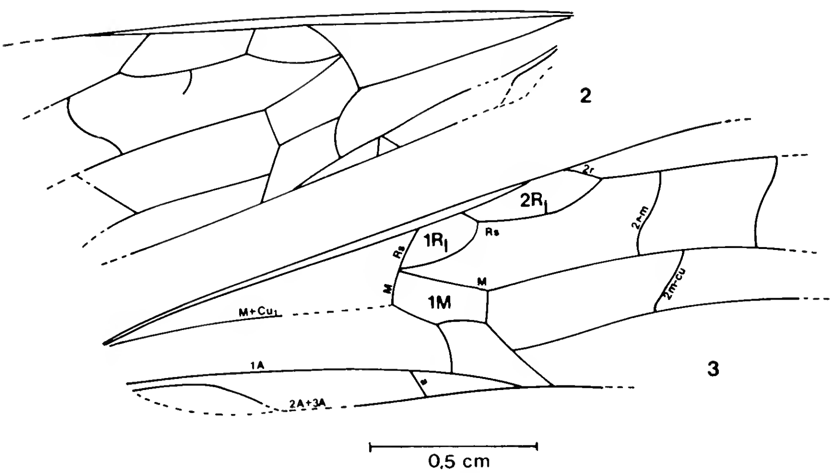


Fig. 1. Photograph of *Urocerus patagonicus* (by Mr. Simon Castro). Actual size indicated.



Figs. 2, 3. Forewings of *Urocerus patagonicus*. 2, Left forewing. 3, right forewing (drawings by PF).

DISCUSSION

The presence of crossvein 2r-m and lack of the basal stub of vein 3A in the forewing helps to place this species in the Siricinae; Tremecinae usually lack 2r-m and have 3A represented as a short stub issuing basally from 2A+3A near the point where 2A+3A curves up. The fossil most resembles *Urocerus* because of the lack of the basal stub of vein Cu_1 and veins Rs and M meeting at about the same point. In *Sirex*, the basal stub of vein Cu_1 is almost always present, and in *Xeris*, RS usually meets vein M on cell 1M, apical to the point where these veins meet in the fossil. These three genera are widespread in the Holarctic Region. *Xoanon* from east Asia lacks the basal stub of vein Cu_1, but cell $2R_1$ is nearly twice the length of cell $1R_1$ and crossvein 2m-cu meets M basal to the point where crossvein 2r-m meets M; and *Siricosoma* from Malaysia has the anal cell of the forewing contracted only in the basal 1/3. Wing venation is usually not significant at the species level in Symphyta, but it includes the only evident characters in most fossil forms. Even though we are unable to differentiate the fossil from current *Urocerus* species, the occurrence of *U. patagonicus* during the Paleocene in an area far removed from where the genus now occurs indicates that it is probably a distinct species.

Several other Siricinae have been described from the Cenozoic (Smith, 1978): *Urocerites spectabilis* Heer (1867) from the Miocene in Yugoslavia; *Eoxeris klebsi* (Brues) (1926) from Baltic amber, Oligocene, in Germany; and *Eosirex ligniticus* Piton (1940) from the Eocene in France. The latter genus and species were overlooked by Smith (1978). All are based on descriptions of the forewing. In *Urocerites* and *Eosirex*, cells $1R_1$ and $2R_1$ are subequal in length; in *Urocerites* crossvein 2r-m is nearly interstitial with 2r, meeting Rs only slightly apical to 2r; and in *Eoxeris* veins Rs meets M on cell 1M, similar to that in *Xeris*.

There were also undetermined conifer impressions found at Laguna del Hunco (LIL-PB#5970 & 5971 in the Instituto Miguel Lillo collections) (J. Durango de Cabrera, personal communication), indicating that conifers may have been the host of this species. All living Siricinae are associated with conifers.

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AMENDED INFORMATION: SECOND CONFERENCE ON PARASITIC HYMENOPTERA

Dates changed to November 19-21, 1987

Other information, as presented in the earlier notice on page 30 of the Jan.- Feb. '87 issue of ENT NEWS remains unchanged. For further information, write to: V.K. Gupta, convener, Center for Parasitic Hymenoptera, Univ. of Florida, 3005 S.W. 56th Ave., Gainesville, FL 32608.

CALL FOR PAPERS

"Endangered and Sensitive Species of the San Joaquin Valley, CA: A Conference on their Biology, Management, and Conservation" will be hosted by Calif. State College, Bakersfield, CA, on December 10-11, 1987.

Papers and poster sessions on endangered and sensitive wildlife and plant species, and unique communities of the San Joaquin Valley are solicited. Presentations should be no more than 15 minutes. Accepted papers will be published in the conference proceedings.

Abstracts (5 copies) should be sent to Daniel F. Williams, Dep't. Biological Sciences, Calif. State Univ., Stanislaus, Turlock, CA 95380 by July 1, 1987.

For additional information, contact Linda K. Spiegel, Calif. Energy Commission, 1516 9th St., MS-40, Sacramento, CA 95814.

NEW DISTRIBUTION RECORDS FOR NORTH CAROLINA MACROINVERTEBRATES[1]

David R. Lenat, David L. Penrose[2]

ABSTRACT: Collections made by the North Carolina Department of Natural Resources were used to establish 30 new distribution records for the state's Ephemeroptera, Plecoptera and Trichoptera. Also, recently published North Carolina distribution records are summarized for an additional 15 species.

The benthic macroinvertebrate fauna of North Carolina had been poorly documented prior to 1982. Some publications were available dealing with specific groups (e.g. Traver 1932), but even these few studies were often out-of-date and/or incomplete. For these reasons, the publication of *Aquatic Insects and Oliogochaetes of North and South Carolina* (Brigham et al. 1982) was a landmark event. This book presented both faunal lists and keys, with an emphasis on immature stages and aquatic adults. Note, however, that Brigham *et al.* (1982) rarely distinquished between North Carolina and South Carolina records. Validation of new North Carolina records requires an examination of earlier literature.

The North Carolina Division of Environmental Management annually collects benthic macroinvertebrates at about 300 sites. This process has resulted in a number of new distribution records. Data for three groups (Ephemeroptera, Plecoptera and Trichoptera) are presented here; distribution records for other groups will be published separately. This paper also summarizes other recently published North Carolina records with notes on abundance and distribution.

New North Carolina Records

Ephemeroptera

The taxonomy of immature Ephemeroptera is relatively well established. However, species level identifications are still difficult for many families, especially the Baetidae, and we expect that further taxonomic revisions will result in many new distribution records. Fifteen new distribution records are listed below; ten of these were listed by Brigham et al. (1982) as occurring, or probably occurring, in North and South Carolina. Unless otherwise specified, all identifications were based on nymphs.

Baetisca gibbera Berner. Distribution records for this species (Pescador and Berner 1981) include most of the southeastern United States from Virginia to Florida, but no North Carolina records had been listed.

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This species is widespread within the inner coastal plain region of North Carolina. Collection localities include: Trent River, Jones Co.; Black River, Sampson Co.; Moseley Creek, Lenoir Co. and Little River, Montgomery Co.

Baetisca obesa (Say). Distribution records available in Pescador and Berner (1981) indicate that this species is widespread throughout the eastern United States (Massachusetts to Florida), but this species had not been reported from North Carolina. Our data indicates that ***B. obesa*** is common in inner coastal plain rivers of North Carolina. Collection localities include Black River, Sampson Co.; Neuse River, Wayne Co. and Tar River, Pitt Co.

Baetisca laurentina McDunnough. Pescador and Berner (1981) indicate that this species is widespread throughout the central United States and Canada. The new North Carolina record is from Jacob Fork, Catawba Co.

Neoephemera youngi Berner. This is a coastal plain and piedmont species, previously recorded from Florida to Virgina (Berner 1977, Kondratieff and Voshell 1983). It had not been reported from North Carolina, but our collections indicate a similar piedmont/coastal plain distribution: Black River, Sampson Co., Little River, Johnson Co.; Knob Creek, Cleveland Co.

Ephemerella argo Burks. There are unconfirmed records of this species in the Savannah River (GA/SC: Patrick et al. 1967), otherwise it is known only from a small area in Illinois and Indiana (Allen and Edmunds 1965). The very distinctly patterned nymph of *E. argo* was collected and identified by Trish Finn MacPherson (NC Dept. Natural Resources) from several locations on the Lumber River, Robeson Co. The identification was confirmed by M. Pescador.

Ephemerella needhami McDunnough. Allen and Edmunds (1965) indicate that *E. needhami* is a northern species, with Virginia as the southern limit of its distribution; Berner (1977) added single collection localities in Alabama and South Carolina. In North Carolina, we have collected this species only in one river basin: Little River, Wake/Johnston Co.; Buffalo Cr., Johnston Co.

Leptohyphes Eaton. This genus has been collected in the southeast only from Georgia and South Carolina (Berner 1977). In North Carolina, we have collected nymphs from several piedmont localities: Little River, Johnston Co.; Uwharrie River, Montgomery Co. and the Tar River, Franklin Co. Specimens from the Little River were verified by M. Pescador, but could not be definitely assigned to any known species.

Choroterpes Eaton. *Choroterpes* (2 species) has been recorded throughout most of the southeastern United States (Berner: FL, MS, LA, AL, GA, TN). We have collections in North Carolina from an unnamed tributary of Lanes Creek, Union Co., and the upper Waccamaw River, Columbus Co. Waccamaw River specimens were verified by M. Pescador.

Leptophlebia bradleyi Needham. *L. bradleyi* is a winter emerging species which has been collected from scattered localities throughout the southeast, with additional records in Texas and New York (Henry and

Kondratieff 1982). Adults of this species were collected and identified by D. Stephan (NC State University, personal communication) at Big Marsh Swamp (below McNeils Lake) in Bladen Co.

Homoeoneuria cahabensis Pescador and Peters. *H. cahabensis* was described by Pescador and Peters (1980) from Alabama and Mississippi. We have collected this species from a limited area of the North Carolina piedmont: Hunting Creek, Iredell Co.; South Fork Yadkin River, Davie Co. and South Fork Catawba River, Lincoln Co. Identification has been confirmed by M. Pescador.

Tortorpus incertus Traver. There are scattered records for this species throughout the southeastern United Stated (Berner 1977: FL, LA, MS, AL, GA, SC). We collected several nymphs from the Tar River in Franklin Co., and D. Stephan (NC State University, personal communication) has collected adults in Bladen Co., near the South River.

Baetis hageni. This is a "northern transcontinental species" with specimens collected as far south as Missouri (Morihara and McCafferty 1979). In North Carolina, we have collected nymphs from an unnamed tributary of Fytes Creek, Mecklenburg Co.

Heterocloeon petersi Muller-Liebenau. This species, identified from our collections by M. Pescador, was found in the New River, Alleghenv Co.

Paracleodes Day. This genus is unusual for its occurence in highly perturbed warm-water rivers (Edmunds et al. 1976). In North Carolina, we have collections (possibly representing two species) from several piedmont and coastal plain sites: Neuse River, Wake/Wayne Co.; Tar River, Edgecombe Co.; Hunts Fork, Davidson Co. The Neuse River specimens were identified from our collections by P. Carlson.

Barbaetis benfieldi Kennedy. This new genus has recently been described from the New River in Virginia, near the North Carolina border (Waltz et al. 1985). We have several North Carolina collections, including the Cullasaja River, Macon Co.; East Fork French Broad River, Transylvania Co.; Cullowhee Creek, Jackson Co and the Tuckaseegee River, Jackson Co.

Plecoptera

Many Plecoptera are poorly known in the nymphal stage, particularly the Capniidae and Leuctridae. Further taxonomic work may yield many new distribution records in North Carolina. Many of the Plecoptera records listed below reflect recent taxonomic revisions of stonefly genera. New distribution records are listed below for eight species; three of these were listed by Brigham et al. (1982) as occurring, or probably occurring, in North and South Carolina. All identifications were based on nymphs.

Zapada chila (Ricker). We have collected this species in North Carolina only from the South Fork New River, Ashe Co.

Paragnetina kansensis Banks. Previous records (Stark and Szczytko 1981) indicate that this species occurs in portions of the southeastern United States (GA, SC). In North Carolina, we have collected *P. kansensis* from the Northeast Cape Fear River, Duplin Co., and the Lumber River, Robeson Co. Dark specimens of *P. fumosa* may be difficult to separate from *P. kansensis* (B. Kondratieff, personal communication), but in this case we would also expect to find some typical *P. fumosa* in the collections.

Diploperla morgani Kondratieff and Voshell. This species was previously collected only in Virginia and West Virginia (Kondratieff *et al.* 1981) Our North Carolina collections were limited to the North Fork of the Mitchell River, Surry Co.

Diploperla duplicata (Banks). This species has been collected in Georgia, South Carolina, Tennessee and West Virginia. Our collections in North Carolina include both piedmont and mountain localities: Big Alamance Creek, Guilford Co., Parkers Creek, Forsyth Co., Jacobs Fork, Burke Co., and West Fork French Broad River, Transylvania Co.

Helopicus bogaloosa Stark and Ray. This species was described by Stark and Ray (1983) from the southeastern United States (FL, GA, AL, MS) and has recently been recorded from South Carolina by Kondratieff and Painter (1986). We have collected *H. bogaloosa* from Naked Creek, Richmond Co. and the Lumber River, Hoke and Robeson Co. It may be found throughout the sandhills region.

Isoperla frisoni Illies. This is primarily a northern species (Hitchcock 1974), but we have North Carolina collections from the Hiawassee River, Cherokee Co. and the Dan River, Stokes Co.

Isoperla slossonae (Banks). This species is often locally common in the northeast, including Virginia (B. Kondratieff, personal communication). In North Carolina, we have collected *I. slossonae* only from localities in the New River basin: South Fork New River, Ashe Co. and Big Laurel Creek, Ashe Co.

Isoperla burksi Friscon. This species is found in North Carolina in the Cape Fear and Yadkin River drainages. Our collections include Fork Creek, Randolph Co. and Bear Creek, Chatham Co.

Trichoptera

The Trichoptera of the Carolina's area are relatively well known, largely due to the work of John Morse and his students. Seven new distribution records are listed below; Four of these were listed by Brigham et al. (1982) as occurring, or probably occurring, in North and South Carolina. All identifications are based on larvae.

Brachycentrus lateralis (Say). *B. lateralis* is primarily a northeastern species, but the known distribution includes South Carolina and Tennessee (Flint 1984). We have a single collection from the Johns River, Catawba Co. Identification of *B. lateralis* was cofirmed by O. Flint.

Brachycentrus incanus Hagen. *B. incanus* is another northeastern species, with the known distribution extending as far south as Virginia (Flint 1984). We have collected larvae which key to this species from the Tar River, Nash Co. Note, however, that Flint's (1984) association of the larvae and adult was considered tentative.

Brachycentrus chelatus Ross. This southeastern species has been collected from Florida, Alabama, Georgia and South Carolina (Flint 1984). We have collected *B. incanus* from two naturally acidic streams in the sandhills region: Naked Creek, Richmond Co. and Quewhiffle Creek, Hoke Co.

H. (C.) ventura Ross. This species may be near its southern limit in North Carolina, having been collected only in the New River basin: South Fork New River, Ashe Co. and New River, Aleghany Co. *H. ventura* larvae were identified from our collections by G. Schuster.

Leucotrichia pictipes (Banks). This pollution–tolerant species is widespread in the northern mountains and piedmont. Larvae of *Leucotrichia* may be missed by normal collection techniques due to their tightly adhering case. North Carolina localities include: Pigeon River, Haywood Co.; Dan River, Stokes Co.; Ararat River; Surry Co.; Catawba River, McDowell Co. and New River, Alleghany Co. Some specimens were verified by J. Morse.

Ceraclea mentiea (Walker). *C. mentiea* has been recorded from the north–central and northeastern United States (Morse 1975). We have collected this species only in the New River basin: New River, Alleghany Co., North and South Forks of the New River, Ashe Co. Identification was confirmed by J. Morse.

Nyctiophylax moestus Banks. Larvae of this species was described by Flint (1964) as *Nyctiophylax* sp. A (Morse 1972). Our collections indicate that it is widespread in the piedmont and southern coastal plain regions of North Carolina: Black River, Sampson Co.; South River, Bladen Co; Lumber River, Robeson Co.; Island Creek, Jones Co.; McLendons Creek, Moore Co. and Barnes Creek, Montgomery Co.

Recently Published Distribution Records From North Carolina

The records listed below are primarily intended to update the faunal lists in Brigham et al. (1982). We include here the species name, the published record(s) and general comments on distribution:

Baetis pluto McDunnough. Lenat (1983). Common throughout the piedmont and mountain regions.

Baetis flavistriga McDunnough. Berner (1977), Lenat (1983). Common throughout North Carolina, especially in smaller streams, very pollution–tolerant.

Ephemerella berneri Allen and Edmunds. Penrose et al. (1982). Common in clean mountain rivers with a single piedmont record (Eno River, Durham Co.).

Baetisca berneri Tarter and Kirchner. Penrose et al. (1982). Found in clean streams and rivers within the New River and French Broad River basins.

Tallaperla elisa Stark, *T. anna* (Needham and Smith), *T. cornelia* (Needham and Smith). Stark (1983). These species are found in mountain streams, but are separable only as adults.

Isoperla namata Frison. Lenat (1983). Common throughout the piedmont region.

Paragnetina ichusa Stark and Szczytko. Stark and Szczytko (1981). Common in large streams and rivers of the mountain region.

Oconoperla innubila (Needham and Claassen). Stark (1985). Found in spring seeps in the maountain area.

Acroneuria evoluta Klapalek. Lenat (1983). Rare in streams and rivers of the Haw River drainage, Chatham, Orange and Alamance counties.

Helicopsyche borealis (Hagen). Penrose et al. (1982). This species is rare in North Carolina mountain rivers, matching the known distribution in other southeastern states. However, a disjunct population of *H. borealis* may also be found in some sandhills streams. The sandhills region is the only area in North Carolina where this species is abundant.

Brachycentrus appalachia Flint. Flint (1984). Common in the mountain region.

Hydropsyche morosa (Hagen). Penrose et al. (1982). Common in the mountain region.

Rhyacophila ledra Ross. Lenat (1983). Widespread in small piedmont streams.

Hydroptila coweetensis Huryn. Huryn (1985). Adults and pupae were collected from a high elevation rock outcrop in Coweeta National Forest, Macon Co.

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THE ANT FAUNA (HYMENOPTERA: FORMICIDAE) IN NORTHERN AND INTERIOR ALASKA.

A SURVEY ALONG THE TRANS-ALASKAN PIPELINE AND A FEW HIGHWAYS.[1]

Mogens Gissel Nielsen[2]

ABSTRACT: The ant fauna in northern and interior Alaska was systematically investigated along the Trans-Alaskan Pipeline. Additionally, samples were also taken at some localities close to certain highways in the interior. Ten ant species were found – three new to Alaska. Synonyms and distribution of all ant species mentioned for Alaska (18 species) are given, although there are questions whether six of these species belong to the Alaskan fauna. For each species, distribution maps and literature references are presented. Further, observed biological information is given for each species and their importance in foodchains and ecosystems is discussed.

The ant fauna in the arctic and subarctic regions of Alaska has never been investigated intensively. The only information on their distribution comes from single samples, often taken in connection with other biological projects. In the paper "The ants of Alaska" Wheeler (1917) wrote "that the Arctic circle may safely be taken as the extreme northern limit of the ant fauna." Later Weber (1950a) stated "Only two species of ants are definitely known from Arctic Alaska, *(Leptothorax acervorum canadensis* and *Camponotus herculeanus)*". By mentioning *Camponotus,* which is strictly associated with trees, Weber must have included at least the tree line in the arctic region. He gives no estimate of the number of ant species in the subarctic part of Alaska.

Isolated records of ants from all parts of Alaska are given by Brown (1955, 1957), Creighton (1950), Farquhard and Schubert (1980), Gregg (1963, 1969), Weber (1948, 1950b, 1953) and Yong (1974). Despite these records very little is known about the distribution of ants in Alaska.

The ant fauna of Canada has been better investigated. Most of the species found in northern Canada may also be found in Alaska, therefore the works of Brown (1949), Francoeur (1973, 1974, 1979, 1984) and Gregg (1972) are important for an understanding of the distribution of ants in Alaska.

The present paper deals with the results of some preliminary investigations of the ant fauna along the Trans-Alaskan Pipeline and some collections in the interior. It was not the aim to produce a complete list of ant species for this area, rather, the purpose was to make a general survey so

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further ecological investigations can be conducted. The very high density of ants at some of the biotopes means that they are very important elements in the ecosystem, e.g. they are probably important parts of the food-chain for many birds and some small mammals.

MATERIALS

Ants were collected during the summer of 1982 from 37 stations which were reasonably close to a road. At every station, 10-20 individuals were taken from each nest found. In all, 315 nests were sampled.

Most of the samples were taken along the Trans-Alaskan Pipeline, although some collecting trips were made between Prudhoe Bay in the north, and Glenallen.

In the Fairbanks area, intensive sampling was conducted. Further collections were made on trips along the George Parks Hwy., the Denali Hwy., and the Steese Hwy., and on a visit to the "Susitna River Project" and Tok. The main collection areas are shown in Fig. 1.

RESULTS

The available published data on the ant fauna of Alaska together with the data from these studies, are summarized in Table 1. Because of the difficulties with nomenclature, some synonyms are included, but only when the species name differs. The distribution of the species is subdivided into distribution in North America (NA) and Alaska (A). Often the literature only tells us that the species is found in Alaska.

The distributions of the 10 ant species found in the arctic and subarctic parts of Alaska in this study, together with the previously published records from other localities, are marked on the maps in Fig. 2.

Myrmica alaskensis Wheeler (Map No. 1)

Of the ants found in Alaska *M. alaskensis* was the most widely distributed species, being found on the south slope of the Brooks Range in the north and all over the interior. It lived in biotopes which ranged from tundra to forest. It was also found on tussocks in very wet swampy areas. The nests were built in old logs, decayed stumps, under stones, and in moss and other plant materials. *M. alaskensis* overwinters with larvae and the sexuals appear in July. This species has previously been accepted as a subspecies of *Myrmica brevinodis.*

Myrmica brevispinosa Wheeler (Map No. 2)

This species was only found in a few localities. There do not seem to be any other records from Alaska. The nests were in the ground in very sandy soil.

Leptothorax acervorum (Fabricius)(Map No. 3)

The records of *L. acervorum* are widely distributed in the interior, but the species was not common at any locality. In the arctic at Happy Valley Cut (69 01' N) 125 km from Prudhoe Bay, a very high density of this species was observed. This area is situated about 150 km north of the tree line and physically is quite isolated from the south by the mountains.

The ants at Happy Valley nest under flat stones on a southfacing slope. All nests contained larvae and pupae in the middle of June, which indicates that they overwinter with larvae and possibly also with pupae. This species has not previously been recorded from Alaska.

Leptothorax muscorum (Nylander) (Map No. 4)

Brown (1955) wrote "of all the ants occurring in North America *Leptothorax muscorum* is the species best able to survive in extreme Arctic-alpine conditions". This is not quite correct because while *L. muscorum* was found at nearly all the sample stations that had ants, these were all south of Brooks Range. Its nests were under stones, in stumps, in decaying logs, under bark and in plant materials in tussocks. In some localities, especially in the taiga, the nest density was very high. The taxonomy of the *muscorum*-complex has been very confused (Brown 1955) and the species has previously been named *Leptothorax acervorum canadensis* Prov.

Camponotus herculeanus (Linné) (Map No. 5)

The boreal North American *Camponotus herculeanus* may differ specifically from the typical form in Europe, and in the future these may be treated as two separate species (Brown, pers. comm. 1986).

The species is strictly associated with trees, and the distribution in Alaska follows closely the distribution of forests. The nests are carved in wood e.g. trees, trunks, decaying branches, roots and lumber (houses).

The density of *C. herculeanus* can be quite high, but because of their hidden habits of life, their shyness, and non aggressive behavior, only few workers are normally seen on the ground.

Sexuals are produced in late summer and they overwinter in the nest. Mating flights take place in the beginning of June. A huge cloud of swarming *C. herculeanus* was observed several hundred meters over Fairbanks on June 6, 1982, and during the following weeks queens were found in great numbers on the ground. During swarming the queens are heavily preyed upon by birds. Frequently sexuals are blown great distances, e.g. to treeless areas and snow patches, giving those ecosystems an input of easily available food (Edwards 1972).

Formica subnuda Emery (Map No. 6)

The distribution of *F. subnuda* nests was patchy in the forested areas although locally they were very common. Most nests contained enslaved *Formica neorufibarbis.* The nests were very variable and often not permanent. The workers are aggressive and it seems likely that they exterminate other ant species in the same area.

Formica whymperi Forel (Map No. 7)

Only two samples were collected. These are the first records for this species from Alaska.

Formica podzolica Francoeur (Map No. 8)

Three samples of this species were taken. Previously it has been recorded only from the Ray Mountains.

Formica fusca Linné (Map No. 9)

All the specimens collected in this investigation belong to the subspecies, *Formica fusca* subsp. *subaenescens.*

This species is distributed throughout the areas south of Brooks Range and locally can be common. Most nests were found in the soil, often having a very small dome made of loose sand and pieces of grass. There are no overwintering larvae in the nests and the sexuals and new workers appear at the same time as *Formica neorufibarbis.*

Formica neorufibarbis Emery (Map No. 10)

Of the Alaskan ants *F. neorufibarbis* is probably the most frequently seen species. Like *Myrmica alaskensis,* it is a very active species, which forages on the ground in great numbers during warm conditions. The nests of *F. neorufibarbis* frequently contain many queens. They are built under stones, in stumps and in hummocks anyplace where there is a protected and sunheated site. At Eagle Creek, nearly all tussocks on the south facing slopes contain nests of *F. neorufibarbis.* There are no overwintering larvae in the nests, so the first brood of workers appears in July and the sexuals some time later.

The color of the alitrunk varies from clear light red in the typical *F. neorufibarbis* to nearly blackish brown in *Formica neorufibarbis* subsp. *gelida* Wheeler. Sharplin (1966) has studied this variation in color of the workers and correlated it with altitude.

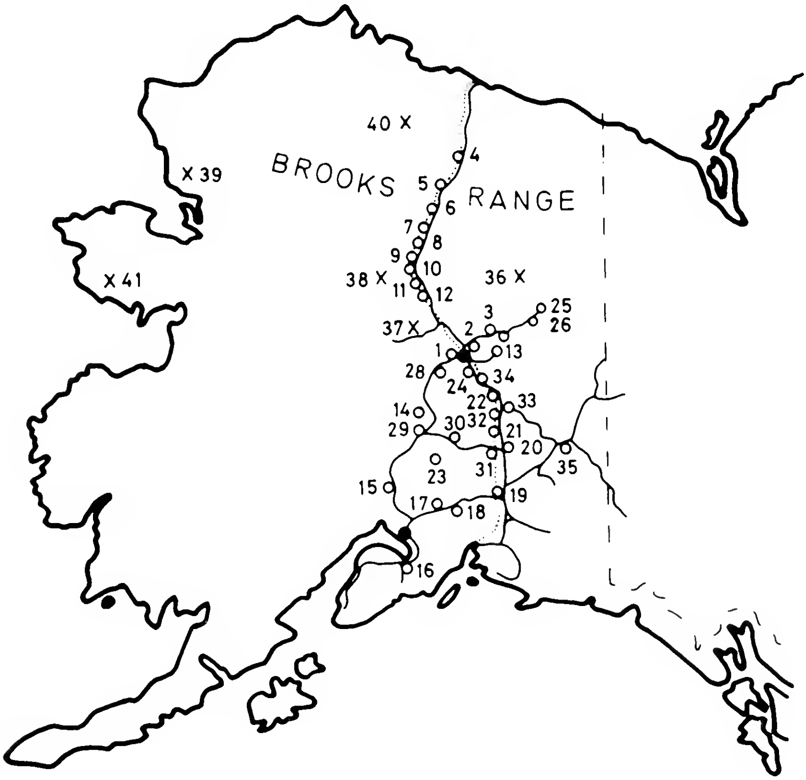
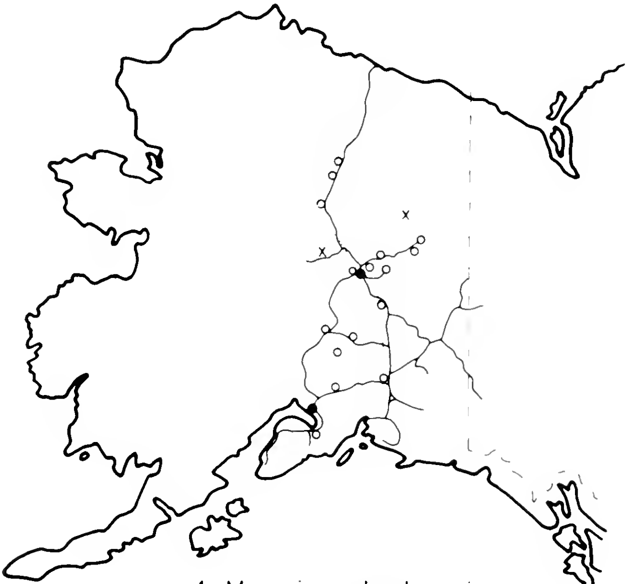


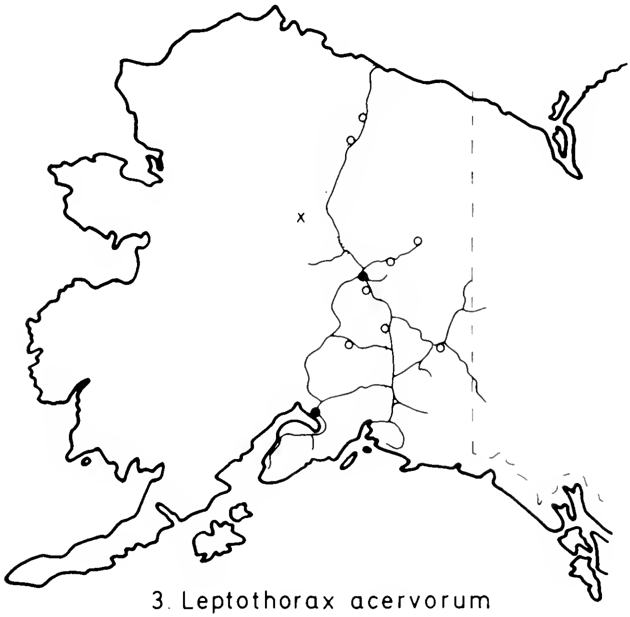
Fig. 1. The main sampling stations in Alaska. This study: (1) Fairbanks; (2) Fox; (3) Chatanika; (4) Happy Valley Cut/Camp; (5) Chandalar Camp; (6) Sukakpak Mt.; (7) Coldfood; (8) Gryling Lake; (9) Goblers Knob; (10) Bonanza Creek; (11) Connection Rock; (12) Old Man Camp; (13) Chena Hot Springs; (14) Iglo Creek; (15)Susitna River; (16) East Granite Creek; (17) Long Lake/Glenn Hy; (18) Caribou Creek; (19) Glennallen; (20) Paxon Lake; (21) Fielding Lake; (22) Shaw Creek; (23) Watana Camp; (24) Eilson; (25) Circle City and Birch River; (26) Central and Miller Creek; (27) Eagle Creek; (28) Nenana; (29) Cantwell; (30) Denali I, II; (31) Tangel Lake; (32) Darling Creek and Donnelly Creek; (33) Delta Junction; (34) Salcha River; (35) Tok; From the literature: (36) Fort Yukon; (37) Pynaw Mt, Rampart; (38) Ray Mtns; (39) Noatak; (40) Umiat; (41) Upper Kugarok near Nome.

Fig. 2. The distributions of ants found in the arctic and subarctic part of Alaska are shown in maps 1 to 10. The samples from this investigation are indicated with (o) and data from literature (x).

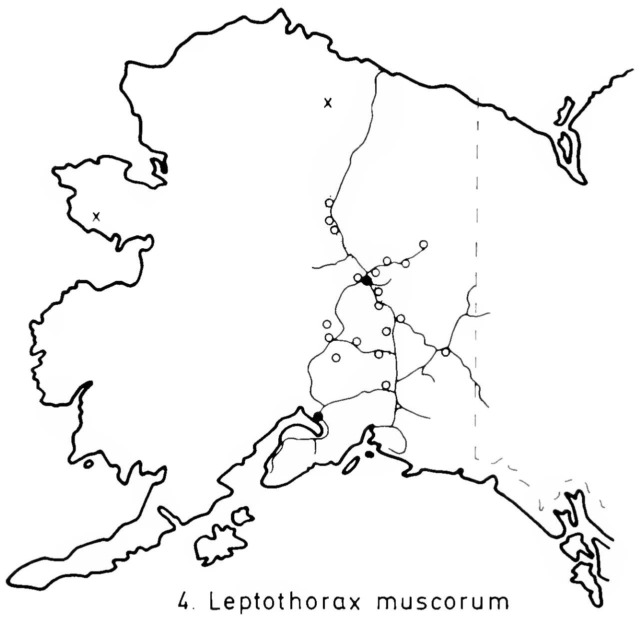


1. Myrmica alaskensis

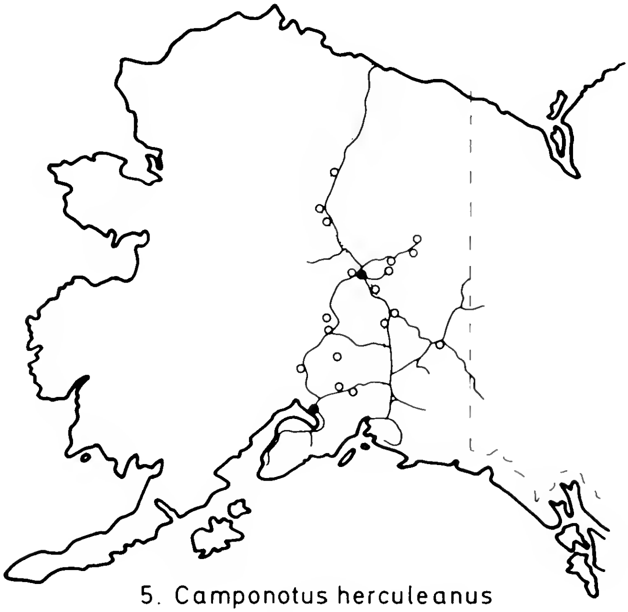
2. Myrmica brevispinosa



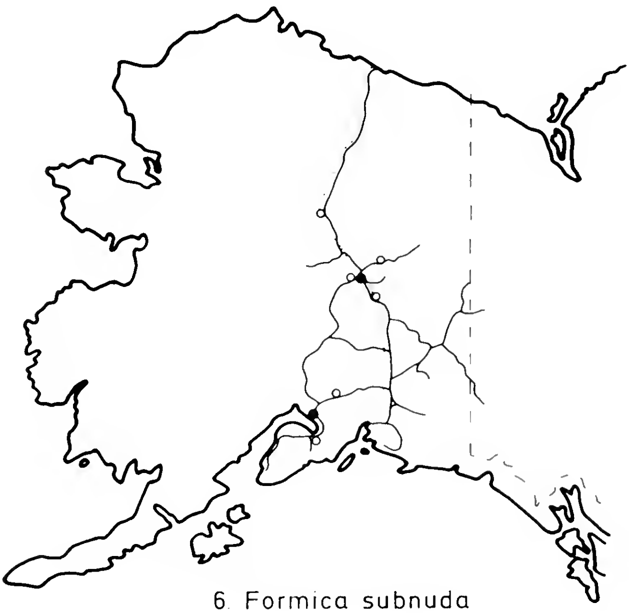
3. Leptothorax acervorum



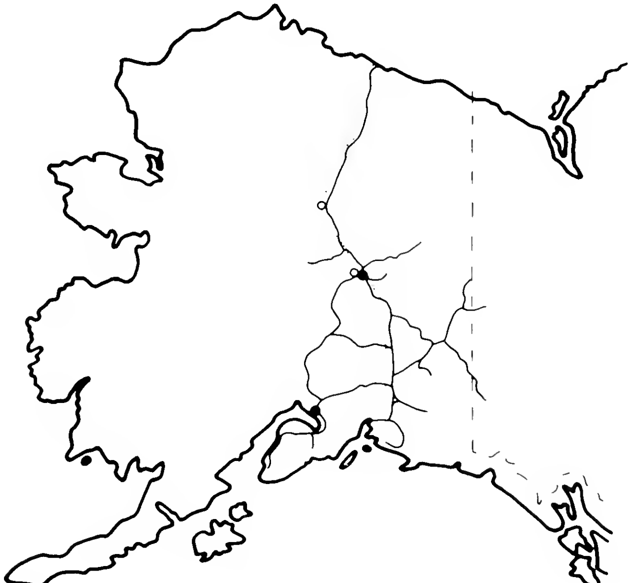
4. Leptothorax muscorum



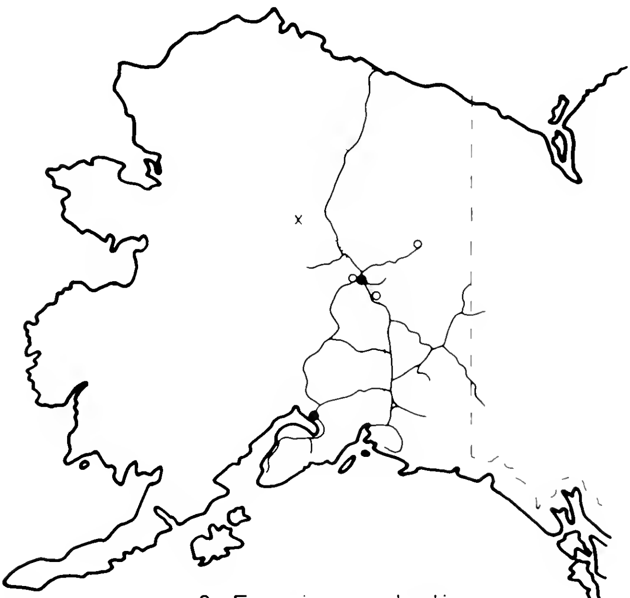
5. Camponotus herculeanus



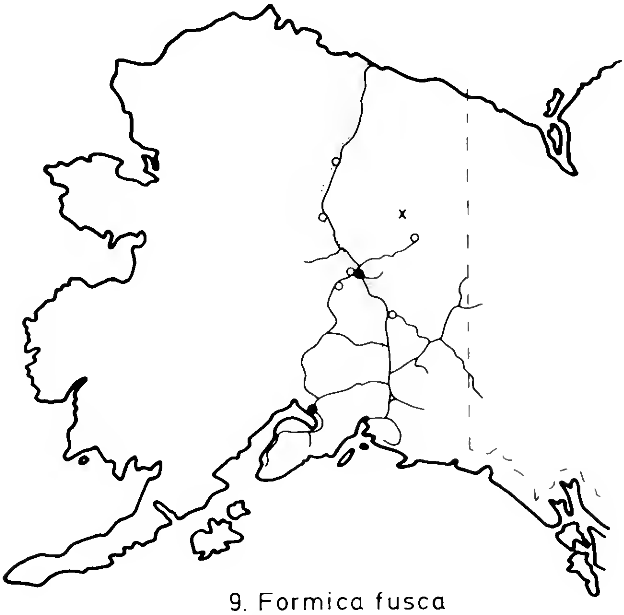
6. Formica subnuda



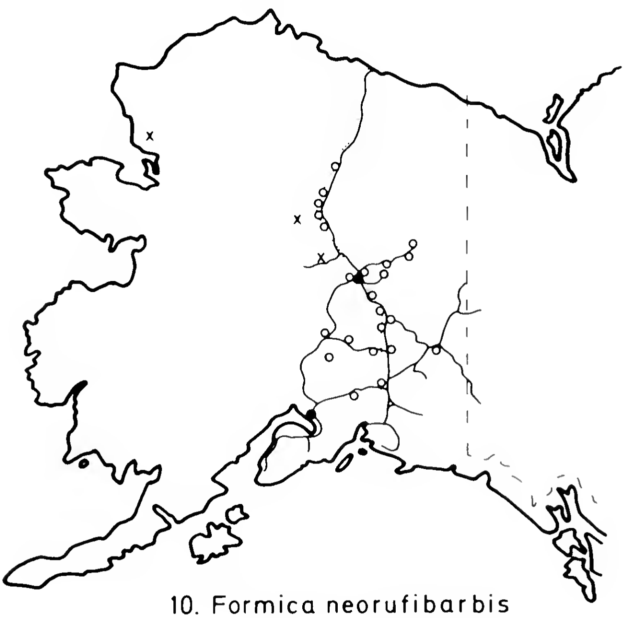
7. *Formica whymperi*



8. *Formica podzolica*



9. Formica fusca



10. Formica neorufibarbis

DISCUSSION AND CONCLUSIONS

The total number of ant species recorded from Alaska is 18 (see Table 1), but six of these are either not well documented or there are questions on the validity of the record. *Lasius neoniger* and one queen of *Acanthomyops latipes* were recorded from Anchorage, and a series of *Formica dakotensis* from Fairbanks. All were found only once and they are a very long distance from their normal distribution. In the literature there are some unspecific records from Alaska for *Manica mutica* and *Formica obscuripes* (Muesebeck et al. 1951) and *Formica neogagates* (Gregg 1963). No documentation is given for these records and no other authors include Alaska in the distribution of these species. In the arctic and subarctic parts of Alaska, ten species were found in this investigation and six of these species are widely distributed.

In the forest areas in the interior of Alaska the diversity of ants is quite high, and in most localities the following species can be found: *Myrmica alaskensis, Leptothorax muscorum, Camponotus herculeanus, Formica neorufibarbis,* and frequently *Formica subnuda.* The density and distribution of the species differ within the biotypes, there being no clear reason why some species are more common in some localities than in others. Generally there is a high density of *Myrmica alaskensis* and *Leptothorax muscorum,* but they are not seen very often on the soil surface and vegetation. The same is true for *Camponotus herculeanus,* which is a very shy species with a secretive way of life. Conversely, the *Formica* species are very active on the ground and therefore it is often assumed that these ants are the most abundant.

On the taiga the population density of ants is also high. The dominant species are *Myrmica alaskensis, Leptothorax muscorum,* and *Formica neorufibarbis.* The two species *Camponotus herculeanus* and *Formica subnuda* were only found in a few localities. The dense plant cover of the soil has the effect that only very few ants are seen, making it difficult to collect ants in this type of biotope. Also in the forest, none of the ants made domes, which is difficult to explain.

The ant fauna on the tundra is very interesting because these areas, above the tree line, are at the limit of where ants can live. On the tussocks tundra close to the camp of the "Susitna River Projects" the density of ants was remarkably high and many of the tussocks contain all three species: *Myrmica alaskensis, Leptothorax muscorum,* and *Formica neorufibarbis.*

The development of ant broods requires quite high temperatures, therefore ants can only survive when their nests can be sufficiently sunheated.

The northernmost record of ants in North America is a single worker of *Leptothorax muscorum* which was found on Richard Island (69°32') about 80 km north of any trees (Brown 1955), and he believed that the ants were not established on this island. In Alaska, the same species was found by Scholander at Umiat (Weber 1948), but there are no records about the number of ants found.

Table 1. Summary of information on the ant fauna in Alaska.

	Synonyms	Distribution in NA: North America A: Alaska	Reference
Myrmica alaskensis Wheeler	M. brevinodis kuschei Wheeler		Wheeler (1917)
	M. brevinodis var. alaskensis Wheeler	A. only in Alaska, map No. 1	Weber (1950)
	M. brevinodis var. sulcinodoides Emery		Creighton (1950)
brevispinosa Wheeler	M. brevinodis brevispinosa Wheeler	NA: New Mexico to Alberta	Wheeler (1917)
	M. rubra brevinodis brevispinosa Wheeler		Weber (1950)
	M. brevinodis var. decedens Wheeler	A: New to Alaska, map No. 2	Creighton (1950)
lobicornis Nylander	M. sabuleti var. lobifrons Pergande (in parts)	NA: Arizona to Alaska	Wheeler (1917)
	M. scabrinodis var. glacialis Forel		Weber (1948)
	M. scabrinodis lobicornis glacialis Wheeler	A: only in southern Alaska	Creighton (1950)
	M. scabrinodis lobicornis lobifrons Pergande		
Manica mutica (Emery)	Myrmica mutica Emery	NA: Northwestern US A: ??	Muesebeck (1951)
Leptothorax acervorum (Fabricius)	L. canadensis kincaidi Provancher	NA: Canada	Gregg (1972)
		A: New to Alaska, map No. 3	Francoeur (1984)
muscorum (Nylander)	L. canadensis Provancher		
	L. acervorum canadensis var. calderoni Forel	NA: Northern US and Canada	Brown (1955)
	L. canadensis calderoni Forel		Creighton (1950)
	L. yankee var. kincaidi Pergande	A: map No. 4	
	L. canadensis var. yankee Emery		
Camponotus herculeanus (Linné)	Formica herculeana Linné	NA: Northern US and Canada	Creighton (1950)
	C. herculeanus pensylvanicus Forel		
	C. herculeanus var. whymperi Emery	A: map No. 5	

	Synonyms	Distribution in NA: North America A: Alaska	Reference
Lasius			
sitkaensis Pergande	L. niger sitkaensis Pergande L. niger neoniger Emery (in parts)	NA: Northern US and Southern Canada A: only in southern part	Wilson (1955)
neoniger Emery	L. niger var. neoniger Emery (in parts)	NA: Eastern US until Iowa A: only one questionable record, 18 miles north of Anchorage	Wilson (1955)
Acanthomyops			
latipes (Walsh)	Formica latipes Walsh	NA: Northern US to Southern Canada	
	Lasius latipes Mayr Lasius (Acanthamyops) latipes (Walsh)	A: A single questionable queen from Anchorage	Wing (1968)
Formica			
neogagates Emery	F. fusca subpolita neogagates Emery	NA: Northern US and Southern Canada	
	F. fusca var. gagates Mayr (in parts)	A: ???	Gregg (1963)
subnuda Emery	F. sanguinea subnuda Wheeler	NA: US and Canada A: map No. 6	Creighton (1950)
dakotensis Emery	F. montigena Wheeler	NA: New Mexico to Alberta A: only one sample from Fairbanks	Brown (1957)
obscuripes Forel	F. rufa obscuripes Forel	NA: Northwestern US and British Columbia	Muesebeck (1951)
	F. rufa aggerens Wheeler	A: ??	
whymperi Forel	F. rufa var. whymperi Forel F. rufa obscuripes whymperi Wheeler F. microgyna rasilis pullula Wheeler F. adamsi Wheeler	NA: Michigan West to Washington & British Colombia A: New to Alaska, map No. 7	Creighton (1950)
poodzolica Francoeur	F. fusca Linné (in parts)	NA: Most of US and Canada A: map No. 8	Francoeur (1973)
fusca Linné	F. marcida Wheeler (in parts) F. lecontei Kennedy and Dennis	NA: Most of US and Canada A: map No. 9	Francoeur (1973)
neorufibarbis Emery	F. fusca var. neorufibarbis Emery (in parts) F. fusca var. algida Wheeler	NA: Most of US and Canada A: map No. 10	Francoeur (1973)

In this investigation the northernmost record of ants was the species *Leptothorax acervorum* and it came from Happy Valley Cut (69° 01' N) at the foothills on the northern side of Brooks Range. The mean temperature in the warmest month is only 11.3°C and the thaw season is only 118 days (Haugen and Brown 1980). All the ants in this area were found under dark slates on steep southfacing slopes. It is clear that the microclimate in the nests on southfacing slopes must be much warmer than the "meteorological climate". On gentle southfacing slopes and plain areas in this locality there were no signs of ants at all. Similar observations were made at the tussocks tundra at Eagle Creek, where *Formica neorufibarbis* inhabits most of the tussocks on the south facing slopes and none were found elsewhere. The warm sunheated climate inside the vegetation makes conditions acceptable for the ants. They rarely are seen on the surface even if they live in very high numbers inside the tussocks.

The density of ants found in a great proportion of the different biotopes was remarkably high. This may have been overlooked in previous studies, possibly because of their strongly aggregated distribution and their hidden way of life in these cold areas. Ants must be very important elements in several of these ecosystems because they can be preyed upon the whole year.

Although little is known about bird predation of ants in these climatic conditions, it should be expected that ants are an important food source for several bird species. At the same time birds and ants are competitors for other food sources, such as other insects.

It would be a great help to a better understanding of Alaskan arctic and subarctic ecosystems if ecological investigation of the ant fauna could be carried out in order to elucidate the role of ants in this fascinating ecosystem.

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LIFE STAGES AND BIOLOGY OF *LIMNEPHILUS RHOMBICUS* (TRICHOPTERA: LIMNEPHILIDAE)[1,2]

R.L. Hoopes[3], Ke Chung Kim[4]

ABSTRACT: The life stages, egg, five larval stages, pupa, and adults, of *Limnephilus rhombicus* are described and illustrated. Oviposition occurred from late September until November, with the peak in October. Larval growth was rapid. By the end of November, most larvae were second, third, and fourth instars. Pupae were collected as early as December, but most pupation occurred during late March and early April. Adult emergence began by early May and continued through June.

The Holarctic *Limnephilus rhombicus* (Linnaeus) was originally described as *Phryganea rhombica* (= *L. rhombicus*) by Linnaeus (1758) from specimens collected in Sweden; its type repository is unknown. Betten and Mosely (1940) redescribed *L. rhombicus* based on Walker's specimens (Walker 1852) which include those from St. Martins Falls, Albany River, Hudson Bay, and the type male of *L. combinatus,* its junior synonym, from Newfoundland. The Nearctic distribution of *L. rhombicus* ranges from the Yukon Territory to Colorado, east to Greenland and Illinois, including Minnesota, Wisconsin, Michigan, Saskatchewan, New York, Hudson Bay, Maine, and Nova Scotia (Ross 1944). New records from Watercress Marsh, Ohio (MacLean and MacLean 1984) and from West Virginia (Tarter and Hill 1980) have expanded its distribution and West Virginia records may represent its southern limit. We studied all life stages and biology of *L. rhombicus* from Big Spring Creek, Cumberland County, in south-central Pennsylvania. In this paper we present descriptions of the egg, five larval stages, pupa, and adults of *L. rhombicus* and our observations on its biology. Adult and pupal descriptions are abbreviated since adequate descriptions are provided by Vorhies (1909) and Ross (1944) for adults and Lloyd (1921) for pupa.

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[4]The Frost Entomological Museum, Department of Entomology, The Pennsylvania State University, University Park, PA 16802.

MATERIALS AND METHODS

A population of *L. rhombicus* in Big Spring Creek, West Pennsboro Township, Cumberland County, Pennsylvania, was studied throughout 1975 (Hoopes 1976). Big Spring Creek rises at 165 m elevation as a large spring from a limestone aquifer and flows north 7.6 km to its confluence with Conodoguinet Creek north of the village of Newville.

Larvae of *L. rhombicus* were reared to adults in the laboratory using a modification of Wiggins' (1959) technique. Larvae collected in the field were kept in water filled jars, placed in an ice filled cooler, and transported to the laboratory with an excellent survival rate. Larval transport usually took three hours. In the laboratory each larva was placed in a closed cylindrical nylon screen cage (20 x 4 cm), with fragments of the living plant materials from Big Spring Creek added to each cage. The larvae obtained food and material for case construction from these plant materials. The cages were placed upright in a continuously aerated aquarium with 5-7 cm of the top of the cylinder above water. Water temperature was kept at 20-22°C. Water and plant material were frequently added as needed. Pharate adults (sensu Wiggins, 1977) swam to the surface of the water within the cage and crawled up the inside of the cage where the adult would emerge and rest on the lid. Although oviposition behavior of *L. rhombicus* was not observed, eggs were collected.

Drawings were prepared from specimens preserved in 70-80% ethanol. Measurements were made by an eyepiece micrometer in a stereo binocular microscope calibrated with a stage micrometer. Laval measurements were made on about 30 specimens for each instar except the first-stage larva for which 15 specimens were examined.

The larval gill arrangement was described by the location and number of gills on each abdominal segment: Dorsal - dorsal position, Ventral - ventral position (both closest to the midline); Dorsolateral, ventrolateral - positioned closer to the lateral margin of each segment; thus, "Dorsal: II-1,2" refers to the dorsal position of abdominal segment 2 with one anterior and two posterior gills."

We followed the terminologies of Ross (1944) for wing venation, and of Ross (1956) and Wiggins (1977) for larval chaetotaxy rather than those of Williams and Wiggins (1981) and Denis (1984) because their terminological simplicity was more suitable for this paper. The fine structural detail of larvae as examined by Denis (1984) and the setal nomenclature and homologies as proposed by Williams and Wiggins (1981) were considered beyond the scope of this paper and not followed.

Study specimens are deposited in the collections of the Frost Entomological Museum, The Pennsylvania State University, and the National Museum of Natural History, Washington, DC.

Life Stages of *Limnephilus Rhombicus*

EGGS (Fig. 1): Eggs were yellowish brown and contained a clear, globular, gelatinous matrix at oviposition.

FIRST-STAGE LARVA (Fig. 2): Total length 1.93-2.77 mm. Body with sclerites concolorous brown and membranes whitish. **Head:** Fronto-clypeus indistinct pale area laterally; chaetotaxy in simple arrangement with 4 setae on head posterior to eyes, 2 long setae between eyes and frontal

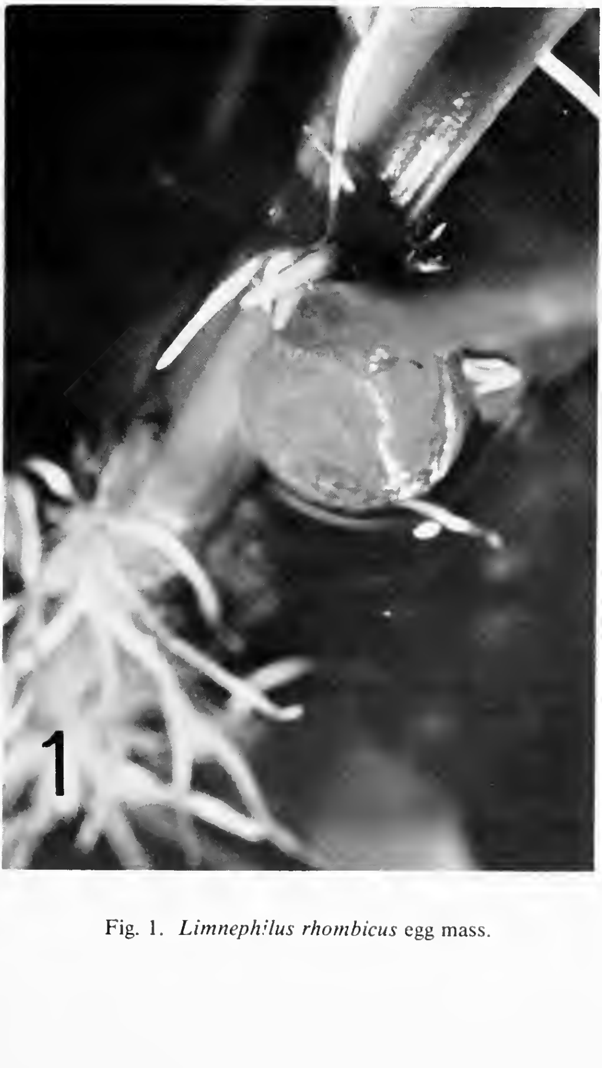


Fig. 1. *Limnephilus rhombicus* egg mass.

suture, longer than head, 2 setae posterior to each eye, 4 setae on anterior margin of fronto-clypeus, 2 lateral setae at constriction of stripe on fronto-clypeus, 4 setae across labrum, and one seta on gena at base of each mandible. **Thorax:** Tergites brown with pronotum and mesonotum posteriorly black; pronotal setal tufts distinct, each with 1-2 setae; mesonotum with distinct setal tufts each with 1 seta; metanotal setal tufts each with 1 seta, each tuft surrounded by a discrete sclerite. **Abdomen:** Pale creamy, segment 1 with 1 seta on each side dorsally and ventrally, 1 seta on dorsal and ventral faces of lateral spacing humps; segment 2 with one seta on each lateral margin; segments 3 to 8 with sparse lateral fringe of filaments; notum of segment 8 with 2 setae; tergite of segment 9+10 with 6 setae, 2 on meson longer than length of segment 8, lateral pairs half that length; lateral sclerites of anal legs each with 4 posterior setae, 1 as long as width of abdomen, others half to one-third that length and 1 lateral seta; no gills present on abdomen.

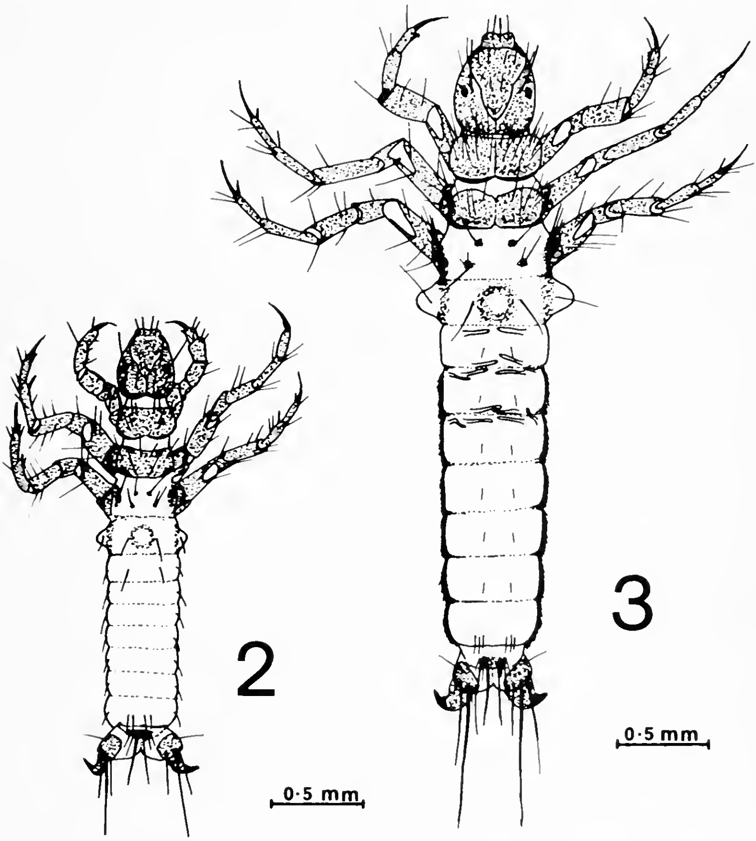
Case.-Constructed of moss stems loosely placed tangential to the cylindrical case; length 2.0-2.67 mm.

SECOND-STAGE LARVA (Fig. 3): Total length 2.75-4.5 mm. Similar to the first instar, unless stated otherwise. Tergites brown with some indistinct pale areas. **Thorax:** Pronotal setal tufts 1, 2, and 3 masked by 14-16 setae on anterior half of tergite. Mesonotal setal tufts 1 and 2, each with 1-2 setae; tufts 3 each with 3 setae. Metanotal setal tufts surrounded by discrete tergites, tufts 1 each with 1 seta, tufts 2 and 3 each with 2-3 setae. **Abdomen:** Creamy; segment 1 with 1 seta on each side dorsally, 2-4 setae ventrally, 1 seta on each dorsal and ventral face of lateral spacing humps; segment 2 with one seta laterally; segments 3 to 7 with 2 setae dorsally; segment 8 with 6 setae; tergite of segment 9+10 with 4 large and 3 short setae; lateral sclerites of anal legs each with 4 large posterior and 1 short lateral setae; anal claw with a single lateral hook.

Gill Arrangement.-Dorsal: II-1, 1; III-1, 1; IV-1, 0; dorso-lateral; II-0,0;III-0 or 1, 1; ventral: II-1, 1;III-1, 1; IV-0 or 1, 0 or 1; ventro-lateral: II-0, 1.

Case.-Similar to that of 1st instar, but plant material more tightly bound; length 1.6-5.0 mm.

THIRD-STAGE LARVA (Fig. 4): Total length 3.4-6.5 mm. Body sclerites yellow with brown pattern. **Head:** Yellow with dark "V"-shaped band on gena contiguous with frontal suture anteriorly but distinct from frontal and epicranial sutures at their junction, fading posteriorly; posterior margin of head brown. Fronto-clypeus with central brown stripe expanded anteriorly; setal pattern complex, with 6 setae arranged transversly on head posterior to eyes, 2 setae between eyes and frontal suture and 1 on gena at base of mandibles; fronto-clypeus with 4 setae on anterior margin, 2 lateral of central stripe, 2 near vertex; labrum with 4 setae across middle, tufts of hairs on antero-lateral corners; mandibles black with 1 lateral seta near base. **Thorax:** Protergite with anterior third dark brown, middle third yellow, posterior third yellow mottled with brown, and its posterior margin black interrupted by pale meson; pronotal setal tufts indistinct with 8 setae in yellow band, 20 setae in anterior brown band; mesotergite light brown with darker mottling; with setal tufts distinct, tufts 1 with 1 seta, tufts 2 each with 3 setae, and tufts 3 each with 5-6 setae; metatergites brown with distinct setal tufts, tufts 1 and 2 each with 4 setae and tufts 3 each with 7 setae anteriorly on an elongate tergite. **Abdomen:** Creamy; segment 1 with 3-4 setae on each side dorsally, lateral spacing humps with 3 setae dorsally and 2 on ventral faces, 6 setae on venter; tergite of segment 9+10



Figs. 2, 3. *Limnephilus rhombicus.* 2. First-stage larva; 3. second-stage larva.

with 4 long and 6 short setae; lateral sclerites of anal legs with 4 long and 2 short posterior setae and 1 lateral seta; claws with 2 hooks and 3 minute dorsal and 2 ventral setae.

Gill Arrangement. Dorsal: II-1 to 2, 2; III-2, 2; IV-2, 1-2; V-1, 1 or 0; VI-1 or 0, 1 or 0; VII-0 or 1, 1; dorso-lateral: II-1; III-2, 0; IV-0-1, 0-1; ventral: II-2, 2; III-2, 2; IV-2, 1; V-1, 1; VI-1, 1; VII-1, 0; ventro-lateral: II-0,2.

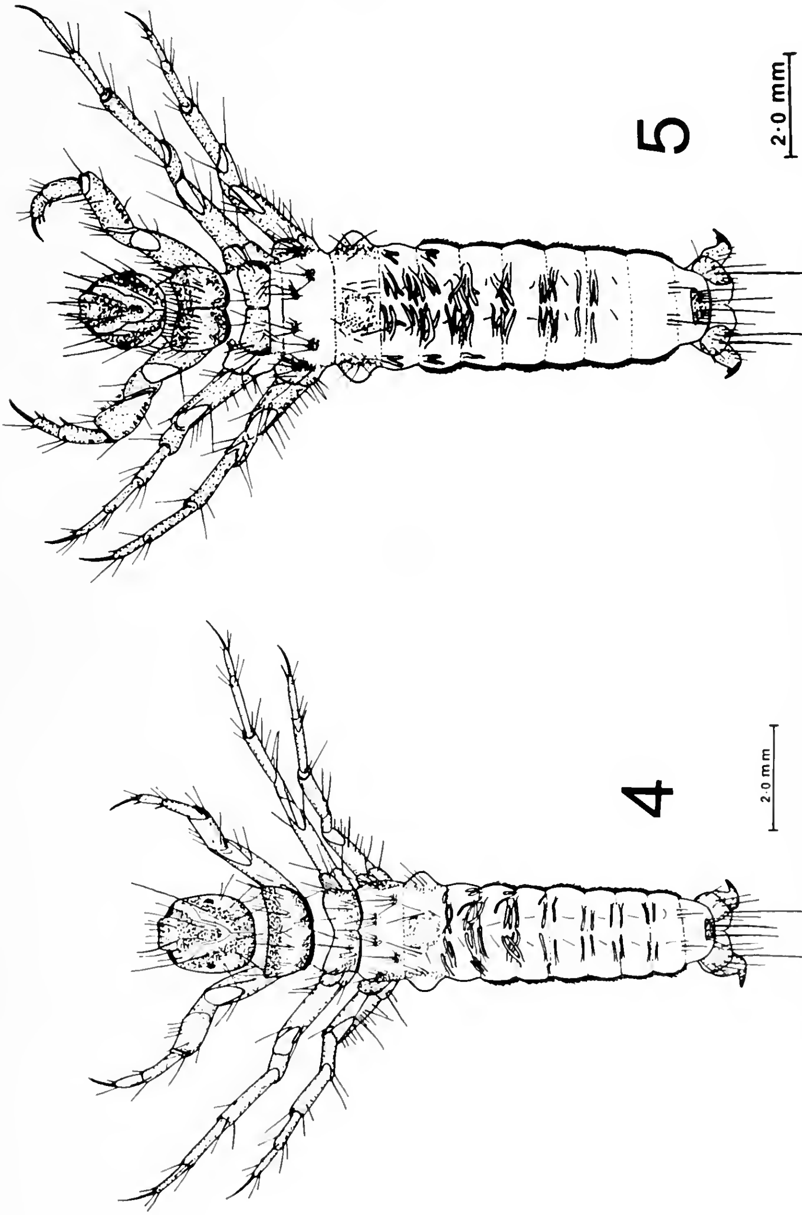
Case. Constructed as in 2nd instar; length 3.0-7.5 mm.

FOURTH-STAGE LARVA (Fig. 5): Total length 7.4-12.5 mm. **Head:** Same as in the third-stage larva but with one more seta between the eye and frontal suture. **Thorax:** Color pattern and chaetotaxy as in 3rd instar, unless stated otherwise; pronotum with more setae, 12-16 setae in transverse yellow band and 24-28 setae in anterior brown band; mesotergite light brown, some darker mottling, with setal tufts distinct, tufts 1 with 2 setae, tufts 2 each with 3-4 setae, and tufts 3 each with 5-6 setae; metatergites with distinct setal tufts, tufts 1 and 2 each with 4 setae, and tufts 3 with 7 each anteriorly on elongate tergite. **Abdomen:** Setae more numerous than in 3rd instar; segment 1 with 4-6 setae on each side dorsally, 7-9 setae on dorsal, 2-3 setae on ventral faces of lateral spacing humps and 14-16 setae on venter; segment 2 with 1 lateral and 2 ventral setae; segments 2 to 7 with 2 setae dorsally; segment 8 with 6-7 setae on posterior margin; segments 3 to 8 with dense lateral fringe of hairs; segment 9+10 with 4 long and 10-12 short setae; lateral sclerites of anal legs with 4 long and 6-8 short setae posteriorly; claw with 3 dorsal setae and accessory hooks.

Gill Arrangement.-Dorsal: II-3, 3; III-3, 3; IV-3, 2; V-2, 2; VI-2, 2; VII-1 to 2, 0; dorso-lateral: II-2, 0; III-2 to 3, 0; IV-0 or 2, 0; ventral: II-3, 3; III-3, 3; IV-3, 3; V-2, 2 to 3; VI-2, 2; VII-2, 1; ventro-lateral: II-0, 2-3; II-0, 1-2; IV-0, 1; V-0, 0 or 1; VI-0, 0 or 1.

Case. Similar to the case of 3rd instar; length 8.1-13.1 mm.

FIFTH-STAGE LARVA (Figs. 6, 8): Total length 11.5-22.8 mm; creamy on membranous areas, ground color yellowish patterned with brown on sclerites. **Head:** Coloration same as in 3rd and 4th instars. Setal pattern: 6 on head posterior to eyes, 2 long and 1 short between each eye and frontal sutures, 1 on gena at base of each mandible, 8 setae on fronto-clypeus; 4 on anterior margin, 2 laterad of central stripe, 2 near vertex; labrum with 4 setae across middle, tufts of hairs on antero-lateral corners; mandibles black, with 1 lateral seta near base. **Thorax:** Colored as in 3rd and 4th instars. Setal tufts of protergite masked by 20-28 setae in central yellow band, 24-32 setae in anterior brown band; mesotergite yellow, mottled with dark brown, posterior margin black; setal tufts 1, 3 distinct with 4 and 10-14 setae respectively; setal tufts 2 united into band of setae; metatergites discrete, brown, surrounding distinct setal tufts; tufts 1 each



Figs. 4, 5. *Limnephilus rhombicus*. 4. Third-stage larva; 5. Fourth-stage larva.

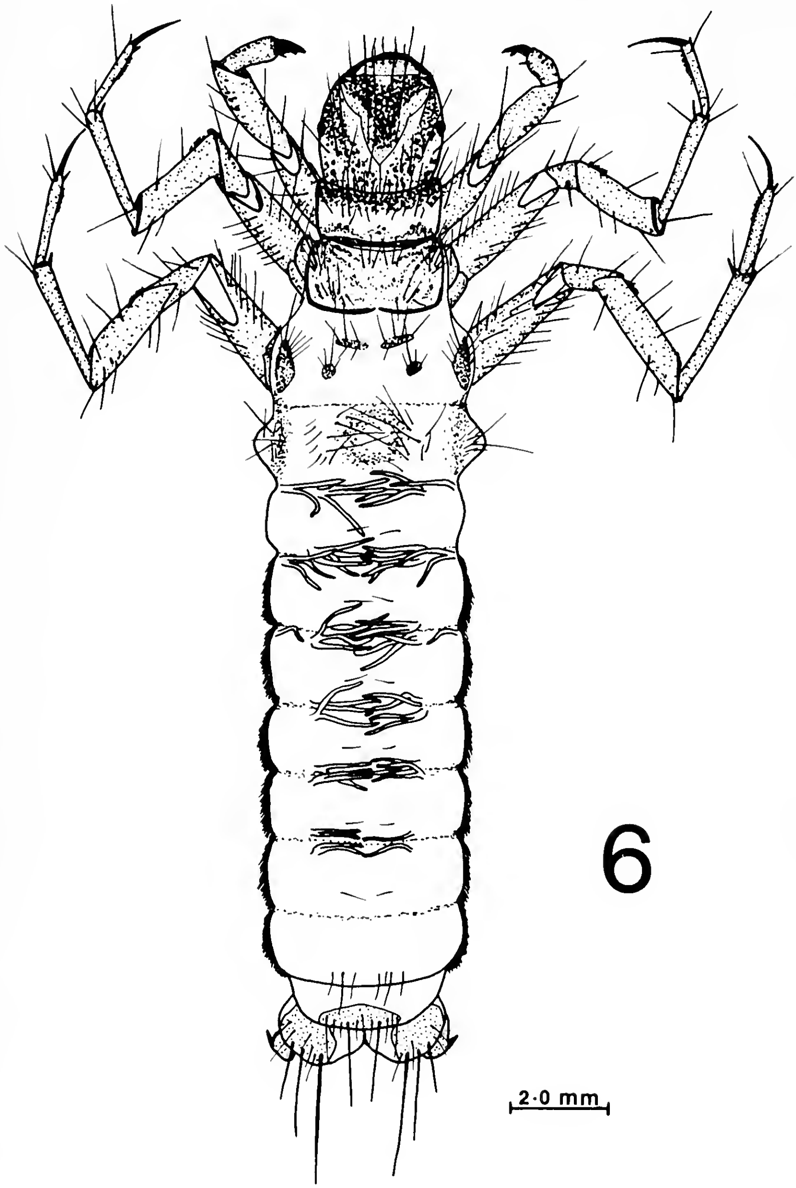


Fig. 6. *Limnephilus rhombicus,* fifth-stage larva.

with 6 setae; tufts 2 each with 4 setae. **Abdomen:** Creamy colored; segment 1 with dorsal and lateral spacing humps. Setal arrangement masked by a profusion of setae; 12-14 setae on each side dorsally, 16-18 setae on dorsal and 6 setae on ventral faces of lateral spacing humps, 50 setae ventrally, setae of other segments as in instar 4.

Gill Arrangement.-Dorsal: II-3, 3; III-3, 3; IV-3, 2; V-3, 2; VI-2, 0 or 1; VII-1, 0; dorso-lateral: II-1-2, 0; III-2 to 3, 0; IV-1, 0; ventral: II-3, 3; III-3, 3; IV-3, 3; V-2 to 3, 2; VI-2, 2; VII-2, 1; ventro-lateral: II-0, 3; III-0, 2; IV-0, 1.

Case. Stems of moss or gravel or both placed tangentially to cylindrical core, length 12.5-22.0 mm.

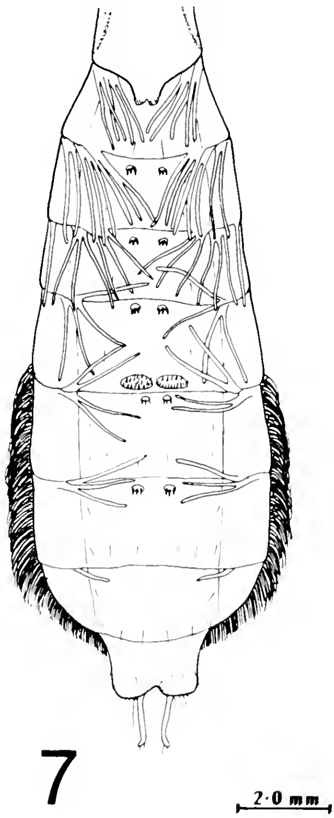


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Fig. 7. *Limnephilus rhombicus*, pupal abdomen.

PUPA: (Figs. 7, 9): Total length 15.5-16.5 mm; body pale yellowish, creamy (Fig. 16). **Head** with 9 pairs of setae; labrum with 5 pair of long hooked setae across middle; mandibles simple, slightly notched on basal mesad margin with 2 setae laterally on base. **Thorax:** Meso- and metalegs modified for swimming with long hairs; pro-, meso-, and metatibia with spur formula 1, 3, 4, respectively, protibial spur short. **Abdomen** (Fig. 7): Gill

Fig. 8. *Limnephilus rhombicus,* fifth-stage larva feeding on aquatic moss.

Fig. 9. *Limnephilus rhombicus,* puparium showing extension of anterior end with stones.

filaments 2-3 per cluster, decreasing in length, thickness, and number on posterior segments; paired hook bearing plates on segments 3 to 7; 3 hooks on anterior plates of segments 4-7, 2 hooks on anterior plates of segment 3 and posterior plates of segment 5 each with 16 hooks.

Gill Arrangement.-Dorsal: II-3, 3; III-3, 3; IV-3, 3; V-3, 2; VI-2, 2; VII-2, 0; dorso-lateral: II-3, 0; III-3, 0; IV-1-2, 0; ventral: II-3, 3; III-3, 3; IV-3, 3; V-3, 3; VI-2, 2; VII-2, 2; ventro-lateral: II-0, 3; III-0, 2; IV-0, 1; V-0, 0; VI-0, 0 or 1.

ADULT (Fig. 10): Body brownish yellow to rufous. **Head** with compound eyes black, large, three-fourths length of head, with posterior linear warts bearing brown macrosetae; 3 ocelli present, with 4 warts dorsally, 2 anterior and 2 posterior to lateral ocelli, each bearing several macrosetae. **Thorax** yellow to rufous, massive; prothorax pale dorsally, darker ventrally, with a large wart on each side of pronotum, covering most of dorsum with 7-8 brown macrosetae and numerous small, pale setae. Mesothorax brownish yellow, warts paler, sutures darker; scutum with 8-10 macrosetae on longitudinal yellow warts on each side of meson; scutellum with pale rhomboidal area in apex bearing 8 macrosetae and a few smaller setae. Mesoplurae without setae except on postero-ventral margin; metanotum and basalaries without setae; metaplurae without setae except on postero-ventral margin. **Legs:** Femur, tibia, and tarsi, with

Fig. 10. *Limnephilus rhombicus*, adult.

numerous minute, brown setae; profemur with 2 apical spurs on ventral face; basitarsus longer than second tarsal segment with a yellow apical spur. **Forewings** pale yellow with distinct brown pattern; length 14.8-18.3 mm; costal, subcostal and R_2 cells pale; stigma faintly brown; cells r_3, r_4, r_5, and m_1 with apical two-thirds brown interrupted by pale spots; cells m_2, m_{3+4}, and cu_1 completely brown interrupted by pale areas; cell r_{2+3} faintly brown apically and basally; radial cell posterior to junction of r_{2+3} and r_{4+5} and basally in median cell with large triangular brown area; radial and median cells basally from junction of m_{3+4} with m_{1+2} with a large rhomboidal brown area with brown spot posterior to rhomboidal brown area; cell cu_2 brown apically and anal cell entirely brown; hindwing entirely pale, minute brown hairs sparsely covering wing, hairs longer on margins and apical veins. **Abdomen** brownish yellow, venter with setous posterior margins, especially posterior segments.

FEMALE GENITALIA: Notum of segment 8 setous; median process of ventral genital plate longer than lateral lobes; cerci long, finger-like processes, widely separated at bases by a small lobe. Venter of segment 9 produced posteriorly, conical, bilobed, setous, and widely separated on meson. Segment 10 cylindrical, sclerous, setous posteriorly, cleft nearly to base dorsally, with a shallow emargination ventrally.

MALE GENITALIA: Notum of segment 8 lobed, slightly produced posteriorly, covered with short black pegs; cerci blade-like, rhomboidal, concave mesad, with dorsal margin longer than the ventral; ventral and posterior margin of cerci black toothed. Venter of segment 9 cleft on meson, posterior margin with setae. Clasper produced posteriorly with long black setae. Tergite of segment 10 bilobed, black, blade-like processes. Ventral arms of aedeagus slender basally, broad in middle, tapering apically to fine point bearing several teeth with a cylindrical central process.

Biology

Observations of *L. rhombicus* in Big Spring Creek, Cumberland County, Pennsylvania, provide new details of its biology. Water quality, temperature and discharge of Big Spring Creek did not fluctuate greatly throughout the year: pH 7.5 ($\bar{x}$), range 7.3-7.8; total hardness 168 mg/1 ($\bar{x}$), range 140-190 mg/1; alkalinity 153 mg/1 ($\bar{x}$), range 115-170 mg/1; dissolved oxygen 10.8 mg/1 ($\bar{x}$); range 9.5-11.2 mg/1; and temperature 10.3°C ($\bar{x}$), range 10.0-10.8°C. The stream produces lush growths of autochthonous vegetation, particularly waterweed (*Anacharis canadensis*), curlyleaf pondweed (*Potamogeton crispus*), watercress (*Nasturtium officinale*), speedwell (*Veronica anagallis aguatica*), water starwort (*Callitriche* sp.) and water mosses (*Fontinalis* sp., *Fissidens* sp.). Channels eroded through extensive beds of vegetation and the velocity in these channels was rapid and transported sediments leaving clean gravel bottoms, while the velocity was greatly reduced in weed beds and sediment built up many centimeters deep. Retarded stream flow in the weed beds also led to greater fluctuations in water temperature than in the flowing water in the adjacent channels; during cold weather thin layers of ice sometimes formed over the surface of water and vegetation in these areas of low flow.

Oviposition occurred from late September until November, with the peak in October. On warm, still afternoons in October, adults were seen flying over the surface of the water and weed beds. Clear, gelatinous egg masses bearing 150-300 eggs were found at the water surface on emergent stems of watercress (Fig. 1). Sometime after oviposition the gelatinous egg masses began to liquify and flow down the stems into the water.

Larval growth was very rapid. They fed primarily on watercress and water mosses (Fig. 8) but also consumed dead sculpins (*Cottus cognatus*). By the end of November 1975 no egg masses could be found and most larvae were second, third and fourth instars. Later instars consumed large amounts of vegetation, primarily living water mosses, reducing the once extensive leafy mats to barren areas of stems. Stems were used to construct cases by placing them transversely, tangential to the cylindrical core of silky secretion.

Pupae were collected as early as December, but most pupation occurred during late March and early April. After much growth, fifth instars moved from the extensive beds of vegetation to the gravel bottom channels of more rapidly flowing water. There, fifth instars added gravel to the anterior end of the case. Some larvae added only pieces of gravel on the anterior and posterior end of the cases made from moss stems; others constructed entire cases of gravel and removed posterior portions of moss stems (Fig. 9). Larger gravel, added to the anterior end of the case, oriented the long axis of the case parallel to the flow of the water. Silken meshes were placed over both ends of the case to complete the puparium.

Adult emergence began by early May and continued at least through June. Details of emergence were observed on 8 May 1975. Pupae cut through the end or side of the puparium and swam about vigorously until they encountered an object, frequently mosses, projecting through the surface film. Pupae climbed up on the surface of the moss and remained still for several minutes. Then by swelling the adult thorax, the ecdysial sutures were split. Continued swelling and undulations freed the adult from the pupal exuvium in 30-60 seconds. Adults, without color pattern, remained on the moss until their wings were sufficiently dry to support flight; some were motionless, whereas others walked about. Many toads gathered on the moss beds snapping up pupae and adults as they appeared on the moss surface.

In captivity adults embibed quantities of water and developed distinctive color patterns after several hours (Fig. 10). In Pennsylvania adult flight has been observed from 8 May to 23 December. Seasonal flight activity appeared bimodal, with one mode at emergence and one at oviposition.

DISCUSSION

Wiggins (1977) suggested that *Limnephilus* larvae can be separated into two distinct groups; those with contrasting light and dark color bands on the head and thorax and a second group lacking contrasting color but having prominent spots. While *L. rhombicus* clearly belonged to group 1 on the basis of color pattern in instars III, IV and V, it was not so with first and second instar larvae, which had head and pronotum concolorous brown with indistinct pale areas. The key character used for *Limnephilus* by Wiggins (1977) is on gill number. As Wiggins noted, the increasing number of gills, in both the number per cluster and occurrence on segments, may change at each instar. However, gill number was a good diagnostic character for instars IV and V of *L. rhombicus* from Big Spring Creek.

Instars of *L. rhombicus* can be distinctly separated by color pattern and size of tergites. Novak and Sehnal (1963) showed a similar analysis of head capsules for this species in Europe. A large larva with head capsule width of 1.55 mm was collected in July (Karl and Hilsenhoff 1979). A head capsule of that size would be between those of the fourth and fifth instar using the head width shown by Novak and Sehnal (1963). This suggests that sclerotized structures may be useful to separate instars in a population but not for the species.

The general lotic habitat of *L. rhombicus* may be described from observations at Big Spring Creek and other published accounts. The most obvious common denominator of Big Spring Creek and other reported sites was an abundance of aquatic vegetation or organic detritus (Hickin 1967; Higler 1975; Karl and Hilsenhoff 1979; Lloyd 1915, 1921; Otto 1976; Slack 1936, Vorhies 1909). Hickin's (1967) description of the duration of various life stages in a natural habitat showed temperatures from 10-15°C which suggest minimum temperatures comparable to Big Spring Creek. Such temperature regimes were not universal. Otto (1976) found low survival of larvae in a stream with temperatures of 4.4°C; however, Novak and Seknal (1963) reported temperatures falling to 0°C in *L. rhombicus* habitats. Larvae, being unable to withstand currents stronger than 9 cm/sec (Otto 1976, Higler 1975), tended to remain in and feed on submerged or marginal vegetation where currents were reduced. The increased oxygen consumption of larvae exposed to currents (Roux 1979, Otto 1976) suggests a bioenergetic saving from avoiding currents. Fifth instar larvae at the prepupa stage, however, move into stronger currents with gravel substrates and construct a partial or complete case of gravel (Roux 1979, Cobb et al. 1984). Perhaps the increased weight of the gravel case reduces the energy expended while larvae were active in the stronger current. The larger gravel observed on the anterior end of *L. rhombicus* puparia from Big Spring Creek would further stabilize the case and provide an orientation parallel to the current for efficient water flow through the case.

L. rhombicus must be considered a facultative omnivore. In Big Spring Creek the primary food was aquatic plants, mainly mosses. When deprived of vegetation or when vegetation has been depleted from over grazing, larvae consume a variety of organic matter from dead sculpins to other living trichopterans including their own species.

The adult emergence at Big Spring, lasting from early May through June, was consistent with the flight periods observed in Wisconsin (Longridge and Hilsenhoff 1973), Ohio (MacLean and MacLean 1984), Manitoba (Cobb et al. 1984), West Virginia (Tarter and Hill 1980) New York (Lloyd 1915, 1921), Minnesota (Elkins 1936) and Michigan (Leonard and Leonard 1949). Based on the Rothamsted Insect Survey, Crichton and Fisher (1981) assigned *L. rhombicus* to a group of caddisflies having an extended flight period and normally with a diapause from spring through summer into autumn. This was consistent with the bimodal flight period observed at Big Spring Creek. Denis (1981) suggested that the length of diapause is related to the photoperiod experienced by the females and also the larvae.

The deposition of egg masses above and away from water in Big Spring Creek was similar to that observed by Hickin (1967) and Novak and Sehnal (1963). They also suggested that larvae can hatch and live within the gelatinous egg mass until submerged in water. This was not observed at Big Spring Creek where eggs were most frequently observed on the stems of watercress at the water surface. Vorhies (1909) observation of small larvae (we assume he meant early instars) in July seems suspect.

Biological attributes, such as diapause, oviposition away from water and a gelatinous matrix that protects eggs from desication and freezing, are important adaptations for caddisflies in temporary pools (Wiggins 1973). *L. rhombicus* possesses these attributes, while inhabiting permanent spring-fed streams. *L. rhombicus* shares many characteristics of the limnephiline species, such as *L. individus* (Wiggins et al. 1980), which inhabit temporary pools or transient aquatic habitats. Thus, this species represents the limnephiline with a specialized habitat, perhaps derived from a more generalized Limnephilinae which goes through adult diapause.

L. rhombicus is known in Pennsylvania only from the Cumberland Valley where there are many limestone aquifers. Critical to further understanding of its biology is the clarification of habitat specialization in this species; especially the degree of dependance on spring-fed streams with an abundance of autochthonous aquatic vegetation and relatively stable water temperatures.

Casual collectors who study limnephilid larvae must be cautious because early instars are not always what they appear to be due to changes in coloration, setation, and gill arrangement. Wiggins (1977) noted that his keys were based on descriptions of the final instar and he suggested diagnostic characters may be less effective for earlier instars. The descriptions presented here for the five larval instars of *L. rhombicus* indicate clearly a limit to the utility of Wiggins' (1977) larval keys.

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NEW HYDROPTILIDAE (TRICHOPTERA) FROM FLORIDA[1,2]

S.C. Harris[3], B.J. Armitage[4]

ABSTRACT: Two new species of microcaddisflies, *Oxyethira kelleyi* and *Ochrotrichia okaloosa,* from the panhandle region of Florida are described and illustrated.

The panhandle region of northern Florida has long been noted for its large number of endemic plants and animals (Neill, 1957). *Agarodes ziczac* Ross and Scott and *Cheumatopsyche gordonae* Lago and Harris are caddisflies endemic to this area. If the panhandle region is expanded slightly to include physiographically related lower Alabama, several other caddisflies can be added, including *Cheumatopsyche petersi* Ross, Morse and Gordon, *Polycentropus floridensis* Lago and Harris, *Nyctiophylax morsei* Lago and Harris, and *Chimarra falculata* Lago and Harris. Microcaddisflies endemic to this area include *Hydroptila parastrepha* Kelley and Harris and *Hydroptila circangula* Harris. Recent blacklight collections by one of us (BJA) on Eglin Air Force Base in northern Florida added two new species to this list of endemic caddisflies.

Type specimens will be deposited at the National Museum of Natural History, Smithsonian Institution (NMNH), Illinois Natural History Survey (INHS), University of Alabama Insect Collection (UA), Florida State Collection of Arthropods (FSCA) and personal collections of the authors (SCH, BJA). Terminology for genitalic structures generally follows that of Marshall (1979).

Oxyethira kelleyi Harris, new species
(Fig. 1)

This species does not fit well into any of the species groups proposed by Kelley (1984), although it has some similarity to *O. elerobi* (Blickle) and members of the subgenus *Holarctotrichia.* *Oxyethira kelleyi* differs strikingly from all other species in the elaborate feathering at the apex of the phallus.

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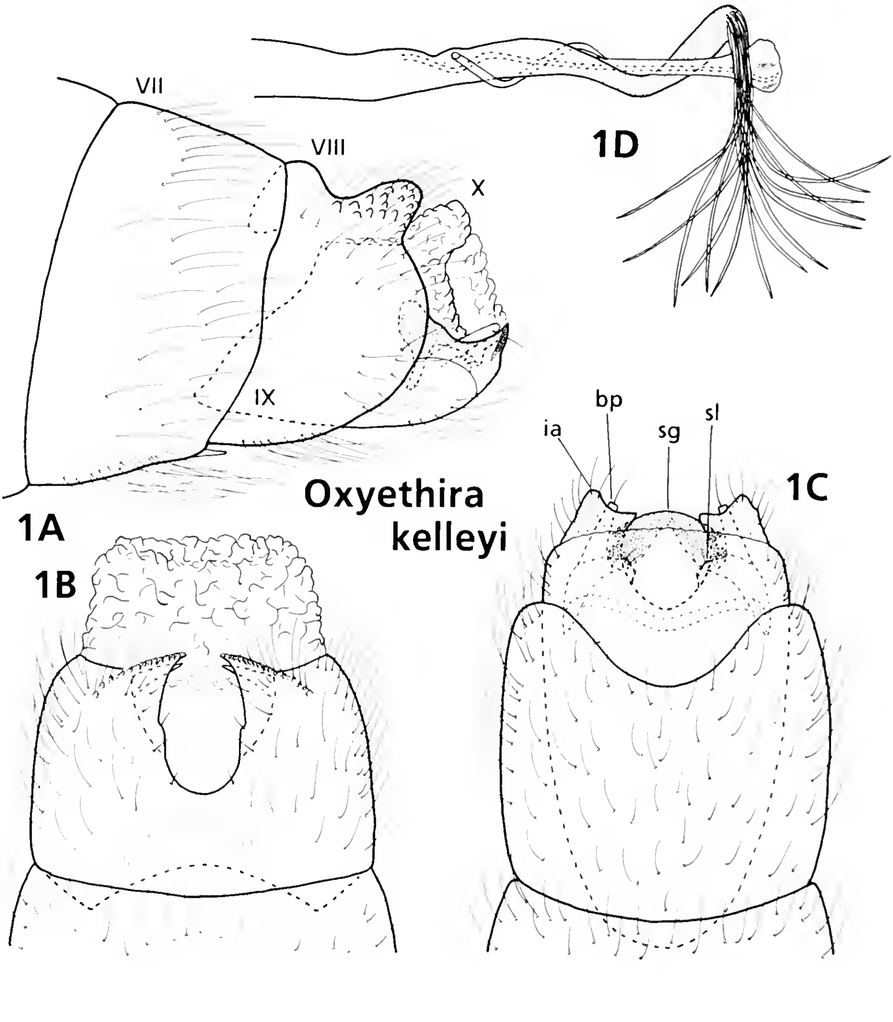

Figure 1. *Oxyethira kelleyi* n. sp., male genitalia. 1A, lateral view. 1B, dorsal view. 1C, ventral view (ia = inferior appendage; bp = bilobed process; sg = subgenital process; sl = setal lobe). 1D, phallus.

Male: Length 1.8-2.2 mm. Antennae with 27 segments. Color brown in alcohol. Venter of abdominal segment VII with short apicomesal process. Segment VIII in lateral view with setose dorsolateral lobe; ventrally with shallow, posterior excision; dorsally with deep, posteromesal incision, the sides of the incision produced into sclerotized, triangular processes. Dorsum segment IX reduced to narrow, semimembranous band; venter produced anteriorly into segment VII. Segment X membranous. Inferior appendages in lateral view short, triangular and heavily sclerotized; widely separated in ventral view. Subgenital process fused ventrally as narrow band; laterally with anteroventral process. Phallus divided into two processes distally, one slender with apical bulb, the other sheath-like ending in elaborate feathering; titillator originating at midlength, extending posteriorly and encircling shaft.

Female. Unknown.

Etymology. Named for Dr. Robert W. Kelley in recognition of his efforts in revising the genus *Oxyethira*.

Holotype ♂. FLORIDA: Okaloosa Co., Turkey Creek at Base Road 233, Eglin Air Force Base, 5.0 mile NW Niceville, 14 August 1985, B.J. Armitage and M.K. Ward (NMNH).

Paratypes. FLORIDA: Okaloosa Co., same locality as holotype, 7 ♂ (NMNH, INHS); Rogue Creek at Base Road 233, Eglin Air Force Base, 3.3 mile NW Niceville, 14 August 1985, 23 ♂, B.J. Armitage and M.K. Ward (NMNH, INHS, UA, FSCA); unnamed tributary to Turkey Creek at Base Road 619, Eglin Air Force Base, 4.6 mile NW Niceville, 14 August 1985, 8 ♂, B.J. Armitage and M.K. Ward (SCH, BJA).

Ochrotrichia okaloosa Harris, new species
(Fig. 2)

This species, only the third *Ochrotrichia,* along with *O. tarsalis* (Hagen) and *O. provosti* Blickle, known to occur in Florida, appears most similar to *O. tenuata* Blickle and Denning. Although the configuration of segment X is similar to *O. tenuata,* a western species, *O. okaloosa* is easily recognized by the large ventromesal lobes of the inferior appendages.

Male: Length 2.7 mm. Antennae broken. Color brown in alcohol. Abdominal segment VIII rectangular. Segment IX trapezoidal laterally; dorsum deeply incised to accomodate segment X; ventrally with deep lateral incisions. Tenth tergum divided into two halves, each with several sclerotized processes. Left component with slender, heavily sclerotized basal process, tapering to acute apex, extending about 1/3 length of segment, in lateral view this process narrow, curving dorsad; lower process narrow and sinuate in dorsal view, in lateral view with ventral lobe at midlength. Right component serrate basolaterally, distally forming a slender, sinuate ventromesal process which lies in a groove formed by convolutions of the left component, laterally forming a slender process, protruding at apex and curving mesad, in lateral view this process bending dorsad. Inferior appendages in lateral view widest at midlength with rounded apex, small projection ventromesally, peg-like setae along ventrolateral surface in distal half; in ventral view mesal projections forming a shelf at midlength, numerous peg-like setae along mesal surfaces in distal half. Phallus simple, tubular, triangular at apex with ejaculatory duct protruding.

Female. Unknown.

Etymology. Named for Okaloosa County.

Holotype ♂. FLORIDA: Okaloosa County, Turkey Creek at Base Road 233, Eglin Air Force Base, 5.0 mile NW Niceville, 14 August 1985. B.J. Armitage and M.K. Ward (NMNH).

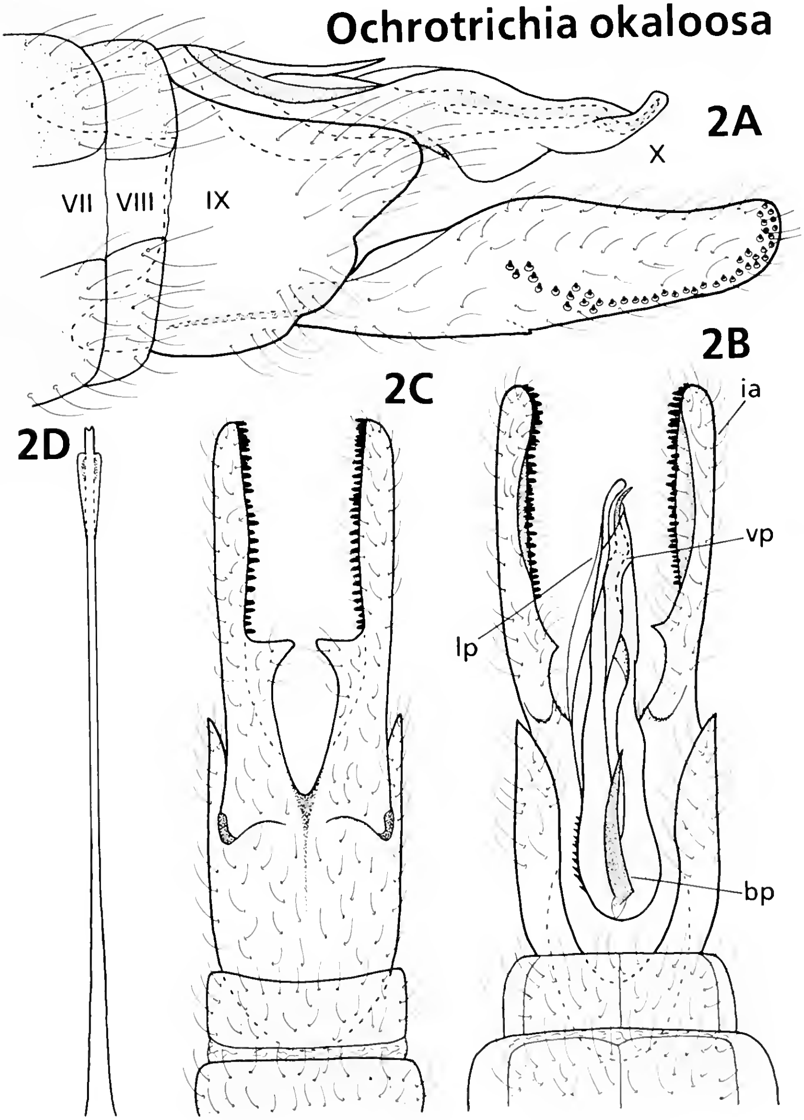

Figure 2. *Ochrotrichia okaloosa* n. sp., male genitalia. 2A, lateral view. 2B, dorsal view (ia = inferior appendage; bp = basal process; lp = lateral process; vp = ventromesal process). 2C, ventral view. 2D, phallus.

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The Geological Survey of Alabama for providing facilities and supplies to the senior author is gratefully acknowledged. R.W. Kelley verified the identity of the new *Oxyethira* and kindly helped in the description. S.W. Hamilton, as well as R.W. Kelley, reviewed the manuscript and offered useful comments. Kathy Ward graciously assisted the junior author in locating the streams on Eglin Air Force Base. Peggy Marsh typed several drafts of the manuscript and Ruth Turner photographed the plates.

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STENELMIS CHERYL: NEW NAME FOR A WELL-KNOWN RIFFLE BEETLE (COLEOPTERA: ELMIDAE)[1]

Harley P. Brown[2]

ABSTRACT: Examination of the cleaned holotype of *Stenelmis bicarinata* LeConte 1852 reveals it to be similar to *S. convexula* Sanderson 1938. The name *Stenelmis cheryl* NEW SPECIES is given to the species treated as *S. bicarinata* by most authors. The holotype of *S. cheryl* N. SP. is from Blanco, Texas; numerous paratypes are from Texas and the Mexican state of Coahuila.

Of about 30 known species of *Stenelmis* in North America, *S. bicarinata* LeConte 1852 is among the most venerable; only *S. crenata* (Say) 1824 is older (Brown 1983). Unfortunately, it turns out that most of what has been reported about *S. bicarinata* actually applies to a different species which is not especially close to the real *bicarinata.* The problem surfaced in July, 1980 when I borrowed the holotype of *S. bicarinata* from the Museum of Comparative Zoology at Harvard. With the permission of then-curator A. Newton, I relaxed and cleaned the encrusted specimen ultrasonically, then extracted and examined the genitalia (happily, it was a male). To my surprise, cleaning revealed a very different appearance than that we all associate with *bicarinata,* and the aedeagus further emphasized the difference. The original description is, of course, still valid (LeConte 1852), but for present-day purposes a redescription and figure of the genitalia will be needed. I shall leave that to Kurt Schmude, who is working on a revision of North American species of *Stenelmis.* The true *bicarinata* keys out to *S. convexula* Sanderson in present keys (Brown 1976, Sanderson 1938), but lacks the secondary sexual character of the male that is typical of most North American species of *Stenelmis*—a spinous ridge on the distal portion of the inside of the middle tibia. My tentative estimate of the geographic range of the true *bicarinata* is from Ohio (type locality) and Indiana south to the Gulf coast and west to Oklahoma and Texas.

As for the species generally identified as *S. bicarinata,* I hereby bestow upon it the name *Stenelmis cheryl* NEW SPECIES in honor of Cheryl Barkley Barr, who is doing excellent work on elmids. For a detailed description, see page 679 of Sanderson (1938), for whom I would have named this species if there were not already a *Stenelmis sandersoni.*

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Briefly, ***S. cheryl*** N. SP. may be characterized as follows: size—length 2.7-3.25 mm; width 1.0-1.25 mm; form and color—elongate, sides of elytra nearly parallel, elytra dark brown to black, each elytron with an entire yellow vitta covering humerus (umbone) and extending inside of sixth interval to near apex; antennae and palpi testaceous to light brown; pronotum with basal tubercle elongate but not carinate; elytra with vittae covering fourth and fifth strial intervals; legs with tarsomere 5 shorter than tarsomeres 1-4 combined.

Holotype: male from the Blanco River at Blanco in Blanco Co., Texas, collected July 27, 1975 by John Mallory Davis.
Paratypes: 31 from the Pedernales River at Johnson City, Blanco Co., TX, collected Aug. 27, 1967 and 13 from the same locality Oct. 5, 1966, all by H.P. Brown; 50 from the San Saba River, Menard Co., TX, May 28, 1969, H.P.B.; 15 from the North Fork of Bosque River at Alexander, Erath Co., TX, May 30, 1969, H.P.B.; 15 from Guadalupe River at Gonzales, Gonzales Co., TX, March 28, 1974, H.P.B.; 44 from Zaragoza, Coahuila, Mexico, May 26, 1969, H.P.B. Holotype deposited in USNM; paratypes in CNCI, FMNH, INHS, LSUC, MCAZ, OSUC, SEMC, SMSH, TAMU, UNAM, USNM, and UWMC (Univ. Wisconsin, Madison; see Brown 1983 for other museum abbreviations).

Geographic distribution as indicated for *S. bicarinata* by Brown (1983); TX: KS OH/ NY PA NJ/ NM TX OK/ Mex. (Coah.). Common to abundant in plains streams.

S. cheryl N. SP. will key out to *S. bicarinata* in available keys (Brown 1976; Sanderson 1938). As explained above, the true *S. bicarinata* will key out to *S. convexula.*

ACKNOWLEDGMENTS

I wish to thank Milton W. Sanderson, Kurt Schmude, and Frank Sonleitner for reviewing the manuscript.

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NEW RECORDS OF CADDISFLIES (TRICHOPTERA) FROM KENTUCKY [1]

M. Ann Phillippi [2], Guenter A. Schuster [3]

ABSTRACT: Six species of caddisflies discovered in eastern Kentucky are added to the previously known fauna of the state. One widespread species, *Heteroplectron americanum,* represents the only species of the family Calamoceratidae known from Kentucky. Other widespread species reported are *Ceratopsyche ventura* and *Diplectrona metaqui* (Hydropsychidae) and *Neophylax fuscus* and *Goerita betteni* (Limnephilidae). One relatively rare species, *Agapetus minutus* (Glossosomatidae), is also reported. The number of caddisfly species now known from Kentucky is 181.

Resh (1975) recorded 175 species of caddisflies from Kentucky. Surber-net collections (Phillippi 1984) from Robinson Forest in Breathitt Co., eastern Kentucky, revealed larvae of two additional species: *Agapetus minutus* (Glossosomatidae) and *Ceratopsyche ventura* (Hydropsychidae). Qualitative collections from five other eastern Kentucky counties (Clark, McCreary, Menifee, Powell, and Whitley) revealed larvae of four additional species: *Diplectrona metaqui* (Hydropsychidae), *Goerita betteni* (Limnephilidae), *Heteroplectron americanum* (Calamoceratidae), and *Neophylax fuscus* (Limnephilidae). There are no Kentucky specimens of these species housed at the University of Michigan Museum of Zoology, Ann Arbor; the Academy of Natural Sciences of Philadelphia (ANSP); the National Museum of Natural History, Washington, D.C. (USNM); the University of Louisville; or the University of Kentucky, Lexington. The specimens reported herein are deposited in the Eastern Kentucky University Insect Collection, Richmond.

Little is known about the habitat of immature *Agapetus minutus.* Three pharate adults were collected on 23 June 1978 in two first-order streams (upper Falling Rock, 5.8 km NE of Noble, Noble 7.5 min Quad; Field Branch, 4 km NE of Noble, Noble 7.5 min Quad) typical of those found in the highly dissected, undisturbed portions of the Cumberland Plateau of eastern Kentucky. The sites lie within the totally forested watersheds of Robinson Forest (Phillippi and Boebinger 1986), a 6000 ha protected forest research station; water quality in the forest is excellent. Substrates consisted of sand, gravel, and cobble with occasional exposed bedrock. Both streams were flowing on the collection date; however, flow may cease during dry summers (Phillippi 1984). Approximately 150 *Agapetus* larvae were

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collected within the fourth-order Buckhorn Creek drainage (11,396 ha). However, differentiation of *Agapetus* larvae (Wiggins 1977) is not presently possible, and the relative abundance of *A. minutus* in the drainage is unknown. One other congener, *A. tomus,* has been reported from Robinson Forest, and three additional species (*A. hessi, A. illini,* and *A,.* nr *rossi*) are known from other widely scattered Kentucky counties (Resh 1975).

The only specimens of *Agapetus minutus* found in the museums previously listed were from White Clay Creek, Chester Co., PA (ANSP). The species also has been reported from extreme southeast TN in Polk Co. (Etnier and Schuster 1979), the northern Piedmont region of DE (Lake 1984), and in central NY in Tompkins Co. (Sibley 1926). These records and ours suggest that *A. minutus* is sporadically distributed in the Appalachain Mountains and Piedmont and Cumberland Plateau. Its apparent sporadic distribution may be due, in part, to the current inability to assign larvae to species.

Other trichopteran species associated with *A. minutus* at the collection sites were *Ceratopsyche sparna, C. ventura, Diplectrona modesta, Dolophilodes distinctus, Neophylax consimilis, Rhyacophila carolina,* and *R. parantra.*

Ceratopsyche ventura is a more abundant and widespread species than *Agapetus minutus.* In Robinson Forest, a total of 277 larval *C. ventura* was collected from six sites in the Buckhorn Creek drainage (23 June 9, 21, July, 22 Aug, 21 Oct 1978; 29 Apr, 1 Aug 1979; 1 Aug 1981). The sites (all Noble 7.5 min Quad) include the two previously mentioned for *A. minutus,* an additional first-order stream (upper Little Millseat, 4.1 km NE of Noble), a second-order stream (lower Falling Rock, 5.3 km NE of Noble), a third-order stream (Clemons Fork, 2.3 E of Noble), and fourth-order Buckhorn Creek (2.3 km SW of Noble). The sites, with the exception of Buckhorn Creek, are located within Robinson Forest and water quality is, therefore, exceptionally high (Phillippi 1984, Phillippi and Boebinger 1986).

Scattered collections of *C. ventura* have been reported from Newfoundland, Ontario, NY, TN, and VA (Schuster and Etnier 1978, Etnier and Schuster 1979). Specimens from WV, PA, and MN were located at USNM. Based on past collections and ours, the distribution of *C. ventura* is sporadic in eastern Canada and broadly scattered throughout the Appalachian Mountains and Cumberland Plateau.

Other trichopteran species associated at the collection sites with *Ceratopsyche ventura* were *C. campyla, C. cheilonis, C. sparna, Diplectrona modesta, Dolophilodes distinctus, Goera* cf. *stylata, Helicopsyche borealis, Hydropsyche betteni, H. dicantha, Molanna blenda, Neophylax consimilis, Rhyacophila carolina,* and *R. parantra.*

Of the 15 North American species of *Neophylax,* five have been reported previously from Kentucky: *N. autumnus, N. ayanus, N. concinnus, N. consimilis,* and *N. nacatus* (Resh 1975). *Neophylax fuscus* (reported herein) is not an unexpected addition to the caddisfly fauna of Kentucky considering its wide range (MI, MN, MO, NH, TN, VA) (Ross) 1944, Etnier and Schuster 1979). Many larvae as well as adults of the species were collected from Boone Creek (Grimes Mill Road crossing, 3 km above mouth, Ford 7.5 min Quad) in Clark County on the western edge of the Cumberland Plateau (10 October 1983). Other caddisfly species also found at the site were *Dolophilodes distinctus* and *Pycnopsyche lepida.*

Numerous larvae of *Heteroplectron americanum* were collected 9 April 1983 from the mouth of an unnamed first-order tributary of Rock Creek in McCreary Co. (Great Meadows Campground on KY 1363, 13 km SSW of Whitley City, Bell Farm 7.5 min Quad). The stream was low gradient with a sandy bottom thickly littered with detritus. Previously, the species was known from Quebec, NY, NH, (Wiggins 1977), NC (Brigham et al 1982), SC (Morse et al 1980), VA (Parker and Voshell 1981), DE (Lake 1984), and GA (Etnier and Schuster 1979). This is the only record of a member of the Calamoceratidae from Kentucky.

Goerita betteni is apparently a localized (Wiggins 1977) Appalachian species previously known from NC, OH, PA, TN, VA, and WV. It has also been taken from three localities in Kentucky: a first-order tributary to the Cumberland River in Cumberland Falls State Park, Whitley Co. (adults and larvae; 18 May 1985), an unnamed first-order tributary to Gladie Creek (off KY 716, Pomeroyton 7.5 min Quad), Menifee Co. (larvae; May 1985) and a first-order tributary to Rock Creek, McCreary Co. (larvae; 9 April 1985; 1 km above Great Meadows campground on KY 1363, approx. 13 km SSW of Whitley City, Bell Farm 7.5 min Quad). Each collection site was a high gradient, permanent, first-order stream with a sandstone substrate. Larvae were collected on the vertical faces of falls and dripping areas and were associated with bryophytes and filamentous algae. Adults were collected while swarming around a 1.5 m waterfall (Whiley Co. site) at 1130 hr. Caddisfly species associated with *G. betteni,* were *Diplectrona metaqui* and *Psilotreta rufa.*

Several larvae of *Diplectrona metaqui* were also collected from a first-order tributary to Rock Creek in the vicinity of the McCreary Co. site mentioned for *G. betteni.* Larvae of this species also have been taken from Powell Co. in a first-order tributary to the Red River (11 Nov 1979; on KY 77, 10 km NNE of Nada Tunnel, Slade 7.5 min Quad). At both sites the habitat consisted of an intermittent, high gradient, first-order stream underlain with sandstone rubble. The larvae were collected under rocks in moist (not flowing) areas. Ross (1970) and Wiggins (1977) listed

Kentucky as part of the range of this species but no localities were given. Resh (1975) did not list the species for Kentucky. The species appears to be sporadically distributed in the eastern U.S. including GA, IL, IN, NC, TN.

Each of the six species reported herein was found in (or at the western edge of) the Cumberland Plateau of eastern Kentucky. Further collecting in this highly dissected and mountainous geographic area may yield new records of additional caddisfly species presently unknown from Kentucky.

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STUDIES ON THE AUSTRALIAN CICINDELIDAE VI: A REVIEW OF THE SUBGENUS *RIVACINDELA* OF THE GENUS *CICINDELA* (COLEOPTERA)[1]

William D. Sumlin, III[2]

ABSTRACT: The subgenus *Rivacindela* of the genus *Cicindela* is reviewed and all known species are illustrated. A key is provided for members of the subgenus. The subgenus is redefined and six new species are described: *Cicindela salicursoria* n. sp., *C. cardinalba* n. sp., *C. ozellae* n. sp., *C. velox* n. sp., *C. collita* n. sp. and *C. vannideki* n. sp.

The genus *Rivacindela* was erected by van Nidek (1973) to contain the species *Cicindela blackburni* Sloane and *C. igneicollis* Bates. In the same paper, he speculated that *C. saetigera* W. Horn and *C. browni* Sloane both belonged to the genus, but did not place them due to a lack of material. Freitag (1979), in his review of Australian *Cicindela* (sensu W. Horn), synonomized the name *Rivacindela* and reverted to calling the species complex by the name "*igneicollis* group" as practiced by Sloane (1906) and W. Horn (1926). Sumlin (1981) recalled the name from synonomy and recognized it as a valid subgenus. Freitag's (1979) study was based upon ca. 57 specimens. The current paper, based upon 305 specimens, redescribes all known species and describes six new species. I feel the redescriptions are necessary because two of the taxa (*C. blackburni* and *C. saetigera*) treated by Freitag (1979) were composites encompassing two additional taxa. Much of the data in the current paper was developed during my expeditions to Australia in 1978-1979 and 1985.

MATERIALS AND METHODS

The specimens comprising this study represent the majority of those studied by Freitag (1979) and many that I collected in 1979 and 1985. Material was borrowed from the following institutions and individuals: Australian National Insect Collection, CSIRO, Canberra, A.C.T., Australia (ANIC); British Museum (Natural History), London, England (BMNH); Institut für Pflanzenschutzforschung, D.E.I., Eberswalde-Finow, DDR (DEIC); Museum of Victoria, Melbourne, Vict., Australia (MVC); South Australian Museum, Adelaide, S.A., Australia (SAMC); Entomological Museum, University of Amsterdam, Amsterdam, The Netherlands (UAMC);

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Western Australian Museum, Perth, W.A., Australia (WAMC); Allan Walford-Huggins, Mt. Molloy, QLD., Australia (WHC).

Measurements were made with an American Optical/Spencer dissecting microscope at 10X magnification using an optical micrometer. Body length measurements were taken from the front of the specimen's clypeus to the extreme apex of the elytra. Body width measurements were taken across the apical third of the elytra. Where possible, twelve specimens of each sex were measured, including the largest and smallest specimens; mean figures were then generated from those sums.

Illustrations were made using the microscope above at 10X and 30X magnifications. Drawings were initially pencilled onto tracing paper using the optical micrometer and ratios and then transferred to scratchboard for inking.

Characters utilized to delimit species within this subgenus are used in the key below. Marked variation in any three of these characters (i.e., maculation, pubescence, color) is sufficient to warrant species-level placement.

Subgenus ***Rivacindela*** van Nidek

Type species: *Cicindela blackburni* Sloane (by original designation).

DESCRIPTION: Member of the subfamily Cicindelinae, tribe Cicindelini, subtribe Cicindelina, genus *Cicindela;* eyes large and prominent; elytra usually noticeably wider in apical half than basal half; elytra usually setose at base; majority of species with extensive elytral maculation - a marginal band of white running laterally from the humeral area to the suture and then up the suture; labrum two or three dentate; majority of ventral segments heavily setose; mesosternum glabrous; metasternum glabrous in posterior half; pro- and mesotrochanters each with a single seta; elytral apices faintly microserrate or without microserrations.

REMARKS: Van Nidek (1973) erected *Rivacindela* based upon two series of specimens that he borrowed from the Western Australian Museum (WAM) at Perth, Western Australia (W.A.). He identified one of the species as *C. blackburni* and the other as *C. igneicollis.* Freitag (1979) apparently never saw these specimens as he did not indicate any specimens from the WAM in his study on the "*igneicollis* group" of the genus *Cicindela.* He did note that van Nidek's (1973) generic description of *Rivacindela* fits *C. saetigera* more closely than it does *C. blackburni* as he indicated the type species as *C. blackburni* Sloane (=*C. saetigera* W. Horn) and credited van Nidek with a misidentification in the synonomy of *C. saetigera.* The type species was, indeed, misidentified, but not as indicated by Freitag (1979). During the course of my studies on this group, I was able to borrow the two series that van Nidek originally studied when he described *Rivacindela* plus four specimens sent by van Nidek himself. Both series carry van Nidek determination labels; one series of 22 specimens is labelled *Rivacindela blackburni* Sl. and the other series (3 specimens) is labelled *Rivacindela igneicollis* Bat. Both of the species are new to science and will be described later in this paper. The problem of the misidentified type species has been referred to the International Commission of Zoological Nomenclature for its opinion.

All known species of the subgenus are inhabitants of salt flats. Their life histories are unknown although I presume they are similar to other saline-dwelling cicindelids such as occur in the Nearctic region. My searches for immatures around the salt flats where I have encountered adults have all yielded negative results. It is possible that the immatures are temporally segregated from the adults to avoid competition; hopefully, this will be determined in the future.

Key to species of **Rivacindela**

1.	Antennal scape with a single seta 2
1′.	Antennal scape with several setae 7
2.	Flightless species, hind wings vestigial, deformed or missing; humeri greatly reduced 3
2′.	Species with well-developed flight wings and humeri 5
3.	Base of elytra very setose .... *C. salicursoria*, n. sp.
3′.	Base of elytra glabrous or with few setae 4
4.	Large species, 19 mm in length; apical lunule not ascending up suture .... *C. gairdneri* Freitag
4′.	Slightly smaller species, 13-14 mm in length; apical lunule ascending partially up suture .... *C. velox*, n. sp.
5.	Maculation running from shoulder to apex 6
5′.	Maculation absent from basal half of elytra .... *C. ozellae*, n. sp.
6.	Maculation broad; elytra punctate, shiny; base of elytra with few setae; pronotum without setae along posterior margin .... *C. cardinalba*, n. sp.
6′.	Maculation narrower; elytra granulate-punctate, dull; base of elytra with many setae; pronotum with setae along posterior margin .... *C. blackburni* Sloane
7.	Species with well-developed flight wings and humeri 8
7′.	Flightless species, hind wings vestigial; humeri greatly reduced ... *C. vannideki*, n. sp.
8.	Frons setose 9
8′.	Frons glabrous .... *C. browni* Sloane
9.	Abdominal sternite 6 of female glabrous; female without apical elytral spines; maculation complex (see fig. 10) .... *C. igneicollis* Bates
9′.	Abdominal sternite 6 of female setose; female with apical elytral spines; maculation usually less complex (see fig. 8) 10
10.	Elytral color primarily cupreous-red; posterior margin of pronotum without setae .... *C. saetigera* W. Horn
10′.	Elytral color primarily green; posterior margin of pronotum with setae .... *C. collita* n. sp.

Cicindela (Rivacindela) blackburni Sloane
(Fig. 1)

Cicindela blackburni Sloane, 1906:342; Horn, 1915:319; 1926:201; 1938:45; Freitag, 1979:59.

DESCRIPTION: **Head:** Labrum white with four primary setae, tridentate, disc glabrous; scape cupreous with green reflections, equipped with a single sub-apical seta, some specimens also have 2-3 small, erect setae at the base; clypeus, genae, frons and vertex glabrous (except for supraorbital sensory setae).

Thorax: Pronotum heavily setose around all margins, some setae found in disc, granulate-rugose in texture, sub-quadrate in shape; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae; female with 6th segment devoid of large, white setae; most of venter of both sexes with very small, erect, clear setae, in addition to the erect, sensory setae.

Elyra: Male, nearly parallel-sided in shape, wider from basal third to apical third then rounded to apex; female, wider than male from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae (>40) along basal margin and extending slightly into disc, strong humeri and subsutural rows of small foveae; both sexes without microserrations; male without apical spine, female with apical spine; maculation consists of a band of white running laterally from the shoulder to the apex and then up the suture to near or just beyond the apical third, the lunules, although confluent are quite discernable; texture punctate-granulate.

Color: Head, metallic cupreous with slight green reflections, antennal segments 1-4 metallic cupreous with green reflections; pronotum cupreous with green reflections, median sulcus metallic green; elytra cupreous with green punctae; lateral thoracic segments metallic cupreous with green reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 9.7 mm in length and 3.5 mm in width; range 9.2-10.1 mm in length and 3.2-3.7 mm in width (n=12); female, 10.7 mm in length and 4.4 mm in width; range 10.3-10.9 in length and 4.2-4.6 in width (n=12).

Holotype: Female, W.A.: Norseman. Not seen. MVC, depository.

Co-type: Female. W.A.: Norseman. DEIC, depository.

Type locality: W.A.: Lake Cowan; **here designated.**

Distribution: W.A.: Lake Cowan; Northern Territory (N.T.): Newhaven Station? (Freitag, 1979).

Activity period: Presently known to be active during the early autumn.

Diagnosis: *C. blackburni* may only be confused with one other species - *C. salicursoria* n. sp. It differs from that species by its more prominent shoulders, shorter legs, functional flight wings and elytral pubescence.

REMARKS: *C. blackburni* was described by Sloane (1906) from two female specimens given to him by French. Until I collected a lengthy series (82 specimens) at the type locality in 1985, the species was known only from those two specimens. Although *C. blackburni* was treated by Freitag (1979), the majority of specimens in his study were actually a new species and not *C. blackburni.* The identity of the female specimen from N.T. listed by Freitag (1979) is somewhat in doubt as it cannot be found at the University of Sydney (F.J.D. McDonald, *in litt.*), its reported depository. I have not seen the type as the MVC would not risk the specimen to the mails.

I compared my series to the co-type from the W. Horn Collection and the comparison was quite favorable. Sloane (1906) stated that the type specimens had come from the "Norseman District" while the co-type carries a label stating "Norseman;" the type, according to Freitag (1979) carries the same label. I thoroughly investigated the area around the town of Norseman in 1979 and found no evidence of saline habitats. As the co-type is virtually identical with most females from my Lake Cowan series, I hereby establish Lake Cowan as the correct type locality in accordance with Article 72(h) of the ICZN. I found the species to prefer the margins of Lake Cowan; no specimens were observed further than 100 m from the playa margins. Unlike other species of *Rivacindela, C. blackburni* is fairly quick to take flight, but generally does not fly more than 5 m before alighting. Although not attracted to lights, it is active on the salt flats at night.

Cicindela (Rivacindela) salicursoria, new species (Fig. 2)

Cicindela blackburni of van Nidek, 1973, not Sloane, 1906.
Cicindela saetigera of Freitag, 1979, not W. Horn, 1893.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate, disc glabrous; scape cupreous with green reflections, equipped with a single sub-apical seta, several examined specimens also have 2-3 small erect setae at the base; clypeus, gena, frons and vertex glabrous (except for supraorbital sensory setae).

Thorax: Pronotum heavily setose around all margins, some setae found in disc, granulate-rugose in texture, cylindrical in shape; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae, female with segment 6 devoid of large, white setae; majority of venter of both sexes with very small, erect, clear setae.

Elytra: Male, ovoid in shape, wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae from basal margin extending into basal third, very reduced humeri, vestigial flight wings and sub-sutural rows of small foveae; both sexes without microserrations and apical spines; maculation very similar to *C. blackburni* except that the middle band is usually somewhat narrower; texture punctate-granulate.

Color: Head, metallic cupreous with green reflections, antennal segments 1-4 metallic cupreous with green reflections; pronotum cupreous with green reflections, median sulcus metallic green; elytra cupreous with green punctae; lateral thoracic segments metallic cupreous with green reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 9.6 mm in length and 3.9 mm in width; range 9.3-9.8 mm in length and 3.7-4.1 mm in width (n=12); female, 11.2 mm in length and 4.7 mm in width; range 10.8-11.4 in length and 4.5-4.9 in width (n=12).

Holotype: Male. W.A.: Lake Lefroy, 4 km N Widgiemooltha, 5-IV-1985, W.D. Sumlin.

Allotype: Female. Same data as holotype.

Paratypes: 27 ♂♂, 13 ♀♀ same data; 2 ♂♂, 1 ♀ W. Australia, Widgiemooltha, 26-IV-1962, J. and A. Douglas.

Type locality: W.A.: Lake Lefroy.

Distribution of Type Series: Holotype to the Australian National Insect Collection, CSIRO, Canberra, ACT. Three paratypes to the University of Amsterdam, Amsterdam, The Netherlands. One paratype to each of the following institutions and individuals: South Australian Museum, Adelaide, S.A.; Museum of Victoria, Melbourne, Victoria; Queensland Museum, Brisbane, QLD.; Institut für Pflanzenforschung, Eberswalde-Finow, DDR; British Museum (Natural History), London, England; Allan Walford-Huggins, Mt. Molloy, QLD.; Ed V. Gage, San Antonio, Texas; Walter Johnson, Minneapolis, Minnesota. The allotype and remaining paratypes to the Sumlin collection.

Etymology: Name from the Latin *salis* (salt) and *cursor* (a runner).

Activity period: Presently known to be active in the early autumn.

Diagnosis: Very closely related to *C. blackburni*. It differs from *C. blackburni* by having much longer legs, very reduced shoulders, vestigial flight wings, very setose elytra, an almost cylindrical prothorax, oval elytra and no elytral spines.

REMARKS: I found this species to inhabit the margins and salt crusts of Lake Lefroy. The highway approaches to within 150 m of the playa 4 km north of Widgiemooltha and there is a jeep trail leading down to the lake's shore at that point. I found it active around the playa margins and out on the salt crust (ca. 150-200 m out on the flats). The specimens that were taken around the margins of the playa were of a much redder color than those found out on the salt crust and are presumed to be teneral adults. The species was not common at the type locality, but I managed to collect 42 specimens in just over an hour. Although *C. salicursoria* cannot fly, it is extremely fleet of foot and difficult to net. The beetles would usually wait until I was close to them and then break into a very fast zig-zag pattern run, always with the direction of the wind.

Cicindela (Rivacindela) cardinalba, new species (Fig. 3)

Cicindela blackburni of Freitag, 1979, not Sloane, 1906.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate, disc glabrous; scape equipped with a single sub-apical seta; clypeus, gena, frons and vertex glabrous.

Thorax: Pronotum with white decumbent setae along all margins except posterior, a few setae extend into the disc, finely rugose in texture, with rounded sides; all lateral and ventral segments (except meso- and metasterna) clothed in white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae; female with segment 6 glabrous; both sexes glabrous medially (except for erect, sensory setae).

Elytra: Male: Nearly parallel-sided although slightly wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with apical microserrations, setae along basal margin (<10/elytron), strong humeri and subsutural rows of small foveae; male without apical spines, females with apical spines; maculation similar to *C. saetigera*, but slightly more confluent and the apical lunule usually does not ascend up the suture; texture tending more toward punctate, shiny.

Color: Head: majority metallic blue and green with some cupreous reflections, vertex metallic red-cupreous; antennal segments 1-4 metallic cupreous with green reflections; pronotum red-cupreous; elytra bright red-cupreous; lateral segments bright cupreous with green reflections;

ventral segments mostly metallic green with cupreous reflections; abdomen brown-testaceous with metallic green edges.

Size: Male, 9.7 mm in length and 3.4 mm in width; range 9.4-10.3 in length and 3.1-3.6 in width (n=12); female, 11.5 mm in length and 4.3 mm in width; range 11.0-11.7 mm in length and 4.1-4.5 in width (n=12).

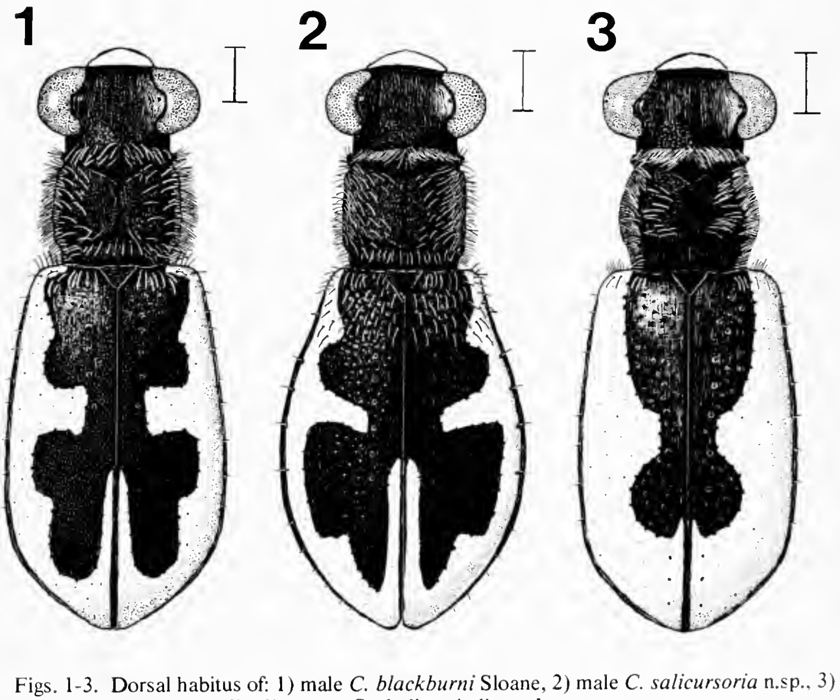
Holotype: Male. S.A.: Old Coward Springs, 10-IV-1985, W.D. Sumlin.

Allotype: Female. Same data as holotype.

Paratypes: 11 ♂♂, 13 ♀♀ same data; 4 ♂♂, 8 ♀♀, S.A.: Lake Eyre South, 10-IV-1985, W.D. Sumlin; 1 ♂, 4 ♀♀, S.A.: Lake Eyre, dead on salt, south shore, 23-IV-1955, G.F. Gross; 1 ♀, S.A.: Lake Eyre, dead on salt surface, Sulphur Pen., 21-VIII-1967, G.F. Gross; 2 ♀♀, S.A.: Lake Eyre, V-1953, K.P. Jones & party; 1 ♂, 4 ♀♀, S.A.: Wobna Mound Spring, +5 mi SE Coward Spring, wet crusty salt surface, day/mating, 30-III-1969, A. Kowanko.

Type locality: S.A.: Old Coward Springs. This is not to be confused with New Coward Springs which is several kilometers to the northeast. Old Coward Springs is approximately 200 m south of the Oodnadatta Track.

Distribution of Type Series: Holotype and 13 paratypes to the South Australian Museum, Adelaide, S.A. Two paratypes to the Australian National Insect Collection, CSIRO, Canberra, ACT. One paratype to each of the following institutions and individuals: National Museum of Victoria, Melbourne, Victoria; Queensland Musuem, Brisbane, QLD.; Institut für Pflanzenforschung, Eberswalde-Finow, DDR; British Museum (Natural History), London, England; Allan Walford-Huggins, Mt. Molloy, QLD.; Ed V. Gage, San Antonio, Texas; Walter



Figs. 1-3. Dorsal habitus of: 1) male *C. blackburni* Sloane, 2) male *C. salicursoria* n.sp., 3) male *C. cardinalba* n. sp. Scale lines indicate 1 mm.

Johnson, Minneapolis, Minnesota. Allotype and remaining paratypes to the Sumlin collection.

Etymology: Name from the Latin *cardinalis* (red) and *alba* (white) alluding to the species' distinctive red and white appearance.

Activity period: Presently known to be active during the early autumn.

Diagnosis: Closely related to *C. blackburni*, but differing in its broader maculation, elytral, pronotal and abdominal pubescence, shape of the prothorax, elytral texture and bright red color.

REMARKS: In addition to morphological characters, the new species differs markedly in its behavior; its flight is quite different from *C. blackburni* in that it lifts higher off the substrate when taking to wing, flies much stronger and flies farther (10-15 m as opposed to 5 m). I found it inhabiting salt crust at both Old Coward Springs and Lake Eyre South where it proved quite skittish and difficult to net. Capturing specimens at Lake Eyre proved to be a major undertaking as I kept breaking through the salt crust and sinking into the black, underlying mud. I felt very fortunate to net 12 specimens at that location.

Cicindela (Rivacindela) ozellae, new species
(Fig. 4)

DESCRIPTION: Head: Labrum white with 4 primary setae, tridentate, disc glabrous; scape equipped with a single, subapical seta; clypeus, gena, frons and vertex glabrous (except for supraorbital sensory setae).

Thorax: Pronotum setose on all margins, lightly rugose in texture; all lateral and ventral segments (except meso- and metasterna) with light to dense covering of white, decumbent setae; meso- and metasternum glabrous.

Abdomen: Lateral edges lightly to densely clothed in white, decumbent setae, glabrous medially (except for sensory setae).

Elytra: Male: nearly parallel-sided though slightly wider from basal third to apical third then rounded to apex; female: unknown; male with setae (<15/elytron) along basal margin, rows of small, subsutural foveae and minute apical microserrations; male without apical spine; maculation consists of band of white beginning in basal half and running laterally to the apex, no ascending basal lunule present; texture punctate, shiny.

Color: Head, metallic green and blue with slight cupreous reflections; antennal segments 1-4 metallic green with cupreous reflections; pronotum cupreous with green reflections, median sulcus metallic green; elytra rose-cupreous with green punctae; lateral segments metallic blue with green reflections; ventral segments mostly green metallic; abdomen brown-testaceous.

Size: Male. 8.5 mm in length and 3.3 mm in width; range same as mean (n=2).

Holotype: Male. S.A.: Eucolo Creek at Island Lagoon, 31.8 km W Woomera, 13-IV-1985, W.D. Sumlin; SAMC, depository.

Paratype: Male. Same data excpet 9-IV-1985; Sumlin collection, depository.

Type locality: S.A.: Island Lagoon.

Distribution: At present, known only from the type locality.

Etymology: I take pleasure in naming this species after my late mother, Ozella R. Sumlin.

Activity period: Known to be active during the early autumn.

Diagnosis: Closest to *C. cardinalba*. May be told from that species by its much smaller size, pronotal pubescence, reduced maculation, rose-red color and elytral texture.

REMARKS: This species was extremely scarce at the type locality; I spent nearly 8 hours walking the flats of Island Lagoon to collect the two specimens comprising the type series. At first glance, the species does not appear to be a member of *Rivacindela,* but a close examination discloses the setose elytra, densely setose undersides and characteristic aedeagus.

Cicindela (Rivacindela) velox, new species
(Fig. 5)

DESCRIPTION: **Head:** Labrum white with 4 primary setae, males bidentate, females tridentate, disc glabrous; scape equipped with a single sub-apical seta; clypeus, gena, frons and vertex glabrous (except for supraorbital, sensory setae).

Thorax: Pronotum with sparse, decumbent and erect setae on lateral and anterior margins, glabrous on posterior margin, a few setae extending into disc, rugose in texture, sides slightly rounded; all lateral and ventral segments (except meso- and metasterna) with light to dense covering of white, decumbent setae; meso- and metasternum glabrous.

Abdomen: Lateral edges lightly to densely clothed in white, decumbent setae; female with segment 6 glabrous; both sexes glabrous medially (except for erect, sensory setae).

Elytra: Oval in shape, widest from basal third to apical third then rounded to apex; both sexes with very small, indistinct subsutural foveae, reduced humeri and several very small setae (<5/elytron) at the base; males, without apical spines, females, with apical spines; both sexes without microserrations; flight wings present, but they are so distorted in shape that they are useless for flight; maculation consists of a single band of white beginning in the basal third and running laterally rearward to the apex and then slightly up the suture to the apical fourth.

Color: Majority of head dark, burgundy-red with cupreous and green reflections; antennal segments 1-4 burgundy-red with some cupreous reflections; pronotum dark burgundy-red with slight, green reflections; lateral segments burgundy-red with extensive light cupreous and green reflections; ventral segments largely cupreous and green metallic; abdomen brown-testaceous with lateral edges cupreous and green.

Size: Male, 13.2 mm in length and 5.7 mm in width; range 12.9-13.5 in length and 5.1-5.9 in width (n=6); female, 14.3 mm in length and 6.3 mm in width; range 14.0-14.7 in length and 5.9-6.5 in width (n=6).

Holotype: Male. W.A.: Lake Cowan, 19.1 km N Norseman, 4-IV-1985, W.D. Sumlin.

Allotype: Female. Same data.

Paratypes: 8 ♂♂, same data; 6 ♀♀ same data.

Type locality: W.A.: Lake Cowan.

Distribution: Known only from the type locality.

Distribution of Type Series: Holotype to the Australian National Insect Collection, CSIRO, Canberra, ACT. One paratype to each of the following institutions and individuals: South Australian Museum, Adelaide, S.A; Queensland Museum, Brisbane, QLD.; Institut für Pflanzenforschung, Eberswald-Finow, DDR; Allan Walford-Huggins, Mt. Molloy, QLD.; Ed V. Gage, San Antonio, Texas; Walter Johnson, Minneapolis, Minnesota. The allotype and remaining paratypes to the Sumlin collection.

Etymology: From the Latin for swift, alluding to the species' rapid running ability.

Activity period: Active in early autumn.

Diagnosis: *C. velox* can only be confused with *C. gairdneri;* it differs from that species by its smaller size, maculation and pronotal pubescence.

REMARKS: I found this species far out on the salt flats of Lake Cowan. The species would, in all cases, wait until I was nearly on top of it before it moved; when it moved, it always broke into an exceedingly fast run, and always in a straight line with the direction of the wind. The beetles were so fast that I had to break into an immediate run in order to intercept them. On two occasions, large females actually outran me for distances of 10-15 m! The species was not common at the type locality during my stay as I saw and collected only about two an hour.

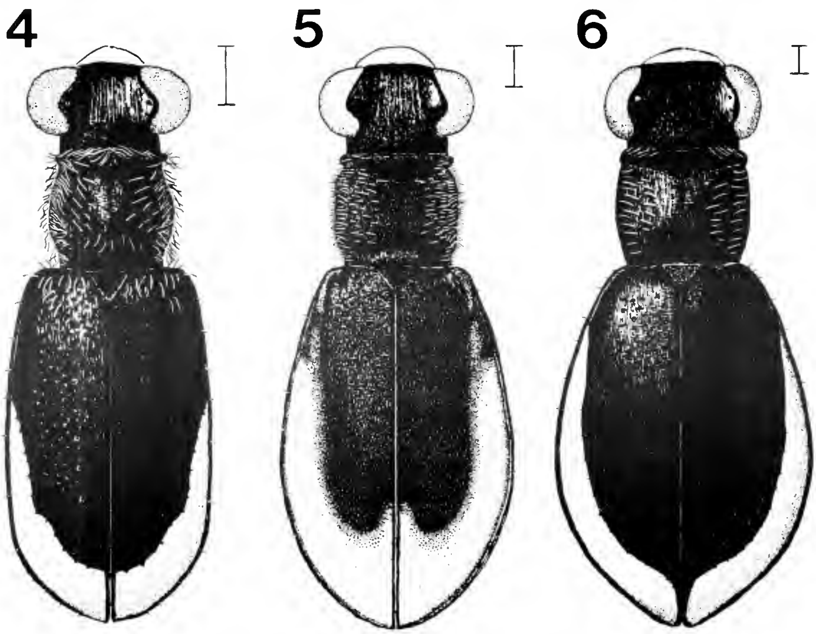
Cicindela (Rivacindela) gairdneri Freitag
(Fig. 6)

Cicindela gairdneri Freitag, 1979:63.

DESCRIPTION: Head: Labrum white with 4 primary setae, female tridentate, male unknown, disc glabrous; scape equipped with a single sub-apical seta; clypeus, gena, frons and vertex glabrous (except for supraorbital, sensory setae).

Thorax: Pronotum with sparse, decumbent and erect setae on lateral margins, glabrous on posterior margin and medial area of anterior margin, disc glabrous, slightly rugose in texture, sides nearly parallel-sided; all lateral and ventral segments (except meso- and metasterna) with light to dense covering of white, decumbent setae; meso- and metasterna glabrous.

Abdomen: Lateral edges lightly to densely clothed in white, decumbent setae; female with segment 6 glabrous, glabrous medially (except for erect, sensory setae).



Figs. 4-6. Dorsal habitus of: 4) male *C. ozellae* n.sp., 5) male *C. velox* n.sp., 6) holotype female *C. gairdneri* Freitag. Scale lines indicate 1 mm.

Elytra: Female markedly oval in shape, widest from basal third to apical third then rounded to apex; male unknown; female with very small, indistinct subsutural foveae, very reduced humeri and apical spines; base of elytra without setae; apex without microserrations; flight wings absent; maculation consists of a band of white beginning in the basal fourth and running laterally posteriorad to the apex.

Color: Most of head dark, burgundy-red with cupreous and green reflections; antennal segments 1-4 burgundy-red with slight cupreous reflections; pronotum dark burgundy-red with slight, green reflections; lateral segments burgundy-red with extensive light cupreous and green reflections; ventral segments largely cupreous and green metallic; abdomen brown-testaceous with cupreous and green edges.

Size: Female, 19.1 mm in length and 8.2 mm in width (n=1).

Holotype: Female. SW Gulf L. Gairdner, 18-III-1950. South Australian Museum, Adelaide, S.A., depository.

Type locality: S.A.: Lake Gairdner.

Distribution: Known only from the type locality.

Activity period: The only known specimen was collected during the late summer.

Diagnosis: Easily separated from the other species of *Rivacindela* by its massive size, type of maculation and lack of flight wings.

REMARKS: This species is known only from the holotype specimen. I attempted to collect the species during my expedition in 1985, but getting to the type locality required four-wheel drive - something my rental vehicle did not have. Judging from the holotype's very long legs and massive body, the species may be fleeter of foot than *C. velox*.

Cicindela (Rivacindela) browni Sloane
(Fig. 7)

Cicindela browni Sloane, 1913:401; Horn, 1915:319; 1926:201; 1938:45; Freitag, 1979:61.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate, disc glabrous; scape metallic cupreous, heavily covered with white decumbent setae; gena lightly setose; clypeus, frons and vertex glabrous; a small tuft of setae found between the antennal socket and the eye.

Thorax: Pronotum setose on all margins, some setae in disc, lightly rugose in texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae; segment 6 of female glabrous (except for 2-4 setae on anterior margin; glabrous medially (except for erect sensory) setae).

Elytra: Male: slightly parallel-sided although wider from basal third to apical third then rounded to apex; female, wider from basal third to apical third then rounded to apex; both sexes with a few (<10) white setae along the basal margin, strong humeri and subsutural rows of small foveae; male without microserrations; female with small microserrations at apex; male without apical spines; female with small apical spines; maculation consists of a confluent band starting at the shoulder and then running laterally to the apex, broadening as it goes, and then up the suture to a point in the basal third; texture granulate-punctate.

Color: Head, metallic cupreous with slight green reflections, antennal segments 1-4 metallic cupreous; pronotum cupreous; elytra light cupreous with green punctae; lateral thoracic segments metallic cupreous with slight green reflections; ventral segments and abdomen largely brown-testaceous.

Size: Male, 11.2 mm in length and 4.1 mm in width; range 11.2-11.3 in length and 4.1-4.2 in width (n=2); female, 12.8 mm in length and 4.8 mm in width; range 12.6-12.9 in length and 4.7-4.9 in width (n=3).

Holotype: Presumed lost.

Co-type: Female. W.A.: Lake Austin, H.W. Brown. MVC, depository.

Co-type: Female. W.A.: Lake Austin, H.W. Brown. DEIC, depository.

Type locality: W.A.: Lake Austin.

Distribution: W.A.: Lake Austin.

Activity period: From all available data, *C. browni* is an autumn species.

Diagnosis: Differs from the other species with setose scapes by its glabrous frons and vertex.

REMARKS: This species is one of the rarest in collections. This is probably due to its remote type locality and activity period. I found it around the margins of Lake Austin on 29 March, 1985. Its behavior was similar to *C. saetigera* in that it flew for long distances (15 m) and was a fast runner.

Cicindela (Rivacindela) saetigera W. Horn (Fig. 8)

Cicindela saetigera W. Horn, 1893:198; 1915:319; 1926:201; 1938:45; Sloane, 1906:343; Freitag, 1979:58; Sumlin, 1981:279; 1984:197.

Cicindela jungi Blackburn, 1901:15; Rainbow, 1904:245; Sloane, 1906:343; Horn, 1915:319; 1926:201.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate (strongly so in female), disc lightly to densely clothed in white, decumbent setae; scape cupreous with green reflections, heavily covered with white, decumbent seate; clypeus, gena, frons and anterior portion of vertex covered with white, decumbent setae.

Thorax: Pronotum heavily setose on lateral and anterior margins, granulate-rugose in texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely clothed in white, decumbent setae; female with setae on segment 6, glabrous medially (except for erect sensory setae).

Elytra: Male: sub-ovoid in shape, wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae on basal margins, small humeral angles and sub-sutural rows of small foveae; both sexes without microserrations; male without apical spines, females with apical spines; maculation consists of a confluent band of white running from the shoulder laterally to the apex and then up the suture to a point just below the bulge of the middle lunule; texture granulate-punctate.

Color: Head, metallic green with cupreous reflections, antennal segments 1-4 metallic cupreous; pronotum metallic cupreous with green reflections, median sulcus metallic green; elytra cupreous with green punctae; lateral thoracic segments metallic green with cupreous reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 11.2 mm in length and 4.3 mm in width; range 10.8-11.9 mm in length and 3.9-4.7 in width (n=12); female, 12.4 mm in length and 4.8 mm in width; 11.8-12.8 in length and 4.4-5.1 mm in width (n=12).

Holotype: Female. "Cap York;" DEIC, depository.

Type locality: S.A.: Yorke Peninsula.

Distribution: S.A.: Wallaroo, Lake Crosby, Lake Bumbinga, Tailem Bend, 19.4 km S. Tailem Bend; Vict.: Swan Hill.

Activity period: Active during the summer months.

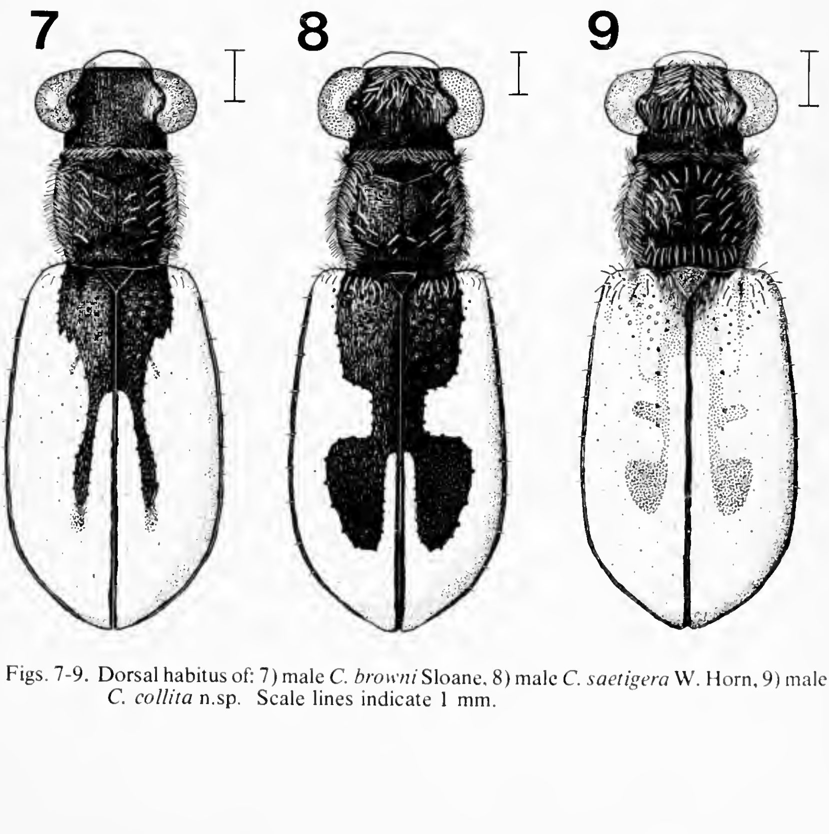
Diagnosis: Closely related to *C. collita* n. sp.; easily separated by its less diffuse maculation, lack of setae along posterior margin of pronotum, red color and larger size.

REMARKS: Contrary to Freitag (1979), I find no tendency toward variation of the elytral maculations in any of the population samples studied; all are essentially identical with the specimen depicted in Fig. 8. This is the most common species of the subgenus but it is not found in many collections. I found it to be a very fast runner and able flier (Sumlin, 1984) on a salt flat in southern S.A. The species is no longer found at Wallaroo due to the destruction of salt flats at that location.

Cicindela (Rivacindela) collita, new species
(Fig. 9)

Cicindela saetigera of Freitag, 1979, not W. Horn, 1893.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate, disc lightly to densely clothed in white, decumbent setae; scape heavily covered with white, decumbent setae; clypeus, gena, frons and anterior portion of vertex covered with white, decumbent setae.



Figs. 7-9. Dorsal habitus of: 7) male *C. browni* Sloane, 8) male *C. saetigera* W. Horn, 9) male *C. collita* n.sp. Scale lines indicate 1 mm.

Thorax: Pronotum heavily setose on all margins, granulate-rugose in texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely clothed in white, decumbent setae; female with setae on segment 6, glabrous medially (except for erect, sensory setae).

Elytra: Male: sub-ovoid in shape, wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae on basal margins, small humeral angles and subsutural rows of small foveae; both sexes usually without microserrations (some females have minute teeth along apex); male without apical spines, females with apical spines; maculation similar to *C. saetigera,* but much more diffuse and all specimens studied have a basal dot; apical lunule in many specimens ascends up suture to become a basal dot and there is an extension of the basal lunule into the disc; texture granulate-punctate.

Color: Head, metallic green with slight cupreous reflections, antennal segments 1-4 metallic green with cupreous reflections; pronotum dark metallic green with cupreous reflections; elytra dark green with cupreous punctae; lateral thoracic segments metallic green with cupreous reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 10.1 mm in length and 3.8 mm in width; range 9.8-10.2 mm in length and 3.4-4.0 in width (n=6); female, 10.4 mm in length and 4.0 mm in width; range 10.0-10.7 mm in length and 3.8-4.2 in width (n=6).

Holotype: Male. On salt edge of Coorong, S.A., I-1967, P. Gniel.

Allotype: Female. Same data.

Paratypes: 5 ♂♂ same data; 22 ♀♀ same data.

Type locality: S.A.: The Coorong.

Distribution: At present, known only from the type locality.

Distribution of Type Series: Holotype, allotype and 23 paratypes to the South Australian Museum (SAM), Adelaide, S.A.; 4 paratypes to the Sumlin collection.

Etymology: Name from the latin *collitus* (smeared) alluding to the new species' smeared, diffuse maculation.

Activity period: Apparently the same as *C. saetigera.*

Diagnosis: May be told from *C. saetigera* by its broad, diffuse maculation, green color, smaller size and setae on the posterior margin of the pronotum.

REMARKS: The new species was discussed by Freitag (1979) as a geographical variant of *C. saetigera.*

Cicindela (Rivacindela) igneicollis, Bates (Fig. 10)

Cicindela igneicollis Bates, 1874:262, Sloane, 1906:344; 1913:402; Horn, 1915:319; 1926:201; 1938:4&11; Freitag, 1979:56.

DESCRIPTION: **Head:** Labrum white with four primary setae, female tridentate, male unknown, disc glabrous; scape with covering of white, decumbent setae; clypeus, gena, frons and anterior portion of vertex with white, decumbent setae.

Thorax: Pronotum heavily setose on lateral and anterior margins, lightly rugose in texture, subquadrate in shape; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered in white, decumbent setae; female with segment 6 glabrous; glabrous medially (except for erec' sensory setae).

Elytra: Female, vaguely-ovoid in shape, widest from basal third to apical third then rounded to apex; male, unknown; base with white setae; humeri prominent; female without apical spines or microserrations; maculation similar to *C. saetigera* except ascending portion of apical lunule ascends well into basal third and there is a discal lunule running parallel to the apical lunule and marginal line.

Color: Head, metallic cupreous with green reflections; antennal segments 1-4 metallic cupreous; pronotum cupreous with green reflections, sulci green metallic; elytra cupreous with green punctae; lateral thoracic segments cupreous with green reflections; ventral segments and abdomen brown-testaceous.

Size: Female, 13.0 mm in length and 4.9 mm in width (n=1).

Holotype: Female. W.A.: Nickol Bay. Presumed lost or destroyed.

Type locality: W.A.: Nickol Bay.

Distribution: W.A.: Nickol Bay; Western Australia [no specific locality], 1922-1923, B.R. Lucas; BMNH, depository.

Activity period: Unknown.

Diagnosis: Differs from the other members of the subgenus by its maculation and pubescence as outlined in the above key and description.

REMARKS: Bates (1874) described the species from two females given to him by DuBoulay. This species shares with *Nickerlea distipsideroides* W. Horn and *C. gairdneri* the distinction of being the rarest Australian cicindelids in collections. As far as I am able to discern, there are no specimens of this species housed in Australian museums. The British Museum (Natural History) possesses the only known example and it is not one of the Bates specimens. The specimen was determined as *C. igneicollis* by Walter Horn in 1926. It fits Bates' (1874) original description, but due to the loss of the types and the fact that the specimen at hand does not bear a Nickol Bay label, I am inclined to view this specimen as a tentative representative of the species. When specimens are finally collected at the type locality, this tentative determination will be confirmed or rejected. I have visited Nickol Bay twice (1979 & 1985) in attempts to collect the species, but it eluded me on both occasions as it was exceedingly hot in both instances. I suspect that the species would be present when the temperature stabilizes around the 30°C mark. According to Bromwyn Hunt of Karratha, W.A. (pers. comm.), this would be sometime in late April or May. The habitat at Nickol Bay has changed very little since the insect was described except that there is now a large salt extraction plant operated by Dampier Salt Ltd. at the southwest corner of the salt flats.

Cicindela (Rivacindela) vannideki, new species (Fig. 11)

Cicindela igneicollis of van Nidek, 1973; not Bates, 1874.

DESCRIPTION: **Head:** Labrum white with four primary setae, tridentate, disc glabrous; scape cupreous with green reflections, heavily covered with white, decumbent setae; clypeus, gena, frons and anterior portion of vertex with white, decumbent setae.

Thorax: Pronotum heavily setose on lateral and anterior margins, granulate-rugose in texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely clothed in white, decumbent setae; female with segment 6 setose, glabrous medially (except for erect sensory setae).

Elytra: Male, sub-ovoid in shape, widest from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae in basal fourth of dorsal surface, small sub-sutural foveae, very reduced humeri and vestigial flight wings; male, with minute microserrations, female, without microserrations; male, without apical spines, female, with apical spines; maculation similar to *C. igneicollis* except that the discal lunule is not attached to the apical lunule and the middle band is much more pitched and discernable.

Color: Head, metallic cupreous with green reflections, antennal segments 1-4 metallic cupreous; pronotum cupreous with green reflections; elytra dark cupreous with green punctae; lateral thoracic segments metallic green with cupreous reflections; ventral segments and abdomen brown-testaceous.

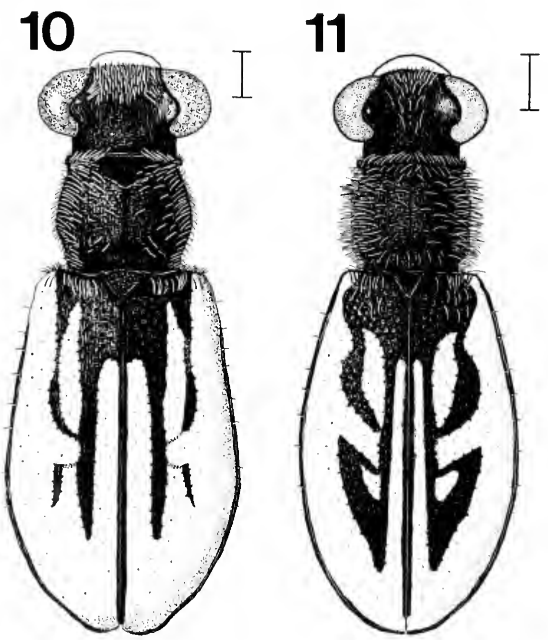
Size: Male, 10.5 mm in length and 3.9 mm in width; range same as means for both length and width (n=2); female, 12.1 mm in length and 4.9 mm in width (n=1).

Holotype: Male. W.A.: North lip of Johnston Lakes, W. of Norseman, 23-III-1968, A. Baynes & J. Bannister; Running on surface of lake; specimen #69-1579; WAMC, depository.

Allotype: Female. Same data (except specimen #69-1581) and depository as holotype.

Paratype: Male. Same data; UAMC, depository.

Type locality: W.A.: Lake Johnston.



Figs. 10-11. Dorsal habitus of: 10) female *C. igneicollis* Bates, 11) holotype male *C. vannideki* n.sp. Scale lines indicate 1 mm.

Etymology: Named in honor of C.M.C. Br. van Nidek, Dutch scholar of the Australian Cicindelidae.

Activity period: From the type specimens, the species is active during the early autumn.

Diagnosis: *C. vannideki* may be separated from the closely related *C. igneicollis* and *C. saetigera* by its maculation, elytral pubescence, reduced shoulders and vestigial flight wings.

REMARKS: This species was apparently the one used by van Nidek (1973) in assessing generic characters for *Rivacindela* as it fits the generic description much better than "*C. blackburni*" with respect to pubescence of the head.

DISCUSSION

From my studies on this subgenus, I believe that the total number of species of *Rivacindela,* when finally described, will far exceed the eleven reviewed in this paper. This projection is based upon the various species' ability to change with the passage of time and the restriction of gene flow from like populations. All of the above species are confined to salt flats and, for the present, are considered to have zero vagility. The number of salt flats in Western Australia, South Australia and Northern Territory that could harbor isolated species is enormous. Most of these flats are in the "outback" and inaccessible to conventional transportation; as more roads are opened and these flats become accessible, the number of known *Rivacindela* species will, in all likelihood, climb accordingly.

As presently defined, there are two main stems of species within *Rivacindela:* the *blackburni* stem (characterized by unisetose scapes and glabrous heads) and the *browni* stem (characterized by multi-setose scapes and setose heads). From out-group comparisons of various character states, I believe the ranking of species presented in this paper to be the most parsimonious. In a future paper (in progress), I will present a phylogeny and male genitalia study for the subgenus.

ACKNOWLEDGMENTS

I wish to extend thanks to the following people for the loan of specimens and/or data: Eric Matthews, South Australian Museum, Adelaide, S.A.; Tom Weir, CSIRO, Canberra, ACT; Terry Houston, Western Australian Museum, Perth, W.A.; Lothar Dieckmann, Institut für Pflanzenforschung, Eberswalde-Finow, DDR; F.J.D. McDonald, University of Sydney, Sydney, N.S.W.; Chris van Nidek, Voorburg, The Netherlands; Allan Walford-Huggins, Mt. Molloy, Qld.; A. Neboiss, Museum of Victoria, Abbotsford, Vic.; M.J.D. Brendell and N.E. Stork, British Museum (Natural History), London, England; B. Brugge, University of Amsterdam, Amsterdam, The Netherlands. Thanks are also extended to E.V. Gage (San Antonio, Texas) and J.M. Cicero (Gainesville, Florida) for their critical reviews of the manuscript.

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HOST PLANTS FOR NORTH AMERICAN SPECIES OF *RIVELLIA* (DIPTERA: PLATYSTOMATIDAE)[1]

B.A. Foote, B.D. Bowker, B.A. McMichael[2]

ABSTRACT: Host plants for 11 of the 31 Nearctic species of *Rivellia* represent 6 species of Leguminosae belonging to 5 genera of the subfamily Papilionoideae. Larvae attack and destroy root nodules and may reduce the nitrogen-fixing capability of the host plant.

The recent discovery that *Rivellia quadrifasciata* (Macquart) has shifted from its native legume host to soybean in Louisiana (Eastman and Wuensche 1977) and North Carolina (Koethe 1982) has stimulated interest in this genus of the largely tropical family Platystomatidae. Newsom et al. (1978) have shown that larval feeding on soybean root nodules by *R. quadrifasciata* can affect the nitrogen-fixing capacity of the plant. Koethe and Van Duyn (1984) have discussed larval feeding behavior on soybean nodules and reported that southern pea (*Vigna unguiculata* (L.) Walp.) was also being attacked by larvae. Later, Koethe and Van Duyn (1986) described the oviposition behavior of this species, and Koethe et al. (1986) discussed its adult seasonality and overwintering habits. Foote (1985) elucidated the life cycle of *R. pallida* Loew, a species associated with hog-peanut (*Amphicarpaea bracteata* (L.) Fernald) in the Eastern States. He also listed the known host plants of the Nearctic species of *Rivellia*, and predicted that several other species of the genus will eventually shift to a variety of introduced, agriculturally important species of Leguminosae. Bibro and Foote (1986) described and illustrated the mature larva of *R. pallida,* utilizing a scanning electron microscope.

The present paper is an expansion of the host plant list published by Foote (1985) and includes natural history observations on several species.

MATERIALS AND METHODS

Most of the field work on potential legume hosts of *Rivellia* was carried out in northeastern Ohio between 1981 and 1986, with occasional trips to sites in the more southeastern counties of the state. Other observations were made during a week-long collecting trip to Missouri, Oklahoma, and Kansas during early May, 1985, and additional records were obtained in eastern Oklahoma on May 23, 1986. Suspected host plants were swept with a standard insect net. A legume species was considered to be a host

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only if at least 2 separate stands of the plant produced adult *Rivellia.* In addition to sweeping, soil samples taken below suspected hosts were examined for immature stages. Larvae and puparia were subsequently reared to the adult stage to obtain species identifications. Larvae were provided with root nodules taken from the host plant. Voucher specimens of the host plants and species of *Rivellia* have been deposited in the research collection of Kent State University.

RESULTS AND DISCUSSION

Six species of Leguminosae representing 5 genera of the subfamily Papilionoideae are now known to serve as hosts for *Rivellia* larvae (Table 1). Observations on each of the *Rivellia* sp. are given in the following section.

The few adults of *R. flavimana* Loew and *R. metallica* Wulp that we have collected were all swept from stands of hog-peanut in northeastern Ohio during mid to late June. One fully grown larva of the former species was encountered in a soil sample taken beneath the host plant on October 5, 1985. Because no pupation had occurred during the 35 days that the larva was held at room temperatures, it was transferred to a refrigerator on November 10 where it remained until April 9, 1986. On that date the larva was returned to room temperatures. It formed a puparium on April 13, with an adult male emerging on April 21. Interestingly, 11 other larvae found in the same soil sample on October 5 all produced adults of *R. pallida.* Namba (1956) encountered adults of all 3 species on hog-peanut in Minnesota.

Both *R. melliginis* (Fitch) and *R. viridulans* Robineau-Desvoidy were swept from black locust (*Robinia pseudoacacia* L.) at numerous localities in Ohio and at one site in western Missouri between early May and late July, with most of the records being obtained in June. Collecting data indicate that *R. melliginis* was, by far, the more abundant species. However, eggs, larvae, and puparia of both species were recovered from soil collected below stands of *Robinia.* At least 2 generations a year are produced in northeastern Ohio, with overwintering occurring as mature larvae in diapause.

The first record of the host plant for *R. micans* Loew was obtained on May 13, 1985, when 5 adults of both sexes were swept from false-indigo (*Amorpha fruticosa* L.) growing on the shoreline of the reservoir at the Great Salt Plains State Park in northcentral Oklahoma. On July 12, 1986, a second collection of some 30 adults was swept from a single specimen of false-indigo growing on the north shore of the Ohio River 20 miles east of Marietta, Ohio. In Oklahoma, this species was associated with adults of *R. munda* Namba, but it occurred alone at the Ohio River site.

Information on the host plant of *R. munda* was first obtained on May 13, 1985, when 31 adults were swept from *A. fruticosa* at the Great Salt Plains State Park, Oklahoma. A second collection was taken from *Amorpha* growing on the shore of Eufaula Lake in eastern Oklahoma on May 23, 1986. Surprisingly, *R. munda* was not taken from *Amorpha* in southern Ohio during July, 1986, although *R. micans* was collected abundantly there.

The natural history and basic ecology of *R. quadrifasciata,* the soybean nodule fly, is now well studied, as it has become an economic pest of soybean and southern pea. Harold Lambert (personal communication) reported that the native host of *R. quadrifasciata* in Louisiana probably is a species of tick trefoil (*Desmodium* sp.).

Immature stages and adults of *R. steyskali* Namba were repeatedly collected in stands of *Desmodium paniculatum* (L.) DC. in northern and southern Ohio. At least 2, possibly 3, generations a year occur in the northeastern part of the state, with overwintering taking place as mature larvae in diapause.

The first record of the host plant of *R. variabilis* Loew was obtained at Kent, Ohio, on May 5, 1986, when a male and female of the black form (Namba 1956) emerged from puparia that had been formed by larvae encountered in soil samples taken below vines of ground-nut (*Apios americana* Medic.) in late November, 1985. The larvae were refrigerated for 150 days before being returned to room temperatures. Two adults were later swept from scattered individuals of ground-nut at the Herrick Fen Nature Preserve in Portage County, Ohio, on July 27, 1986. Interestingly, adults and immature stages of a second species, *R. winifredae* Namba, have also been recorded from ground-nut (Foote 1985).

The available evidence strongly suggests that all Nearctic species of *Rivellia* are restricted to various species of Leguminosae for their larval nutrition. Apparently this is true also in other regions of the world. Koizumi (1957) and Bhattacharjee (1977) found *Rivellia* larvae attacking root nodules of soybean in Japan and India, respectively. Seeger and Maldaque (1960) reported that an undetermined species of *Rivellia* was an important enemy of peanut, *Arachis hypogea* L., in equatorial Africa. Finally, Diatloff (1965) stated that *Rivellia* larvae were consuming root nodules of a pasture legume, (*Glycine javanica* L.) in Australia.

It may be significant that all known hosts of the Nearctic species of *Rivellia* belong to the legume subfamily Papilionoideae. No adults were obtained in repeated sweeping of honey locust (*Gleditsia triacanthos* L.) and redbud (*Cercis canadensis* L.), both of the subfamily Caesalpinioideae, in Ohio. Similarly, no adults were taken from prairie clover (*Desmanthus illinoensis* (Michx.) MacM.) or sensitive brier (*Schrankia nuttallii* (DC.) Standl.), of the Mimosoideae, in Missouri and Oklahoma. Species belonging to the Caesalpinioideae generally do not produce root nodules, although several taxa of Mimosoideae are well nodulated (Allen and Allen 1981). Unfortunately, most of the agriculturally important species of Leguminosae belong to the very large, widespread, and well nodulated subfamily Papilionoideae. The recent reports that larvae of *R. quadrifasciata* have shifted to southern pea (Koethe and Van Duyn 1984) and soybean (Eastman and Wuensche 1977) supports the suggestion (Foote 1985) that additional species of the genus will eventually shift to introduced legume crops that are now widely planted in North America.

Table 1. Native Host Plants of North American ***Rivellia.***

Species of ***Rivellia.***	Host Plant	Study Site
R. flavimana	*Amphicarpaea bracteata*	OH, MN
R. melliginis	*Robinia pseudoacacia*	MO, OH
R. metallica	*Amphicarpaea bracteata*	OH, MN
R. micans	*Amorpha fruticosa*	OH, OK
R. munda	*Amorpha fruticosa*	OK
R. pallida	*Amphicarpaea bracteata*	OH, MN
R. quadrifasciata	*Desmodium* sp.?	LA, NC
R. steyskali	*Desmodium paniculatum*	OH
R. variabilis	*Apios americana*	OH
R. viridulans	*Robinia pseudoacacia*	OH
R. winifredae	*Apios americana*	OH, MN

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We are indebted to Barbara Andreas, Cuyahoga Community College in Cleveland, for taxonomic aid in determining species of Leguminosae. Harold Lambert, Department of Entomology at Louisiana State University, provided information on the native host of the soybean nodule fly, *Rivellia quadrifasciata.*

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XVIII INTERNATIONAL CONGRESS OF ENTOMOLOGY

Vancouver, Brit. Col., Canada
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Persons wishing to receive the Second Announcement Brochure containing details of program, registration, accommodation, tours, etc. should write to Dr. G.G.E. Scudder, Secretary-General, XVIII International Congress of Entomology, Dep't of Zoology, Univ. of British Columbia, Vancouverm B.C. V6T 2A9, Canada.

SUITABILITY OF *BREVICORYNE BRASSICAE* AND *MYZUS PERSICAE* (HOMOPTERA: APHIDIDAE) AS HOSTS OF *DIAERETIELLA RAPAE* (HYMENOPTERA: APHIDIIDAE)[1]

G.B. Wilson, P.L. Lambdin[2]

ABSTRACT: The green peach aphid, *Myzus persicae*, and the cabbage aphid, *Breviocoryne brassicae*, were suitable hosts for the parasite *Diaeretiella rapae*. No significant differences in developmental or performance criteria were exhibited by the two aphid hosts. *D. rapae* oviposited more frequently and produced a significantly higher percentage of female progeny when reared on the cabbage aphid.

Diaeretiella rapae (McIntosh) was first described by Curtis (1885), and was recorded as the only primary parasite of the cabbage aphid, *Brevicoryne brassicae* (L.) (George 1957, Hafex 1961, Chua 1977). *D. rapae* has been considered both important (Strickland 1916, Barnes 1931) and insignificant (Prethbridge and Mellor 1936, Todd 1959) in the control of cabbage aphid infestations.

Habitat selection by the Aphidiidae in general and *D. rapae* in particular was speculative until recent works by Read et. al. (1970) and Akinlosotu (1980). They concluded that *D. rapae* responded to olfactory cues in selecting habitat, and then relied on random search to discover hosts within the habitat. The mustard oil, allyl isothiocyanate, is the stimulus by which *D. rapae* orients to habitat, and it may play a role in stimulating the parasite to oviposit (Read et. al. 1970). *D. rapae* is reported to parasitize eight different aphid species, but is seldom found parasitizing aphids not on crucifers. Host association with habitat may be of more importance in determining host range than taxonomic affinity (Townes 1960). Simpson et. al. (1975) used the green peach aphid, *Myzus persicae* (Sulzer), to rear the parasite, but in earlier tests, cabbage aphids were considered the preferred hosts (Hafez 1961). For most parasites, host preference may affect progeny size, fecundity, vigor and sex ratio (Salt 1935).

This study was undertaken to assess host preference and suitability of green peach aphids and cabbage aphids as hosts for *D. rapae*. Longevity and fertility of the female parasite and sex ratio of the progeny were used to determine suitability.

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MATERIALS AND METHODS

Laboratory colonies of *M. persicae* and *B. brassicae* were maintained at 19 ± 5° C and 70% ± 10% RH with a photoperiod of 15L:9D at the University of Tennessee, Knoxville. Parasites were obtained from *B. brassicae,* and were allowed to mate 0-24 h after emergence. Female parasites were placed in individual cages after mating, and were daily presented a minimum of 50 second and third instar aphids reared on broccoli leaves. Infested leaves were removed daily and held for mummy formation. Mummies were removed, counted and placed in 2 ml vials until emergence of adult parasites. The procedure was replicated 10 times with *M. persicae* alone, *B. brassicae* alone, and both species simultaneously as potential hosts. Developmental time, emergence success, and sex ratio of progeny were recorded. No effort was made to determine if mummies from which no parasites emerged contained dead or diapausing parasites.

Host preference was assessed by comparing the mean number of each species parasitized when both were available. Sex ratios from the three host groups were compared as was sex ratio of the progeny from each aphid species when both were available. Sex ratio in this study was not the primary sex ratio, but that of progeny surviving to adulthood and successfully emerging. All mean comparisons were made using the t-test ($p=0.05$).

RESULTS

Mean fertilities of *D. rapae* ovipositing in the three groups accounted for over 50% of all progeny produced by the fourth day after onset of oviposition. A rapid decline in the rate of oviposition followed, and no aphids were successfully parasitized after the seventh day (Fig. 1a). Parasite fertility ranged from 27 to 135 aphids parasitized, but mean fertilities for the three host groups were not significantly different. The rate at which each of the two aphid species was parasitized in the mixed colony was significantly different from other host groups and from each other (Fig. 1b). The rate of parasitization of the cabbage aphid was ca. four times greater than that of the green peach aphid. The mean percentage of females produced from the three host groups increased from 55% on the first day to 85% on the fourth day, but then declined steadily until the sixth day (Fig. 2a). Although no significant differences were noted for the mean number of females produced from each of the three host groups, the percentage of females reared from green peach aphids in the mixed colony was significantly lower than the percentage of females reared from cabbage aphids of that group or from green peach aphids and cabbage aphids presented alone (Fig. 2b). No significant differences were noted for longevity, developmental time, or percent successful emergence of *D. rapae* in three host groups.

DISCUSSION

Once a host has been selected by a female parasite, development of the next generation depends on the suitability of the selected host (Vinson 1976). Presentation of the two aphid species in a homogenous environment and at

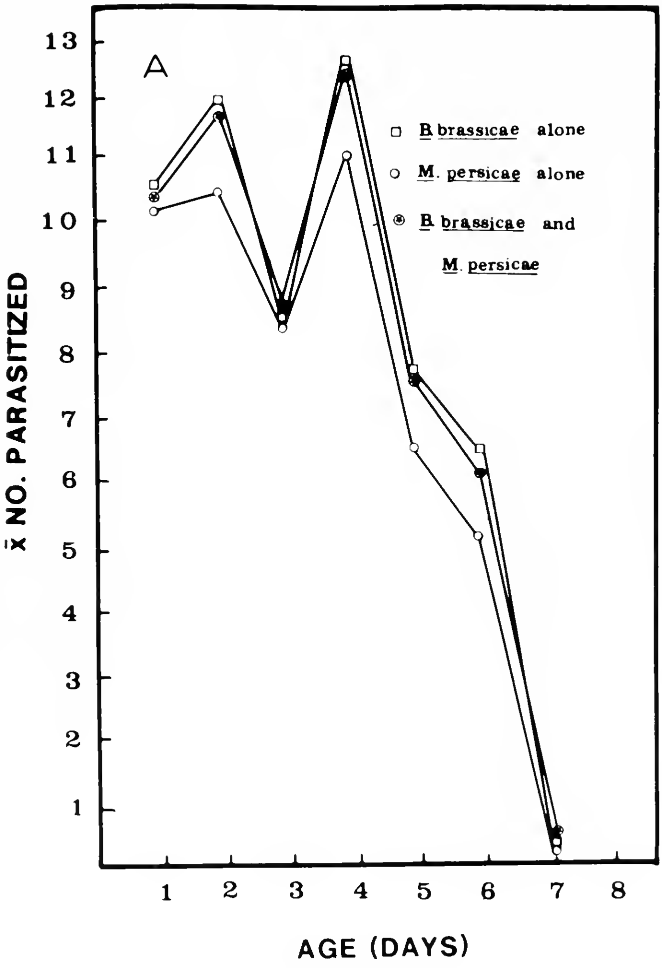
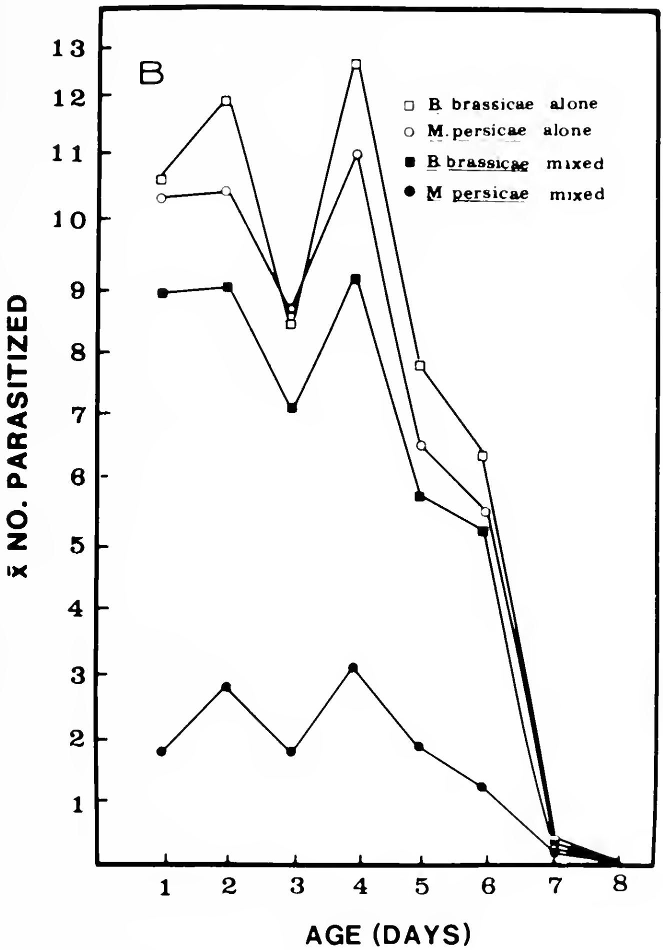


Fig. 1. Mean number of *Brevicoryne brassicae* and *M. persicae* parasitized daily by *Diaeretiella rapae*: (A) for three host groups, (·) for each species.

equal densities eliminated two of the four steps necessary for successful parasitization (Salt 1935, Flanders 1953, Doutt 1959) leaving only host acceptance and suitability as determining factors. Lack of significant differences in mean fertility, developmental time, sex ratio or percent successful emergence for *D. rapae* on either of the two aphid species presented alone suggests their equal suitability as hosts.

Hafez (1961) reported that *D. rapae* averaged 10.3 eggs per day per female on cabbage aphid hosts when superparasitism was considered. The



parasitism rate of 8.3 aphids per female per day in this study is similar with Hafez's because superparasitism was not taken into account.

Longevity for females in an insectary at 20 °C varied from 4.8 days (Akinlosotu 1980) to 15 days (Hafez 1961). Nutritional stability of a host may have an effect on developmental time of the parasite and successful emergence (Vinson and Iwantsch 1980) and different hosts may have different effects. Mean developmental time for *D. rapae* was 13 days in this study which fell between the reported minimum of 11 days on the green peach

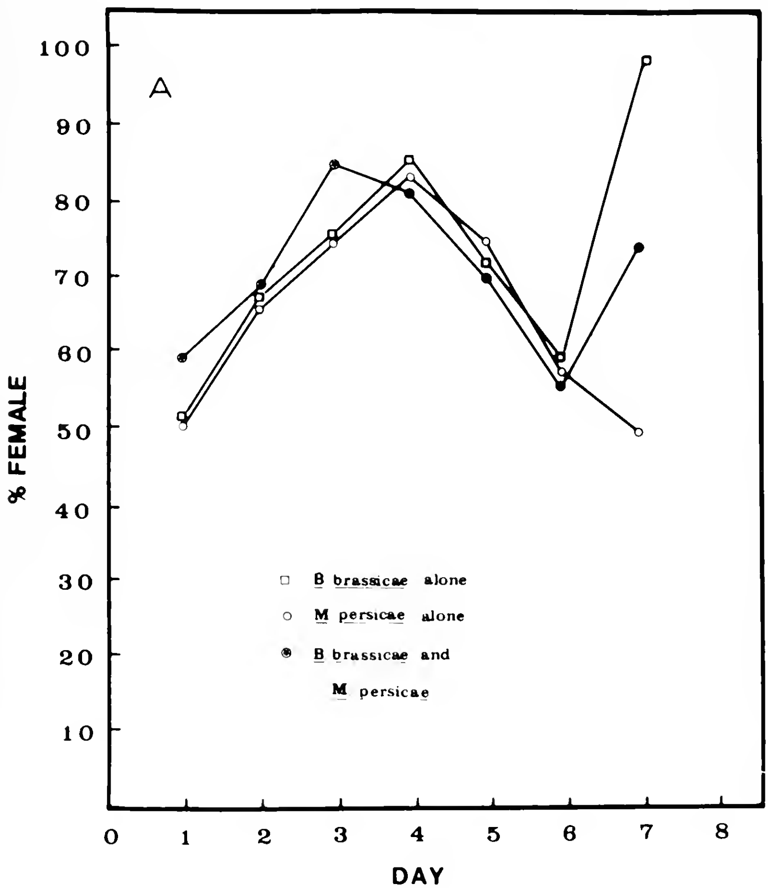
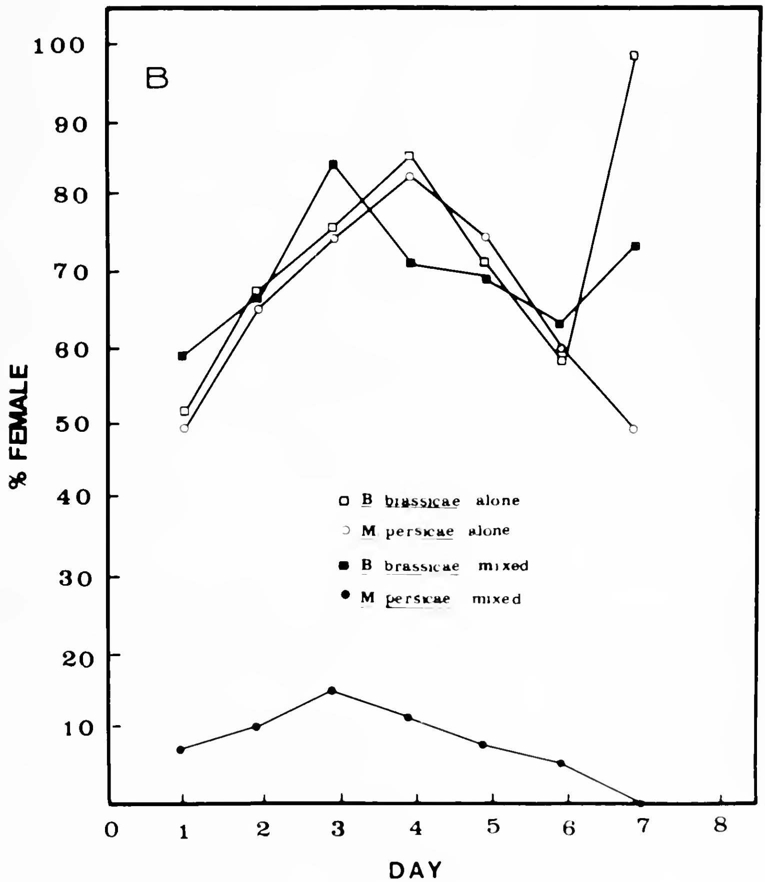


Fig. 2. Percent female progeny of *Diaeretiella rapae* produced from: (A) each of three host groups, (B) each species.

aphid (Simpson et al. 1975) and the maximum of 15 days on the cabbage aphid (Akinlosotu 1977). The variation in percent successful emergence was 0.8% which indicated no substantial difference in the suitability of either host. The sex ratio of 66% females on the green peach aphid to 73.5% on the cabbage aphid in our study closely approximates the range of 60% (Simpson et al. 1975) to 73.4% (Hafez 1961).

In the mixed colony of green peach aphids and cabbage aphids, there was a significant difference in the rate of parasitization of the two species. Host discrimination had an impact on sex ratio of the progeny. The parasitization rate of the green peach aphid dropped 77.7% when it was the only available



host and resulted in an 87% decline in female progeny. Conversely, the rate of parasitization of the cabbage aphid dropped 21.2% and the female progeny dropped 3.6%.

Although each aphid species was equally suitable as host for *D. rapae,* the parasite oviposited more frequently in cabbage aphids and more female progeny were produced with this host. The parasite apparently prefers the cabbage aphid as a host which corresponds with earlier findings by Heong (1981).

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MAINTAINING CAVE CRICKETS (ORTHOPTERA: RHAPHIDOPHORIDAE) IN THE LABORATORY[1]

Richard Y. Lamb[2], Robert B. Willey[3]

ABSTRACT: Cave crickets of the genera *Euhadenoecus* and *Hadenoecus* (Raphidophoridae) have been maintained in the laboratory for more than 6 months at 15°C with nearly 100% RH. They were fed a mixture of whole egg, oatmeal flakes and a triple sulfa antibiotic, plus mineralized water *ad libitum*. Minimal attention (once a week) reduced disturbance and chances of damage to molting crickets.

The genera *Euhadenoecus* Hubbell and *Hadenoecus* Scudder (Orthoptera: Rhaphidophoridae) are found in or near many caves of karst regions in several states east of the Mississippi River (Hubbel and Norton, 1978). Although two species appear to prefer moist forest litter, the remainder occupy caves. These wingless crickets are among the most numerous large arthropods in caves and are familiar to cave biologists and spelunkers. Taxonomy and general biology have been thoroughly covered by Hubbell and Norton (1978), and the few other reports deal largely with ecology (see Barr 1967, 1968; Barr and Kuehne 1971), population genetics models (Caccone 1985), or physiology (Studier et al., 1986). Lamb and Willey (1975) announced the discovery of parthenogenetic populations in one species of each genus.

Doctoral research on parthenogenesis by RYL necessitated keeping these crickets, in particular *Euhadenoecus insolitus* Hubbell, alive in the laboratory for an extended time. We developed procedures allowing caged populations, which usually "crashed" a few weeks after capture, to be maintained in healthy condition for many months. Much trial and error experience was necessary to find the methods which we present here for the benefit of others who study these interesting insects. Full colonization over several generations was never attempted due to the long developmental time (one to two years) of these crickets (Hubbell and Norton 1978).

Capture and Transport to the Laboratory. - Inside caves the crickets are usually found hanging upside down from the ceiling and overhanging rocks. They were captured by placing a widemouthed quart jar just beneath them. When 10 had been collected, they were transferred to a 40 x 75 cm plastic bag containing 6 crumpled, moist paper towels and a tablespoonful of oatmeal.

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After 50-60 adults and subadults had been put into a bag, it was inflated to prevent crushing the insects, tied and placed in a large styrofoam cooler for transport. When the outside temperature warranted, ice in another bag was kept in the cooler to maintain the crickets at a few degrees below cave temperature. The lower temperature decreased cricket movement, preventing damage to them. Ice bags did not touch cricket bags, however, because cooling too far below cave temperature results in mortality.

Care of Crickets in the Laboratory. - The typical lab cage consisted of a 40-liter styrofoam ice chest with a 6 mm thick plate glass top through which the insects could be viewed. In the bottom of this chest were placed the following: approximately one m^2 of cheesecloth wadded into a flattened ball and soaked with distilled water to maintain nearly 100% RH, a plastic petri dish (15 x 60 mm) with food, and another dish of distilled water containing dolomite pebbles to supply minerals. Twenty adults per cage was the largest density at which no appreciable limb loss or mortality occurred. Cages were placed in a large circulating air climate chamber (Percival, Model I 35 LVL) which was kept dark at a constant 15°C. Food and water in the cages were changed and the cheese cloth doused with water once every third day for the first two weeks and once per week thereafter to minimize the chance of disturbing molting crickets. At this time the open cage was briefly fanned manually to freshen the air. Only new cages were used for newly captured crickets, and were not cleaned nor reused.

Food was a mixture of whole raw egg and oatmeal flakes, 2:1 by weight. To the egg we added three sulfa compounds (Sigma Chemical Co.: sulfathiazole, sulfapyridine, sulfamethazine, 6:4:3 by weight), at 1.6% the total weight of the mixture. Sulfa and egg were mixed thoroughly for ten minutes and then the oatmeal was mixed in with a tongue blade to make a moist doughy mass. Food was prepared fresh about once a month and kept covered in a refrigerator. Triple-sulfa was used to prevent cage deaths from endemic gregarine infections and possible cross-infection by *Malamoeba locustae* from grasshoppers reared in the same room. The sulfa compounds do not kill the parasites but do prevent their reproduction and spore formation (Henry, 1968). Lower (e.g., 1.0%) or higher (3.0%) percentages showed more cricket mortality, the higher percentage perhaps due to sulfa toxicity (Henry, 1968). With the triple-sulfa additive the caged crickets lived at least 6 months; without it the cage populations would crash about 5 to 6 weeks after they were brought in from the field.

At times, crickets were observed to be debilitated despite the sulfa treatment. For experimentation it was necessary to distinguish sick crickets from healthy ones; the following criteria were developed:

A healthy cricket's crop was full or 3/4 full of food, visible through the dorsal thorax and abdomen. The insect was alert to escape during attempts to capture it. At postmortem, the body hemolymph was plentiful and the gonads were plump and of appropriate size for its age.

On the other hand, a sick cricket had a gas filled crop without other contents. The escape reaction was minimal and the cricket walked stiffly as if "arithritic." At postmortem, the body cavity was dry, gonads were small, dry and/or discolored.

Although eggs were laid readily by mated controls in moist sand about 1 or 2 cm deep in battery jars, we did not keep sand in the cages nor did we attempt to hatch the eggs. Instead eggs were allowed to accumulate in the female for 5 weeks. The crickets then were sacrificed and the mature unfertilized or parthenogenetic eggs were allowed to develop to blastoderm stage in shallow tapwater at culture temperature. Females can live for many months without laying eggs, resorbing them eventually. Full details can be found in Lamb (1985).

The above methods would probably work equally well for cave crickets of the genus *Ceuthophilus* and other camel crickets that are dependent on high humidity.

ACKNOWLEDGMENTS

We are grateful to Thomas Poulson and Bernard Greenberg for reviewing the manuscript and offering many helpful suggestions. This report is part of a thesis presented in partial fulfillment of the requirements for the Ph.D. in Biological Sciences at the University of Illinois at Chicago.

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SOCIETY MEETING OF FEBRUARY 18, 1987

The third membership meeting of the 1986-87 year attracted 15 members and five guests to the Academy of Natural Sciences in Philadelphia. The meeting included the election of officers. The following were reelected to two-year terms: Roger Fuester (President), Joseph Sheldon (Vice President), Jesse Freese (Treasurer), and Harold White (Corresponding Secretary). Karla Ritter was elected as the new Recording Secretary replacing Ronald Romig who had served for 2 years.

The featured speaker of the evening was Philadelphia physician and member Kenneth Frank who spoke on "Electric Lighting, Moths, and Urban Ecology". His talk was based on his past research on insect circadian rhythms, his long standing interest in Lepidoptera, and his perspectives as an urban resident. It is a common perception that populations of large moths in cities have declined precipitously in recent history. This has occurred during a period in which there has been a tremendous increase in outdoor lighting and a casual link between the correlated phenomena has been suggested. Dr. Frank systematically discussed the many ways in which urban lighting could affect the populations and behavior of night flying insects. For instance, electric lighting could shift circadian rhythms so that flight periods would not coincide with the optimum time for mating. Flight to electric light sources could disturb navigation, and it could increase exposure to predators. Both positive and negative effects are possible, and counter balancing ecological responses may modify these effects. Given the fact that outdoor lighting has increased at the same time as many other changes that could affect urban moth populations, it is impossible to conclude that there is a casual relationship between declining moth populations and outdoor lighting.

Populations of the cynthia moth (*Samia cynthia*) have been declining precipitously in recent decades as has been discussed in recent meetings. Vincent Ventre reported that he and several others observed only one cocoon of this species in an intensive search last November 18 in an area of Philadelphia where several cocoons were found in recent years. Mr. John C. Bair, a lighting contractor for the Philadelphia Department of Streets, came to the meeting because of an invitation extended by Dr. Frank. Mr. Bair brought with him a high-pressure sodium vapor lamp of the kind used to illuminate Philadelphia streets. Dr. Frank set up a spectroscope for observation of the lamp and to demonstrate the difference between the sodium emission spectra and the spectra of fluorescent lighting. The increasingly common "orange" halide lamps used for outdoor lighting do not produce light at the wavelengths (ultraviolet) perceived by most insects in their flight to light. Dr. Frank's multidisciplinary talk and the demonstration elicited many questions. Members entering the night time urban environment after the meeting could not help but look at street lights differently even though it was too cold for moths.

Harold B. White,
Corresponding Secretary

SOCIETY MEETING OF MARCH, 18, 1987

"Butterflies! Butterflies!" was the title of the talk presented by Dr. Stanley Temple to the 15 members and six guests who attended the March membership meeting at the University of Delaware. Dr. Temple, a chemist with the duPont Company in Deepwater, N.J., has devoted much of his spare time to various conservation and natural history organizations. In particular he highlighted the activities of the Xerces Society whose name comes from the now extinct butterfly, the Xerces Blue. The Society is dedicated to the preservation of endangered invertebrates of all kinds, not only butterflies. In keeping with the ethics of insect conservation rather than preservation, Dr. Temple showed beautiful slides of many local and exotic butterflies that never entered a killing jar or specimen box. Although Dr. Temple's interest in insects has its roots in a childhood hobby of rearing caterpillars, his interest in insect photography evolved from attempts to make photographs of plants more interesting by combining flowers and their pollinators. In the question session that followed the talk, Dr. Temple discussed topics ranging from food plant preferences of caterpillars to the photographic techniques he uses.

Harold B. White
Corresponding Secretary

AMERICAN ENTOMOLOGICAL SOCIETY AWARDS THE FIRST CALVERT PRIZE TO A YOUNG ENTOMOLOGIST

The Calvert Prize has been established by the American Entomological Society. This award will be given annually, if appropriate, to a young scientist from the Delaware Valley who displays unusual accomplishments in the area of entomology. Margot Livingston, an eighth grade student at Allen Middle School in Moorestown, N.J., is the first recipient of the Calvert Prize. The award includes one year memberships in the American Entomological Society and the Young Entomologists Society, a subscription to Entomological News, and a $25 check to be used for entomological books or supplies.

"Sevin lasts for seven days but its effects last for seven years", was a comment that stimulated Margot to initiate a science project. She compared the effects of Sevin and B.t. on the survival of Black Swallowtail larvae fed foliage sprayed with the insecticides at various times before feeding. In addition to the Calvert Prize her project, "Effects of Gypsy Moth Spraying on the Eastern Swallowtail Butterfly", also won first prize in the Zoology Division and the Gold Medal top prize at the Albert Einstein Science Fair held April 8th at the Pennsylvania National Guard Armory. Members of the Society had the opportunity to meet the prize winner, her parents, and teacher; and see her project at the April 15th membership meeting at the Academy of Natural Sciences of Philadelphia where the award was made.

Philip P. Calvert was commemorated at the 125th Anniversary Meeting of the Society in 1984 (See *Ent. News,* 95(4), 155-162). Beginning at the age of 16 Calvert had a 74 year association with the Society serving as President (1900-15) and Editor of Entomological News (1911-43) among other positions. His teenage interest in insects was nurtured by the Society and the Academy of Natural Sciences of Philadelphia. He in turn nurtured the entomological interests of other young people through the Society and the Academy and as Professor of Biology at the University of Pennsylvania. It is therefore appropriate that the Society should sponsor an award for young entomologists in honor of Dr. Philip P. Calvert. It is particularly fitting that the first recipient of this prize has a strong interest in art. As a teenager Calvert was an accomplished artist. Among Calvert's belongings now preserved in the Archives of the Academy's library is a beautiful color illustration of the larva, pupa, and adult of the Eastern Black Swallowtail Butterfly drawn 102 years ago when he too was 14! A photograph of this drawing will be given to Margot Livingston.

Harold B. White
Chairman, Education Committee

SOCIETY MEETING OF APRIL, 15, 1987

Myrmecocystus mexicanus hortideorum was the featured species in Dr. John Conway's illustrated talk, "The Biology of the Honey Ants," at the final membership meeting of the 1986-87 season. Dr. Conway, an Associate Professor of Biology at the University of Scrantan, Pennsylvania, has devoted much of his professional career to studying and popularizing honey ants. He clearly has been successful considering that several among the 12 members and 10 guests realized at the meeting that their familiarity with honey ants had come from one of Dr. Conway's many articles in various science journals, e.g. *Am. Biol. Teacher* 48: 335-343 (1986).

In a casual walk along the ridges in the suburbs of Colorado Springs, the presence of occasional volcano-shaped ant hills with no daytime activity around them would attract little attention. Yet beneath these inconspicuous mounds lie colonies of fascinating honey ants. Hanging from the ceilings of many subterranean chambers are repletes, helpless members of the colony which store large quantities of nutrients for the colony in their crops and have enormously distended abdomens. The queen lives in the lowest chamber well over a meter below ground level. In the evening workers emerge to scavenge for dead insects, nectar, and plant exudates. They in turn feed the repletes that account for about a quarter of the 5000-member colony. Once a year in late July young winged queens and males emerge, mate in flight, and disperse to found new colonies.

Dr. Conway reported that honey ants have a taste like cane molasses provided the formic acid-containing parts are not eaten. The amount of work required to exhume these ants make it unlikely they will ever become a delicacy except to occasional badgers or coyotes. Interestingly honey ants have also evolved independently halfway around the world in Australia. Dr. Conway will be leading an Earthwatch trip to study these apparent examples of convergent evolution to understand the selective pressures that led to their peculiar specialization.

Among the people attending the meeting at the Academy of Natural Sciences in Philadelphia was the Society's newest member, Margot Livingston, an eighth grade student from Moorestown, New Jersey. Margot was honored as the first recipient of the Calvert Prize, a newly established award of the Society to be given on an annual basis to a young entomologist in the Delaware Valley. Margot was given membership in the Society and in the Young Entomologists' Society for her outstanding science project, "Effects of Gypsy Moth Spraying on the Eastern Black Swallowtail Butterfly." Roger Fuester, President of the Society, also presented Miss Livingston with a $25 check for entomological books and supplies.

Harold B. White
Corresponding Secretary

Ed. note: Dr. Conway's Earthwatch trips to study Australian honey ants are scheduled for July 12-26, July 28-Aug. 11, and Aug. 13-27, 1987. Earthwatch needs paying volunteers to help with field work. Interested persons should contact Earthwatch, 680 Mt. Auburn St., Box 403, Watertown, Mass. 02272.

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(Continued on inside of back cover)

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SUPERCOOLING POINTS OF RED IMPORTED FIRE ANTS, *SOLENOPSIS INVICTA* (HYMENOPTERA: FORMICIDAE) FROM LUBBOCK, TEXAS[1]

Stephen W. Taber[2], James C. Cokendolpher[2,3], Oscar F. Francke[4]

ABSTRACT: Supercooling points were measured for multiple queen colonies of the red imported fire ant, *Solenopsis invicta*, from Lubbock, Texas. Ten minor workers from each of three marked field colonies and from one colony held at constant conditions in the laboratory were tested at two week intervals from 14 October 1985 to 17 February 1986. Supercooling abilities of field specimens differed markedly from those of laboratory specimens. Significant differences among mean supercooling temperatures of ants in the field were found among sampling periods, but not among colonies. The maximum difference over time among sample mean supercooling points was less than 2 C°, and the lowest mean supercooling point was slightly higher than -6°C.

We first became aware of the presence of red imported fire ants in Lubbock, Texas, during August 1985, when homeowners from a single subdivision reported colonies which apparently had been present for several years. This information was of immediate interest because Lubbock, at 33.5° N latitude, then represented the extreme northwestern record of *Solenopsis invicta* Buren. Furthermore, at 980 m elevation the Lubbock population is among the highest on record in the U.S.A.

Winter-kill has been cited as an important limiting factor in the northward spread of introduced fire ants (Moody et al. 1981). The ultimate distributional limits of the introduced fire ants in the U.S.A are thought to be linked to cold-hardiness (Francke and Cokendolpher 1986, Francke et al. 1986 and citations therein). One prediction of the ultimate range of this species in Texas excluded the Panhandle area north of the -18°C minimum temperature isotherm because of low winter temperatures in that area (Pimm and Bartell 1980 and citations therein). Lubbock County is located at the base of the Texas Panhandle, along the -18° C minimum temperature isotherm, and therefore is an ideal position for researchers to examine cold-hardiness of *S. invicta* and its ability to survive winter conditions.

Cold-hardiness in insects may be divided into three general categories: (1) cold-acclimation and acclimatization, (2) supercooling, and (3) freezing-tolerance (Salt 1961). Cold-acclimation/acclimatization require some tolerance or physiological preparation to avoid injury at

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temperatures too low for continued growth. We herein refer to short-term, physiological adjustments in the laboratory as acclimation and those occurring naturally in the field as acclimatization. The ability to supercool is an adaptation in which insects avoid injury by resisting the freezing process. If the organism is able to withstand bodily freezing, it is described as being freeze-tolerant.

Previous work with laboratory colonies of North American fire ant species revealed no significant differences among mean supercooling temperatures of *Solenopsis aurea* Wheeler, *S. richteri* Forel, and *S. xyloni* McCook within the minor caste (Francke et al. 1986). Neither was a significant difference found between *Solenopsis invicta* and *S. geminata* (Fabricius), but the two species were significantly different. From the same study the following generalizations were made: (1) worker ants have a slightly lower supercooling point than do reproductives, (2) within a given species, immature ants have lower supercooling points than do adults, and (3) pupae have lower supercooling temperatures than do larvae. The effects of acclimation on the freezing point of *S. invicta* were tested by maintaining major, medium, and minor workers at each of three temperatures: 12°, 22°, and 32°C. No significant differences were noted among treatments, nor in the interactions between castes and treatments, but significant differences were found among castes. However, nothing was previously known of the acclimatization abilities of *S. invicta*. Therefore, we investigated the supercooling abilities of red imported fire ants in a field situation during the fall and winter months.

MATERIALS AND METHODS

The same equipment and procedures reported by Francke et al. (1986) were used to measure supercooling points (lowest body temperature reached before spontaneous freezing). Following those procedures the temperature of the ants decreased by approximately 5C° per minute. At two week intervals, from 14 October 1985 until 17 February 1986, we collected 10 minor workers from each of three designated mounds and determined their supercooling points immediately upon returning to the laboratory. Experiments were concluded by March because the ants were poisoned in an effort to control their spread in Lubbock. Ten samples were taken during the 18 week period. The previous study (Francke et al. 1986), demonstrated that supercooling abilities differ among caste members. Therefore, we used minor workers in the present experiments because they were reported to have the lowest supercooling points among adults tested. Supercooling points of 10 minor workers, from a laboratory colony previously (September 1985) removed from the field locality, were determined at two week intervals until 3 February. The laboratory colony was maintained with the same food, light, and temperature regimens used by Francke et al. (1986). Direct observations of the laboratory colony and numerous other colonies collected from the study site revealed the Lubbock population to be composed of multiple queen colonies.

RESULTS AND DISCUSSION

No significant differences were found among mean supercooling points from the three field colonies using a one-way analysis of variance [$F(2, 297) = 0.45$, $p>0.05$]. Analysis of covariance confirmed this finding but revealed significant differences among samples taken throughout the season [$F(1,294 = 115.38$, $p < 0.05$]. The mean supercooling temperature ± standard error for each sampling period is shown in Fig. 1. The data seem to show oscillatory changes in the supercooling points over the 18 week period, and there does not appear to be monotonic acclimatization in minor workers of *S. invicta.* The maximum difference between mean supercooling temperatures is less than 2C^{o}, and the minimum individual supercooling temperature recorded was -7.6^{o}C.

The mean supercooling points ± standard errors for minor workers from a laboratory colony are shown in Fig. 2. The reasons for the large standard errors are not immediately apparent. Diet may be a factor; the laboratory colony was supplied with cockroaches, mealworms, and water. Temperature and photoperiod may also affect the supercooling point. The laboratory colony was kept in complete darkness at a constant 22^{o}C, whereas the field colonies experienced normal photoperiods and fluctuating temperatures. These comparisons are interesting; but because the primary goal of this study was to observe changes of mean supercooling points in field colonies over time, no further investigation of the laboratory colony was pursued.

Like Francke and Cokendolpher (1986) and Francke et al. (1986), we noted no ants that survived freezing, and therefore, freeze-tolerance as a possible overwintering mechanism in *S. invicta* was excluded.

In summary, the following points are important: (1) differences among supercooling abilities of ants in the field were noted among samples over time, but not among colonies, (2) differences among sampling periods might not be due to acclimatization, (3) the mean supercooling points for field colonies varied less than 2^{o}C from October through February, but never fell below -6^{o}C, and (4) supercooling abilities of the red imported fire ant are altered in the laboratory.

Recent soil temperature measurements (Harlan Thorvilson et al., unpub. data) obtained in the immediate vicinity of the field colonies indicate that the temperature at a depth of 30 cm between 6 January and 20 February 1986 never fell below 4^{o}C. If the supercooling temperature of *S. invicta* is the primary measure of cold-hardiness, such a soil temperature would cause little mortality.

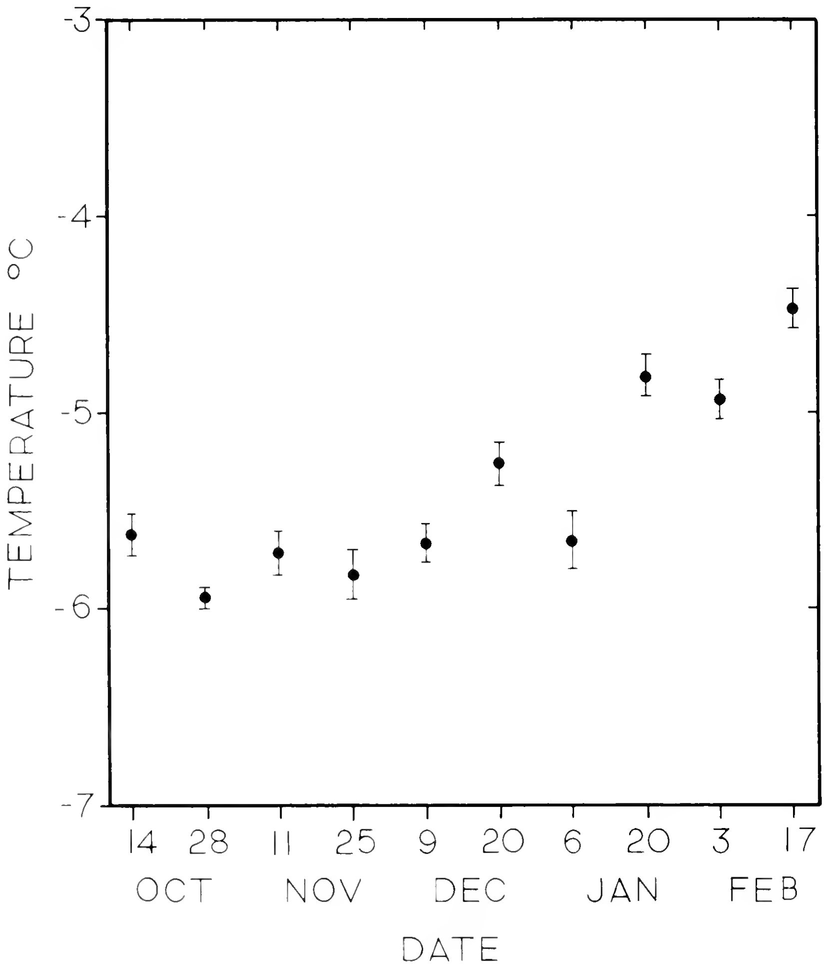

Fig. 1. Mean freezing points ± standard errors of minor workers of *Solenopsis invicta* in field samples from Lubbock, Texas.

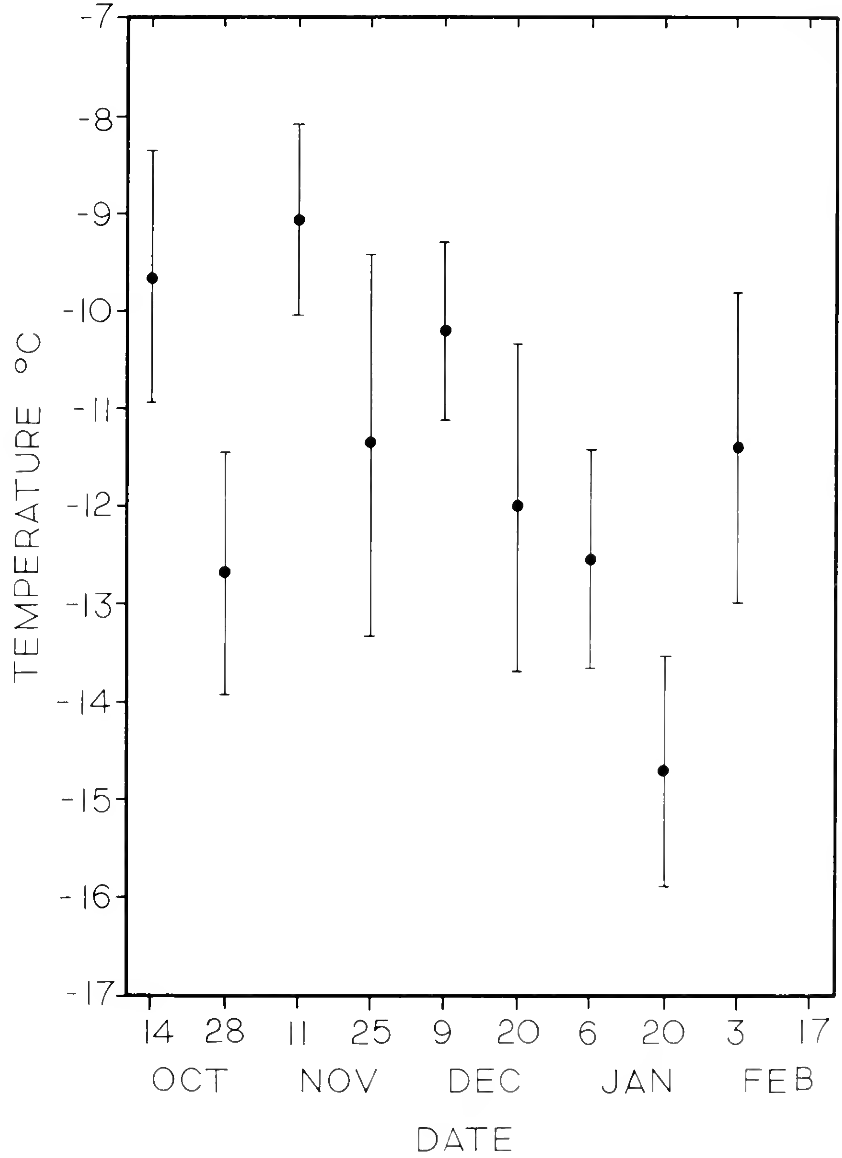

Fig. 2. Mean freezing points ± standard errors of minor workers of *Solenopsis invicta* from a laboratory maintained colony from Lubbock, Texas.

ACKNOWLEDGMENTS

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OFFICIAL LISTS AND INDEXES OF NAMES AND WORKS IN ZOOLOGY

A revised and updated edition of the *Official Lists and Indexes of Names and Works in Zoology* has now been published. For the first time all the names and works on which the International Commission on Zoological Nomenclature has ruled since it was set up in 1895 are brought together in a single volume. Entries are arranged in four sections giving in alphabetical order the family-group names, generic names, specific names and titles of works which have been placed on the Official Lists or the Official Indexes. There are about 9,900 entries of which 134 are for works. In addition, there is a full systematic index and a reference list to all relevant Opinions and Directions. The volume is 366 pages, size A4, casebound.

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NOTES ON PHORESY BETWEEN *RHEOTANYTARSUS* SP. (DIPTERA: CHIRONOMIDAE) AND *TRICORYTHODES* SP. (EPHEMEROPTERA: TRICORYTHIDAE) IN A SOUTH CAROLINA TAILWATER STREAM[1]

Thomas J. Wilda[2]

ABSTRACT: A phoretic relationship between larvae of *Rheotanytarsus* and *Tricorythodes* is reported for the first time.

White et al. (1980) reported that phorsey involving chironomid larvae is relatively common in the Piedmont region of South Carolina. They found *Rheotanytarsus* sp. (Diptera: Chironomidae) larvae on the odonates *Boyeria venosa* (Say), *Macromia* sp., and *Calopteryx maculata* (Beauvois), the trichopteran *Nectopsyche exquisita* (Walker), and the ephemeropteran *Stenonema smithae* Traver. *Rheotanytarsus* sp. have also been reported in phoretic associations with *Pteronarcys dorsata* (Say) (Dosdall et al. 1986) and *Corydalus cornutus* (Linaeus) (Furnish et al. 1981 cited in Dosdall et al. 1986). I collected a 5 mm-long larva of *Tricorythodes* sp. with a fourth instar *Rheotanytarsus* sp. larva attached dorsally to its thorax (Figure 1) in September, 1986, while sampling the Saluda River below Saluda Hydroelectric Station (Greenville Co., SC). This is the first report of a phoretic relationship between these organisms.

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Figure 1. *Tricorythodes* larva with *Rheotanytarsus* encased on its thorax.

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A DETRITIVORE *TIPULA* (DIPTERA: TIPULIDAE) AS A SECONDARY HOST OF *POECILOGONALOS COSTALIS* (HYMENOPTERA: TRIGONALIDAE)[1,2]

Jon K. Gelhaus[3]

ABSTRACT: *Poecilogonalos costalis*, a hyperparasitoid trigonalid wasp, was reared from a tachinid fly which had parasitized a *Tipula* larva. The use of a crane fly larva as a secondary host by the trigonalid represents the first reported detritivorous host. In addition, the discovery of *Poecilogonalis costalis* in Kansas extends its range significantly westward.

Wasps of the family Trigonalidae are recorded as hyperparasitoids of tachinid flies and ichneumonid or vespid wasps which parasitize or prey on leaf-feeding larvae of Lepidoptera and Symphyta (Townes 1956; Carlson 1979). In 1985, I reared *Poecilogonalos costalis* (Cresson) from a puparium of *Allophorocera arator* (Aldrich) (Diptera: Tachinidae), which parasitized a larva of *Tipula (Triplicitipula)* sp., probably *flavoumbrosa* Alexander (Diptera: Tipulidae). The *T. flavoumbrosa* larva was collected in forest soil at the University of Kansas Natural History Reservation, 8.0 km NE of Lawrence, Douglas Co., Kansas, on March 18, 1985. In the laboratory, two tachinid larvae emerged from the *Tipula* and pupated on April 2, and the trigonalid adult emerged from one of the tachinid puparia on April 27.

Trigonalids oviposit near the margins of living angiosperm leaves or petals, and the eggs must be ingested by a caterpillar or sawfly larva before hatching (Clausen 1940). Further development of the trigonalid larva only occurs if the parasitoid host is present inside the secondary host. Larvae of *Tipula flavoumbrosa* feed in the upper levels of forest soil as shredders on fungi-conditioned, decomposing leaves and other litter (pers. obs.). Apparently, the trigonalid egg remained viable even as the leaf it was deposited on died and decomposed. Trigonalid egg viabilities of several months have been noted by Clausen (1940), presumably on living leaves. There is the additional possibility that the trigonalid oviposited directly on decaying litter, although this ovipositional site has not been noted in the few

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published observations of trigonalid oviposition. The present report represents the first of a trigonalid from a parasitoid whose host is a detritivore and not an herbivore. Additionally, the secondary host in this instance is a dipteran larva and not a lepidopteran or symphytan larva.

The record of *Poecilogonalos costalis* from Kansas represents a significant westward extension of the previously known eastern and southeastern North American distribution (Ohio, Louisiana; Carlson 1979).

ACKNOWLEDGMENTS

I thank David Wahl, American Entomological Institute, Gainesville, Florida, for identifying the trigonalid wasp, and Norman Woodley, Systematic Entomology Laboratory, United States Department of Agriculture, Washington, D.C., for identifying the tachinid host. I appreciate the comments and discussions of this paper with J. Wenzel, D. Wahl, G. Byers and C. Michener. All specimens are deposited in the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

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CALL FOR NOMINATIONS FOR NEW MEMBERS OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

The following members of the Commission reach the end of their terms of service at the close of the XXIII General Assembly of the International Union of Biological Sciences to be held in Canberra in October 1988: Prof Dr. R. Alvarado (Spain; specialist field Echinodermata); Dr. G. Bernardi (France; Lepidoptera); Prof. C. Dupuis (France; Heteroptera) and Dr. L.B. Holthuis (The Netherlands; Crustacea). A further vacancy arises from the death of Prof. B.S. Zheng (People's Republic of China; Ichthyology).

The addresses and specialist fields of the present members of the Commission may be found in the *Bulletin of Zoological Nomenclature,* 44(1): 2-3 (March 1987). Under Article 3*b* of the Commission's Constitution a member whose term of service has terminated is not eligible for immediate re-election unless the Council of the Commission has decided to the contrary.

(Continued on page 170)

FEEDING HABITS OF THE WEEVIL *BARYPEITHES PELLUCIDUS* (COLEOPTERA: CURCULIONIDAE)[1]

Jimmy R. Galford[2]

ABSTRACT: The weevil *Barypeithes pellucidus* was observed feeding on 18 species of plants in central Ohio. Feeding was light to very light on most species. Northern red oak, asters, American elm, hawthorn, and black cherry were preferred.

Adults of the introduced weevil *Barypeithes pellucidus* (Boheman) were reported feeding on northern red oak, *Quercus rubra* L., seedlings growing in the understory of a 20-year-old red oak plantation near Delaware, Ohio (Galford, 1986). The weevil population in this plantation was very low in 1985, but, in the spring of 1986, hundreds of adults were found easily.

The following life history observations were made: adults began emerging in mid-April, peaked in early May, and had disappeared by June 10th. The adults were mainly nocturnal but continued to feed on heavily shaded plants during early morning hours. Adults could be found feeding all day when the sky was heavily overcast. On sunny days, the adults aggregated in groups of 2 to 36 under piles of moist, dead oak leaves, logs, stones, moss, and fresh fallen tree leaves. The adults usually aggregated on one plant when feeding, and, in one instance, 42 weevils were found on a single wild rose, *Rosa* sp. Only once was feeding observed above 60 cm. The preferred feeding sites were leaves of small plants (2-30 cm. high) or the lower portions of larger plants in contact with the soil or duff, near piles of dead oak leaves. The adult weevils fed on leaves, small stems of new growth, or the epidermis of large green stems. On the common dandelion, *Taraxacum officinale,* the weevils fed lightly on the leaves but moderately on the epidermis of the flower stems. The epidermis of the midrib vein of dead, wet (saturated) red oak leaves was also consumed. Although feeding occurred on 18 plant species, feeding was light to very light on most and might have been termed "sampling." The following species are listed in order of observed feeding preference:

Scientific Name	Common Name	Degree of Feeding
Quercus rubra	Northern red oak	Heavy
Aster divaricatus	White wood aster	Heavy

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Scientific Name	Common Name	Degree of Feeding
Aster lowrieanus	Lowrie's aster	Heavy
Ulmus americana	American elm	Heavy
Crataegus sp.	Hawthorn	Moderate
Prunus serotina	Black cherry	Moderate
Taraxacum officinale	Common dandelion	Light
Potentilla sp.	Cinquefoil	Light
Senecio sp.	Ragwort	Light
Cirsium arvense	Canada thistle	Light
Rhus radicans	Poison-ivy	Light
Rosa sp.	Wild rose	Light
Lysimachia nummularia	Moneywort	Very Light
Pastinaca sativa	Wild parsnip	Very Light
Scutellaria sp.	Mint	Very Light
Vitis sp.	Wild grape	Very Light
Barbarea verna	Early winter cress	Very Light
Dipsacus laciniatus	Teasel	Very Light

About half of nearly 200 2-year-old red oak seedlings under observation in the oak plantation understory were defoliated partially to wholly by the weevils before a violent storm littered the ground with leaves. The weevils then fed on the fallen leaves, and damage to the red oak seedlings nearly ceased. After several days of overcast, rainy weather, the weevils died by the hundreds from a fungus disease. This same disease made laboratory studies on the weevils very difficult because most of the weevils died in 3 to 4 days.

Weevils that were kept in 150- x 20-mm petri plates and provided fresh red oak leaves laid eggs sparingly in moist soil. The oblong, dark yellowish-brown eggs began to hatch in ca. 12 days at 22-26°C.

Larvae of *B. pellucidus* may be root feeders. A few larvae have been reared into second and third instars on small fibrous red oak roots in 30-ml plastic cups. Soil excavations made in late April near a sprouting red oak stump revealed several teneral adults at depths of 5 to ca. 15 cm; however, several other species of plants were growing around the stump. The larval host or hosts of *B. pellucidus* need to be determined.

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THE DISTRIBUTION OF SHORE FLIES (DIPTERA: EPHYDRIDAE) IN ILLINOIS[1]

B.A. Steinly[2], E. Lisowski[3], D. Webb[3]

ABSTRACT: New state and/or habitat records are reported for *Ephydra cinerea, Ditrichophora exigua, Lemnaphila scotlandae, Lytogaster excavata, L. furva, Nostima scutellaris, Paralimna punctipennis, Polytrichophora orbitalis, Pseudohecamede abdominalis, Psilopa dupla, Scatella obsoleta, S. quadrinotata, S. stagnalis,* and *Scatophila unicornis* (Diptera: Ephydridae). Notably, *Scatella obsoleta,* and *S. stagnalis* were collected in a hydroponics greenhouse.

Many species of Ephydridae (Diptera) are found in semi-aquatic and aquatic habitats. The ecology and distribution of shore flies have been investigated in aquatic habitats in Iowa (Deonier, 1965), and Ohio (Scheiring and Foote, 1973; Deonier and Regensburg, 1978; Steinly and Deonier, 1980; Steinly, 1986). In addition, ephydrid habitats and population composition have been studied within limited geographic areas in North Dakota (Harris and Deonier, 1979), California (Barnby and Resh, 1984), Washington (Zack, 1979, 1983) and Ohio (Steinly, 1978, 1984a and b). These Nearctic habitats are delimited by vegetation types, substratum conformation, and surface water abundance. Thus, while shore flies have received much attention, the majority of ephydrid ranges, habitat distributions, and population characteristics are unknown.

In this paper, we present new state (SR) and habitat (HR) records. The distributions of selected ephydrid species are discussed.

METHODS

Adult shore flies were collected with a modified aerial sweep net (Regensburg, 1977). In the field, selected adults were aspirated into 7-dram vials, and the remaining adults in the collecting bag were killed with ethyl acetate. Adult specimens were point-mounted in the laboratory and examined to determine reproductive condition.

Lemnaphila scotlandae Cresson eggs and larvae were removed from field-collected samples of *Lemna minor* Linnaeus (duck weed) and placed in beakers of pond water at room temperature. Eggs were left on the duckweed thallus to facilitate handling. Larvae found mining duck weed were

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transferred to holding beakers without removing them from the thallus. Also, free-floating puparia were collected from field samples and placed in holding beakers. Newly emerged adults of *L. scotlandae* were aspirated into vials, killed with ethyl alcohol, and pointmounted.

Specimens designated INHS were examined from the Illinois Natural History Survey Collection, Champaign, Illinois. Voucher specimens of field-collected material have been deposited in the INHS collections.

RESULTS

For the first time, *Ephydra cinerea* Jones, *Ditrichophora exigua* Cresson, *Ilythea spilota* (Curtis), *Lemnaphila scotlandae* Cresson, *Nostima scutellaris* Cresson, *Paralimna punctipennis* (Wiedemann), *Polytrichophora orbitalis* (Loew), *Pseudohecamede abdominalis* (Williston), *Psilopa pulchripes* Loew, and *Scatophila unicornis* Czerny are reported from Illinois (Table I.). New habitats have been recorded for *Lytogaster excavata* (Sturtevant and Wheeler), *L. furva* Cresson, *Pa. punctipennis, Po. orbitalis, Ps. dupla* Cresson, *Scatella obsoleta* Loew, *S. quadrinotata* Cresson, *S. stagnalis* (Fallén), and *Scatophila unicornis.* Notably, *Lemnaphila scotlandae* was collected from duck weed and *E. cinerea* was associated with salt habitats. *Scatella obsoleta* and *Sc. stagnalis* were collected in a hydroponics greenhouse.

Ephydra cinerea Jones

Patoka, Ill., in salt pool, July-19-1945, 29 adults, Ross. and Sand., INHS. (SR)

Ditrichophora exigua Cresson

Vermilion Co., Forest Glen Forest Preserve, 7 mi SE Westville, VI-25-1984, B.A. Steinly, grass shore, 3 adults. (SR)

Ilythea spilota (Curtis)

Vermilion Co., Forest Glen Forest Preserve, 7 mi SE Westville, VI-25-1984, B.A. Steinly, Woodland stream, silt impregnated sand, 5 adults. (SR)

Lemnaphila scotlandae Cresson

Vermilion Co., Forest Glen Forest Preserve, 7 mi SE Westville, IX-20-1986, B.A. Steinly, *Lemna minor* (Duck Weed), 10 adults and 47 larvae; Clay Co., Buck Creek, Sta. 3, 4.1 km (2.5 mi) NNE Flora, T3N, R7E, Sec 18 SW/4, IX-16-1986, B.A. Steinly and E.A. Lisowski, Duck Weed, 7 adults; Buck Ck., Sta. 6, 7.1 km (4.4 mi) NE Flora, T3N, R7E, Sec 9, NE/4, SE/4, NW/4, IX-16-1986, E.A. Lisowski and B.A. Steinly, 1 adult and 31 larvae; Grundy Co., 0.6 mi S Morris, SE/4, NE/4, SE/4 Sec 9, TssN, R7E, IX-21-1986, E.A. Lisowski, Duckweed, 14 larvae and 3 puparia; La Salle Co., I and M Canal, 1 mi W Utica SW/4 Sec 8, T33N, R2E, IX-21-1986, E.A. Lisowski, Duckweed, 27 larvae; La Salle Co., Illini State Park, 0.8 mi SE Marseilles, SE/4, NW/4 Sec 19, T33N, R5E, IX-21-1986, E.A. Lisowski, 15 larvae. (SR)

Lytogaster excavata (Sturtevant and Wheeler)

Vermilion Co., Forest Glen Forest Preserve, 7 mi SE Westville, VI-25-1984, B.A. Steinly, Sedge Meadow, *Scirpus* sp., 18 adults. (HR)

Lytogaster furva Cresson
Vermilion Co., Forest Glen Forest Preserve, 7 mi SE Westville, VI-18-1986, B.A. Steinly, Sedge Meadow *Scirpus* sp., adult. (HR)

Nostima scutellaris Cresson
Vermilion Co., Forest Glen Forest Preserve, 7 mi. SE Westville, VI-25-1984, B.A. Steinly, Grass shore adjacent to woodland stream in ravine, 1 adult. (SR)

Paralimna punctipennis (Wiedemann)
Vermilion Co., Forest Glen Forest Preserve, 7 mi SE Westville, VIII-18-1986, B.A. Steinly, Sedge meadow, 3 adults. (SR & HR)

Polytrichophora orbitalis (Loew)
Vermilion Co., Forest Glen Forest Preserve, 7 mi. SE Westville, VII-13-1986, B.A. Steinly, silt impregnated sand, 5 adults. (SR & HR)

Pseudohecamede abdominalis (Williston)
Mason Co., Illinois River, Havanna, (INHS), 1 adult. (SR)

Psilopa dupla Cresson
Vermilion Co., Forest Glen Forest Preserve, 7 mi. SE Westville, V-21-1986, 41 adults; V-29-1986, 47 adults; VI-15-1986, 34 adults; VIII-18-1986, 15 adults; IX-20-1986, 6 adults; X-6-1986, 4 adults B.A. Steinly, Terrestrial mowed grass. (HR)

Psilopa pulchripes Loew
Champaign Co., Urbana, Ill., I-II-1986 (INHS), 1 adult; Lake Co., Waukegon, VIII-21-1917 (INHS), 1 adult; St. Clair Co., Centerville, VIII-18-1914 (INHS), 1 adult. (SR)

Scatella obsoleta Loew
Macon Co., Decatur, V-10-1986 (D. Webb) (INHS), Hydroponics greenhouse, 1 adult, 2 puparia. (HR)

Scatella quadrinotata Cresson
Vermilion Co., Forest Glen Forest Preserve, 7 mi. SE Westville, VI-13-1986, B.A. Steinly, duck weed on mud, 1 adult. (HR)

Scatella stagnalis (Fallen)
Macon Co., Decatur, XI-7-1986 (D. Webb), Hydroponics greenhouse, 50 adults, (INHS). (HR)

Scatophila unicornis Czerny
Du Page Co., Lisle, (INHS), greenhouse, 1 adult. (SR & HR)

DISCUSSION

Psilopa dupla was consistently collected from May through October, and gravid females from late May through August, 1986. At Forest Glen Forest Preserve, *P. dupla* specimens were not collected in the adjacent undisturbed marsh-reed and grass shore habitats. In southern Ohio, a few *P. dupla* and *P. compta* (Meigen) were found in a terrestrial mowed grass habitat that had thick mats of grass clippings (Steinly and Runyan, 1979; Steinly, 1984b). During 1976, *P. girschneri* von Röder was very abundant in two northern Ohio habitats (Steinly, 1979) that had prominent accumulations of decaying vegetation. Association with decaying vegetation, reproductive condition, and frequency of collection suggests that Psilopa species have encountered favorable breeding conditions in disturbed terrestrial grass habitats.

Although numerous *Ephydra cinerea* Jones specimens were found in the INHS collection, attempts to locate viable populations in Illinois proved futile. This halphilic species was very abundant in a single salt habitat at Rittman, Ohio (Steinly, 1979). In all probability, the distribution of *E. cinerea* has decreased because of the reduction in the number of brine storage ponds (natural basins) in Illinois oil fields. The elimination of salt brine holding ponds does not preclude the possibility that *E. cinerea* may be found in less conspicuous or accessible salt habitats.

Lemnaphila scotlandae Cresson has been reported from New York (Cresson, 1933), Michigan (Wirth, 1965), and Ohio (Deonier and Regensburg, 1978). During October of 1986, *L. scotlandae* was reared from *Lemna minor* (duck weed) obtained from four widely separated Illinois localities. The Illinois records constitute a significant range extension. The October collection of *L. scotlandae* eggs, larvae, and puparia suggests that breeding continues into late fall in the presence of viable duck weed populations.

TABLE I
New state and habitat records for the Ephydridae (Diptera) in Illinois.

Species	County and Habitat	Records
Ephydra cinerea Jones	Marion Co., salt pool (INHS)[1]	SR[2]
Ditrichophora exigua Cresson	Vermilion Co., grass shore	SR
Illythea spilota (Curtis)	Vermilion Co., woodland stream, silt impregnated mud	SR
Lemnaphila scotlandae Cresson	Vermilion Co., Clay Co., Grundy Co., La Salle Co., *Lemna minor*	SR
Lytogaster excavata (Sturtevant and Wheeler)	Vermilion Co., sedge meadow, *Scirpus* sp.	HR[3]
L. furva Cresson	Vermilion Co., sedge meadow, *Scirpus* sp.	HR
Nostima scutellaris Cresson	Vermilion Co., grass shore adjacent to woodland stream	SR
Paralimna punctipennis (Wiedemann)	Vermilion Co., sedge meadow	SR&HR
Polytrichophora orbitalis (Loew)	Vermilion Co., silt impregnated sand	SR&HR

Species	County and Habitat	Records
Pseudohecamede abdominalis (Williston)	Mason Co., habitat unknown (INHS)	SR
Psilopa dupla Cresson	Vermilion Co., terrestrial mowed grass	HR
P. pulchripes Loew	Champaign Co., Lake Co., St. Clair Co., habitat unknown (INHS)	SR
Scatella obsoleta Loew	Macon Co., hydroponic greenhouse (INHS)	HR
S. quadrinotata Loew	Vermilion Co., *Lemna minor* on mud	HR
S. stagnalis (Fallen)	Macon Co., hydroponic greenhouse (INHS)	HR
Scatophila unicornis Czerny	DuPage Co., greenhouse (INHS)	SR&HR

[1]INHS - Illinois Natural History Survey Collection

[2]SR - State Record

[3]HR - Habitat Record

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The Commission now invites nominations, by any person or institution, of candidates for membership. Article 2b of the Constitution prescribes that:

"The members of the Commission shall be eminent scientists, irrespective of nationality, with a distinguished record in any branch of zoology, who are known to have an interest in zoological nomenclature".

(It should be noted that 'zoology' here includes the applied biological sciences (medicine, agriculture, etc.) which use zoological names).

Nominations, giving the dates of birth, nationality and qualifications (by the criteria mentioned above) of each candidate should be sent by 31 March 1988 to: The Executive Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, SW7 5BD, U.K.

THREE INEXPENSIVE AQUATIC INVERTEBRATE SAMPLERS FOR THE BENTHOS, DRIFT AND EMERGENT FAUNA[1]

William R. English[2]

ABSTRACT: Construction plans and methodology are provided for three easily constructed, low cost aquatic macroinvertebrate samplers: a benthic sampler, an adjustable aquatic drift net, and an insect emergence trap. Costs for materials and construction-time estimates are provided.

The quantitative assessment of benthic aquatic invertebrates is often central to the goals of ecological research. Three common quantitative sampling devices used to measure aspects of aquatic invertebrate populations are the benthic sampler (e.g., Surber and Hess samplers), drift net, and emergence trap. Several varieties of these sampling devices are commercially available (Merritt and Cummins 1984); and plans for homemade samplers have been published (e.g. Mackie and Bailey 1981; Brown 1984). My principal criticism of commercial samplers is the high cost of these 'standard-dimensioned' samplers which often do not fit the needs of the research program. In my experience, having a sampler built commercially to the dimensions (e.g., mesh size or sampled area) appropriate for a specific research goal nearly doubles the cost. Homemade sampling devices are generally less expensive than those commercially supplied, but are often difficult and time consuming to construct. In the field, many of these devices are too heavy or complicated; the tenets of simplicity appear to have been ignored. This paper provides plans and construction methodology for three low-cost, easily constructed samplers: a benthic sampler, an adjustable aquatic drift net, and an aquatic insect floating emergence trap.

Benthic Sampler

The most commonly used benthic macroinvertebrate sampler is one which defines an area of bottom from which organisms are collected. Following are construction plans and methods for a benthic sampler that costs about $75 for materials and takes less than 4 hrs construction time (Table 1). This sampler is designed for collecting in shallow, flowing water but may be modified for use in deeper or nonflowing water.

An 8 inch (21 cm) PVC sewer T-joint serves as the frame of the sampler (Fig. 1a). Different sized T-joints (sizes up to 24 in.) may be acquired to fit specific research needs. Two 7 x 2 3/4 in. (18 x 7 cm) holes are cut in the front wall opposite the junction orifice. These holes allow a current to flow through

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the sampler and carry organisms lifted from within the sampler into the collection net. The junction orifice, to which the collection net will be attached, is shortened to extend only 1 in. (2.54 cm) beyond the outside wall. The final cuts in the frame are 3/8 in. (1 cm) deep, 2 1/2 in. (5.7 cm) long crenations cut into what will become the bottom of the sampler. Silicone rubber is used to glue fiberglass window screening over the 7 x 2 3/4 in. openings in the sampler's front wall. A mesh size larger than that used in the collection net will allow a rapid flow rate through the sampler and prevent drifitng organisms outside the sampler from inadvertently entering the collection net. The mat stripe of 3/4 in. Velcro® tape is glued with silicon rubber to the 1 in., outside lip of the junction orifice.

The collection net for the benthic sampler (Fig. 1b) is constructed of 363 micron mesh netting (Nitex®); however, any mesh size may be used. The open end of the net bag is made slightly larger than the outside diameter of the sampler's junction orifice, 9 1/2 in. (24 cm) in this case. The net pattern is cut in the shape of a large isosceles triangle. One side of the triangle must be long enough to encircle the PVC pipe junction orifice (28 3/8 in. or 72 cm). The length of the other sides, which determines the net length and volume, depends on the requirements of the investigation. For my research on smaller (2nd order) streams, a length of 28 3/8 in. (72 cm) worked well. To construct the net bag, the two equal edges of the netting material are rolled and sewn together with two stitchings (double seam) of nylon thread or light weight monofilament fishing line (Fig. 1b). Place a double row of stitches about 3 in. (7.6 cm) from the narrowed end of the collection net. Sewing these stitches in the shape of a slight arc greatly increases the ease of sample removal. Lightly cover frayed edges with silicone rubber, let dry, and trim. With the rolled edge turned inside the net and the smoothest side out, the hooked strip of the 3/4 in. Velcro tape is sewn to the outside rim of the net. The net is turned so that the Velcro strip is inside the opening and then slipped over the Velcro mat strip of the frame junction orifice. The net is constructed so that frayed ends or rough surfaces do not impede movement of sampled organisms to the constricted end of the net. The Velcro tape allows easy attachment of the net to the sampler.

This sampler is easily modified for use in water deeper than the sampler height 17 in. (43 cm). A mesh sleeve is attached to the top of the sampler which allows the researcher to reach into the sampler while preventing escape of organisms. The mesh sleeve is constructed using roughly the same dimensions and pattern as the collection net, but inexpensive mosquito netting may be used. The Velcro tape may be attached to the top of the sampler and sleeve as it was to the junction orifice and collection net, however, a strong elastic band stretched over the sleeve and around the top of the sampler also works well. The sleeve differs dimensionally from the

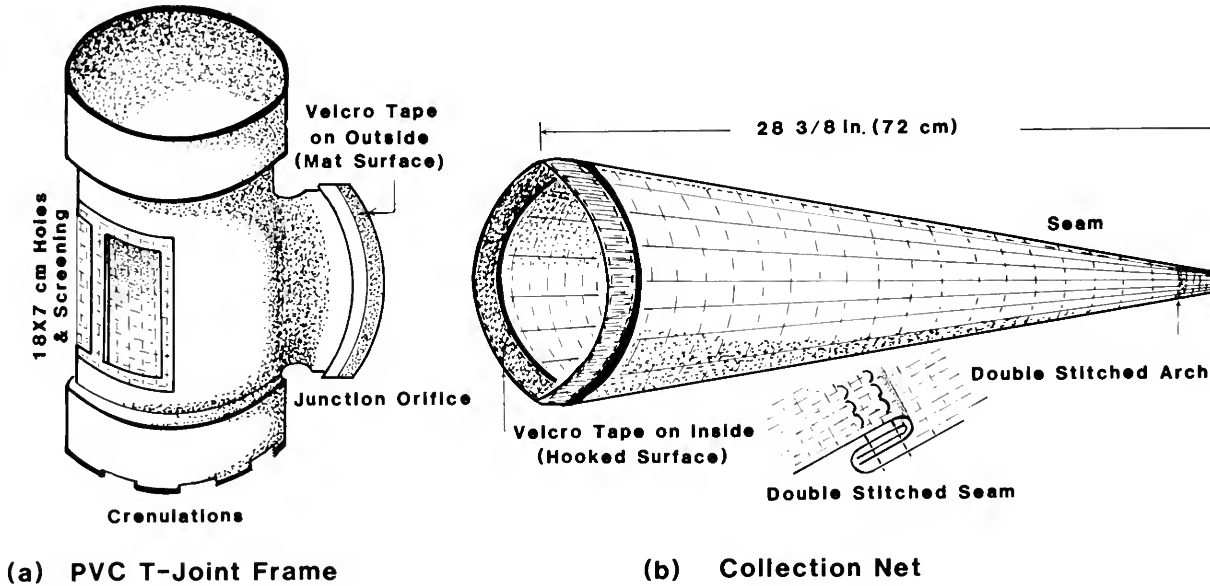

Fig. 1. Benthic sampler. (a) Eight inch PVC T-joint (sampler frame). (b) Collection net with double stitch seam inset.

collection net only at the constricted end. Here the net is shortened three inches (7.6 cm), leaving an opening through which an arm may fit.

Samples may be taken in non-flowing water by adding a diaphragm pump to the system. The inflow hose of the pump may be attached to a brush for scrubbing surfaces. The outflow hose, attached to the front of the sampler (flow directed rearward), provides a current within the sampler that carries organisms into the collection net.

To use the sampler, press the frame with attached net onto the substrate and revolve in both directions until the side orifice comes in contact with the substrate (crenations on the frame bottom facilitate rock displacement better than a smooth-edged frame). The bottom of the sampler is now 4 in. (10 cm) into the substrate, a depth at which Williams and Hynes (1974) found the greatest biomass and number of organisms. Using this method, samples are consistently quantified on a volumetric basis (organisms/m^3) as well as by surfaces area (organisms/m^2).

Drift Sampler

The movement of aquatic organisms with the current of flowing water is commonly referred to as drift (reviews by Waters 1972, Muller 1974). Sampling drifting organisms in a variety of stream and river types requires many different types and dimensions of drift nets. The drift sampler discussed below has adjustable inflow dimensions, is lightweight, and can be completely dismantled for easy transportation in the field. It takes about two hours to construct and costs about $56 (Table 1).

The frame is constructed of 1/2 in., schedule 20, PVC pipe, and cross-joints fitted together to form a rectangle (Fig. 2a). The length of pipe can be varied to accommodate the appropriate cross sectional area of the water column that will be sampled. The net, constructed of 363 micron mesh netting (Nitex®), is sewn to a Cordura® apron (other moisture resistant material may be used for the apron) and the apron is attached to the drift frame (Fig. 2b). The net material is cut as a single piece. The long cut edges are rolled twice and sewn together lengthwise with a double seam of nylon thread. Six inches (15.2 cm) up from the constricted end of the collection net an arch is double stitched. As with the benthic sampler, this makes sample removal much easier. The open edge of the Nitex is folded once and double stitched against the exterior edge of the Cordura apron. This creates a downstream facing lip which should deter upstream movement of crawling invertebrates that have entered the drift net.

The frame edge of the apron is folded back 2 in. (5 cm) and sewn along the cut edge to form a tube into which the PVC pipe will be positioned. All frayed edges of the net and the apron should be coated with silicone and trimmed. Apron and net sections of the sampler are designed for a frame that measures 24 in. (61 cm) by 12 in. (30.5 cm) but will easily

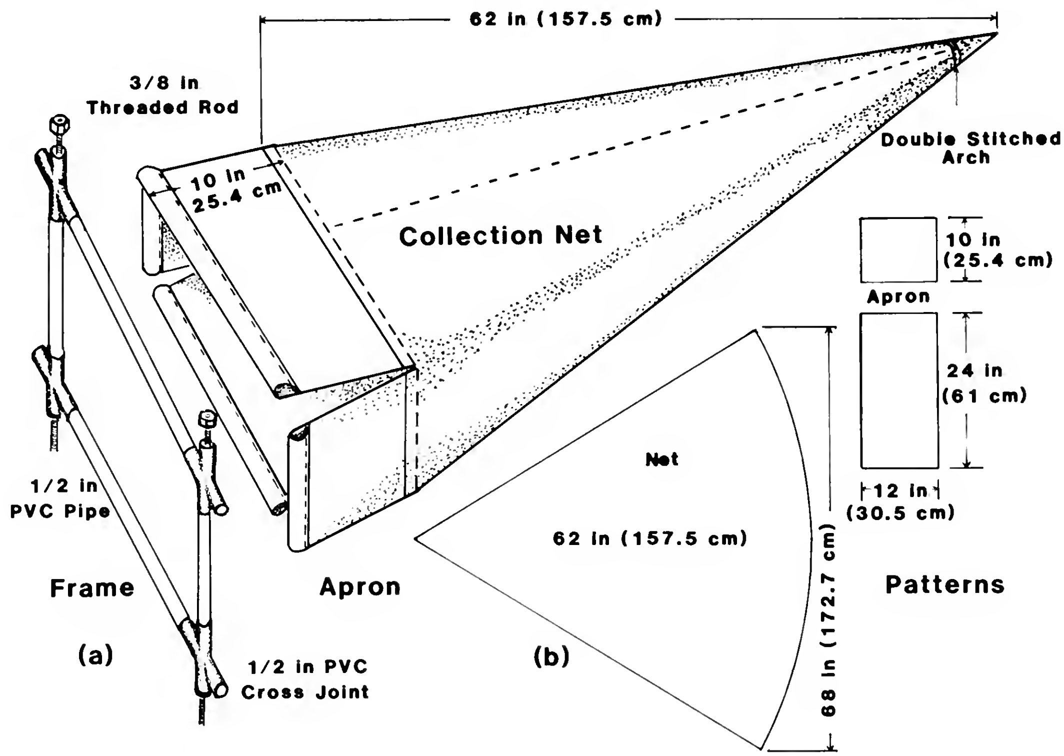

Fig. 2. Drift sampler, (a) Sampler frame of 1/2 in. PVC pipe and cross-joints held in position by 3/8 in. threaded rod, depth in channel adjusted by 3/8 inch nuts. (b) Collection net with patterns for net and apron panels.

accommodate smaller frame sizes. Frame size is reduced simply by shortening the lengths of PVC pipe. Frame sections of the sampler should not be glued together so that the sampler can be dismantled for easy transportation in the field. If the stream to be sampled is very narrow or deep, the net may be stood on end. The sampler is staked to the substrate with two threaded rods passed through the frame. A set of nuts on the rods allows for adjustment of the sampler's height in the water column. This drift sampler is easily constructed and inexpensive. The extremely large net of my prototype (ca. 25 ft^2) accounted for 75% ($41.55) of the total cost (Table 1).

Emergence Trap

There are many designs for traps which capture emerging aquatic insects (Merritt and Cummins 1983). Often these are difficult and expensive to construct and removal of organisms from the trap may be difficult and result in the loss of organisms. Some traps require aspiration of the insects from inside the trap or the trap must be tipped or inverted to remove the collected insects. The emergence trap (Fig. 3) described below is inexpensive ($19) and requires about two hours to construct (Table 1). It is constructed of 1 x 2 in. pine lumber, plywood, fiberglass window screening, a funnel, pint jar, corner plates, and corner braces. The best sequence for construction and methodology follows:

The 9 1/2 x 7 7/8 in. (24 cm x 20 cm) top plate is cut from 5/8 in. plywood and a 6 3/8 in. (15.8 cm) diameter hole is cut in the center of the plate through which the collection assembly is removed. Next, all 1 x 2 in. (2.5 x 5.1 cm) pine strips (without knots) are cut with ends at 45° angles to lengths given in Figure 3a. The base joints of the traps are held together with 1 1/2 in. metal corner plates. The top plate and the angle arms are assembled with 1 1/4 in. metal corner braces (Fig. 3b). A wire loop about 14 cm in diameter (Fig. 3b) is screwed to the underside of the top plate. This loop suspends the collection assembly 10 cm below the top plate and allows the emerging insects easy access to the collection funnel and jar (collection assemblage). The collection assembly (Fig. 3c) consists of a pint jar and lid screw ring to which a funnel has been attached with metal screws. The top plate and angle arm assembly is then attached to the base by corner braces (Fig. 3d). The whole trap frame is covered with marine paint, varnish or other wood preservative. Screening material and mesh size of choice is cut to fit over the side frame openings. The edges are rolled once and stapled in place with a staple gun to the angle arms, top plate, and trap base. A plexiglass cover is cut to fit over the 15.8 cm hole in the top plate. The cover is held in position by beads of silicone glue located just outside the plexiglass cover. Styrofoam strips 2 in. (5 cm) thick are attached to the structure's base for flotation. The trap is then tethered to an anchor or other

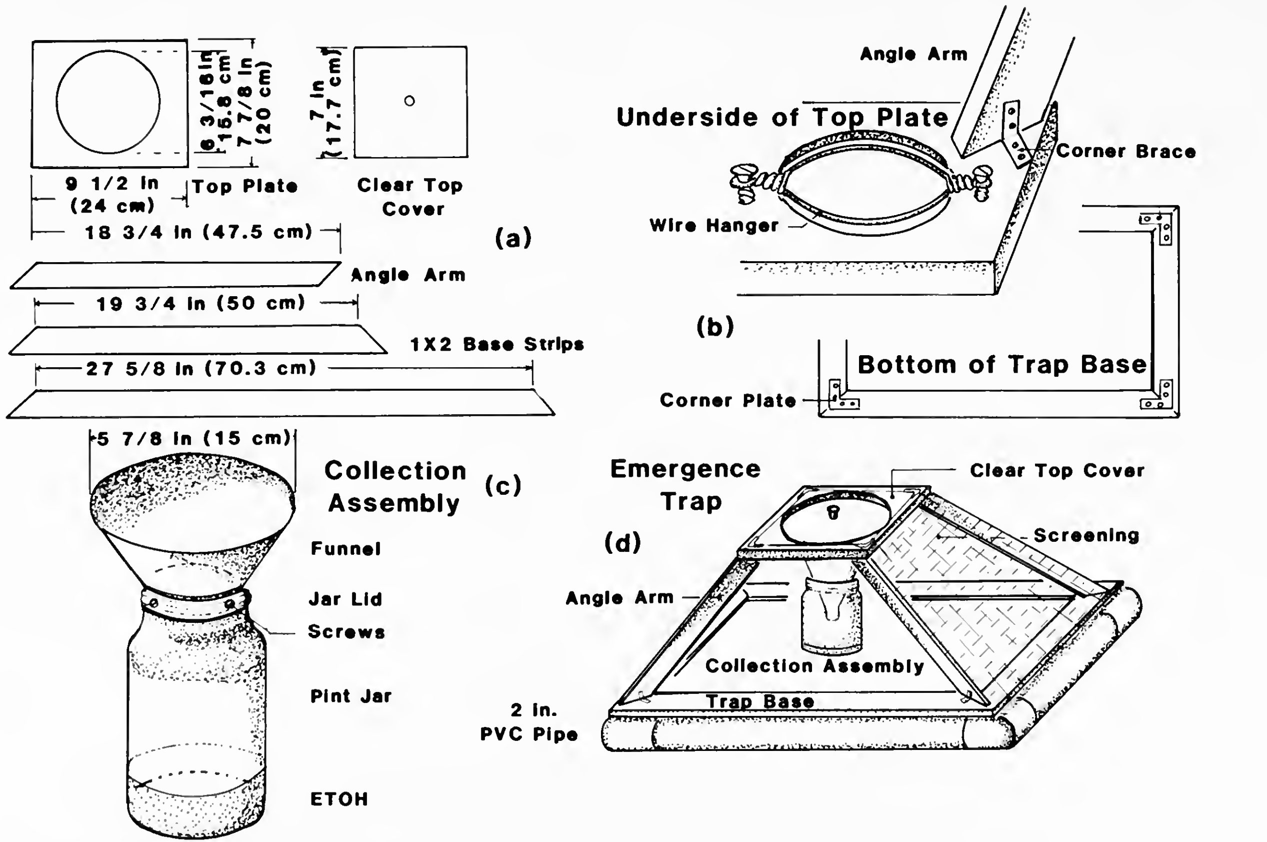

Fig. 3. Emergence trap. (a) Clear top cover and wood cut patterns. (b) Method of assembly for underside of top plate, and bottom of trap base. (c) Collection assembly, consisting of a funnel attached to a jar screw ring, and a pint jar with ETOH. (d) Fully assembled emergence trap with a PVC pipe fotation base.

permanent object. Some modifications may be required for specific research needs. For example, a modification of this type trap was required in a Canadian wetland study where Wrubleski and Rosenberg (1984) found chironomids of the genus *Glyptotendipes* were colonizing the styrofoam

Table 1. Cost of materials and construction time for:

Item	Quantity	$Cost
	BENTHIC SAMPLER	
8 in. PVC T-Joint		45.00
Nitex Netting	784 in.^{2} (5041 cm^2) @ $41.55/yd	22.20
Velcro Tape	69 in. (174 cm)	5.22
Screen	69 in.^{2} (600 cm^2)	0.70
Thread, Silicon Rubber, Misc. Hardware		3.00
TOTAL COST		75.00
CONSTRUCTION TIME		3.5 hrs
	DRIFT SAMPLER	
Nitex Netting	1888 in.^{2} (12.2 m^2) @ $41.55/yd	41.55
Cordura Pack Cloth	6 ft.^{2} (0.56 m^2) @ $1.00/ft.^{2}	6.00
PVC 1/2 in. Cross-joints	4 at $0.75/each)	3.00
PVC 1/2 in. Pipe	6 ft (183 cm) @ $0.14/ft.	0.84
Threaded 3/8 in. rod	two 4 ft. pieces @ $1.35/each	2.70
Thread, Pins and Misc.		1.00
TOTAL COST		55.09
CONSTRUCTION TIME		2 hrs.
	EMERGENCE TRAP	
1 x 2 in. Pine Lumber	10 ft. (205 cm) @ $0.30/ft.	3.00
Screening Material	7 x 3 ft. @ $0.50/ft.	3.50
Corner Braces	8 metal 1 1/4 in.	4.00
Corner Plates	4 metal 1 1/2 in.	1.75
Funnel	5 7/8 in. (15 cm) diam.	0.75
Marine Paint or Varnish		0.75
Top plate	9 1/2 x 7 7/8 in. (24 x 20 cm)	1.00
Clear Cover Plate	7 x 7 in. (17.7 x 17.7 cm)	1.00
Hanger wire, Staples, Silicon, Pint Jar.		2.40
Options for flotation:		
a) Styrofoam	3 x 3 x 96 in.	1.00
b) 2 in. PVC Pipe	4 ft. @ $0.50/ft.	2.00
2 in. PVC Elbow	4 @ $1.35/each	5.40
TOTAL COST (with styrofoam float)		19.05
CONSTRUCTION TIME		2 hrs.

floats, resulting in extremely high numbers being collected in the trap and thus biasing his study. Styrofoam based traps did not function well in rivers with extreme fluctuations in discharge. Both these problems were solved by gluing a base-sized loop of 2 in. PVC pipe to the base of the trap (Fig. 3d). However, the use of PVC adds considerable weight and $6.50 to the cost of the trap.

Emerging insects, having flown to the top of the trap will fall into the collection jar containing 95% ethanol. Pint size or larger jars may be used to collect emerging insects and ethylene glycol (antifreeze) may be substituted for 95% ethanol because it does not evaporate as quickly as ethanol (2 weeks for 100 ml). The sample is taken by lifting the clear cover and removing the collection assembly (funnel and attached jar) from the assembly hanger (wire loop) located within the trap. The jar containing the sample is unscrewed from the funnel and a new jar with about 100 ml of ethanol or antifreeze is again screwed to the funnel and the collection assembly is replaced on its hanger. After replacing the clear top cover, the trap is again set to collect emerging aquatic insects.

All three samplers have had at least three years of use in the field. Very little maintenance was required and all functioned well in a variety of habitats. The comparatively low cost, simplicity of construction, and small time investment for construction make these samplers highly desirable to most aquatic researchers.

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NEW COLOR PATTERN AND MORPHOLOGICAL VARIATION FOUND IN *TOMOCERUS FLAVESCENS* (COLLEMBOLA: ENTOMOBRYIDAE)[1]

Frank Calandrino[2]

ABSTRACT: New variations in dental spination and color pattern were found in a population of *Tomocerus flavscens* from Lane County, Oregon.

While examining pitfall trap samples of Collembola collected from the H.J. Andrews Experimental Forest in Lane County, Oregon, I encountered what appeared to be a new species of *Tomocerus.* Using Christiansen (1964) and Christiansen and Bellinger (1981), the specimens were identified as *Tomocerus flavescens* (Tullberg). There were, however, characteristic variations in this western North American population of *T. flavescens* that have not been previously reported.

Christiansen (1964) commented on the enormous variation within this species complex, including different combinations of mucro, claw and dental spination types that do not follow any geographic pattern. The new color pattern has a background color of pale cream to grey under the scales. The body has light purple along the lower margins of the abdominal segments which is suffused with scattered oval and round maculae. There are patches of dark purple on the procoxa; mesoprecoxa, mesocoxa, mesofemur; metacoxa, metatrochanter, metafemur (Fig. 1). The new dental spination variations found in the Andrews Forest population are shown in Figs. 2 and 3.

Folsom's (1913) system of notation for dental spination was used. In his formula the oblique line represents the suture between the proximal and middle series of spines. The first and third numbers represent the longer size of certain spines while the second number denotes the smaller size spines: dental spine formula 2/4, 2 (Fig. 2); dental spine formula 3/7, 2 (Fig. 3).

The following table lists differences between the Andress Forest population and species description in Christiansen and Bellinger (1981):

Different Morphological Characteristics

dental spination: 2/4, 2; 3/7, 2
color pattern
Collection data: Oregon, Lane County, H.J. Andrews Experimental Forest, pitfall trap, 28-III-73 and 18-IV-73.

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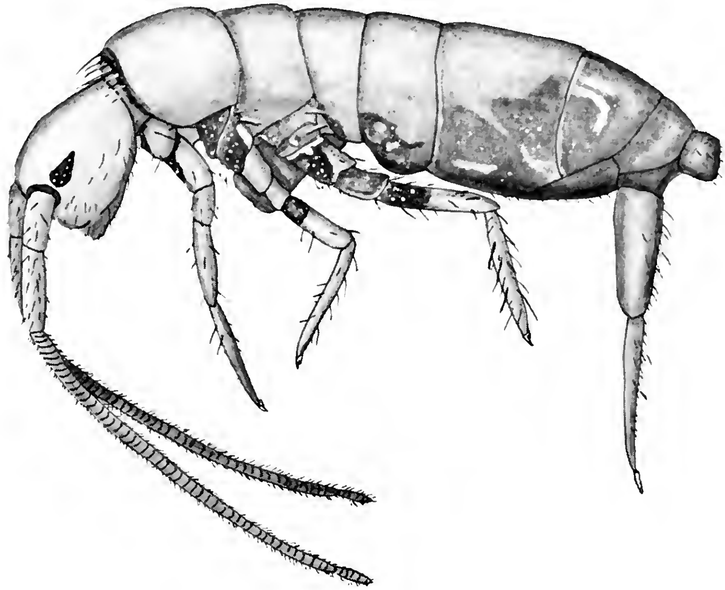


Fig. 1. *Tomocerus flavescens,* habitus, lateral view.

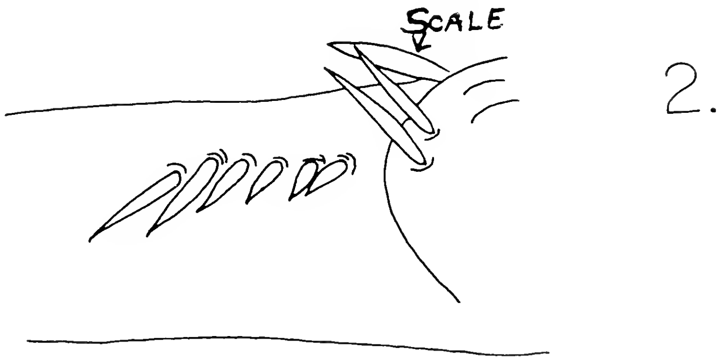
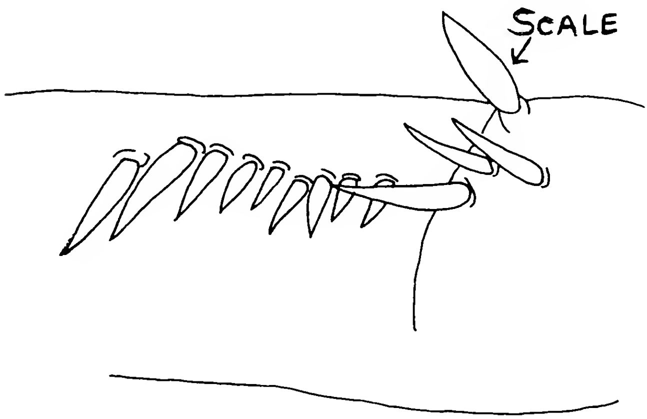


Fig. 2. *Tomocerus flavescens,* dental spines.



3.

Fig. 3. *Tomocerus flavescens,* dental spines.

ACKNOWLEDGMENTS

I thank Richard Snider for laboratory facilities and criticism and John Lattin, Oregon State University, for the loan of the specimens. I also thank Peter Carrington, graphic illustrator, for his help in rendering the habitus, and Kenneth Christiansen, Grinnell College, for suggestions and reviews.

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NOTES ON THE BIOLOGY AND DISTRIBUTION OF *ARADUS ROBUSTUS* (HEMIPTERA: ARADIDAE)[1].

Richard A.B. Leschen[2], Steven J. Taylor[3,4]

ABSTRACT: The fungus *Irpex lacteus* is reported as a new host for *Aradus robustus*. New records of feeding, flight and mating are provided. New state records for the species are given for Arkansas and Mississippi along with additional records for Missouri and Florida.

Little is known about the biology of *Aradus robustus* Uhler. Blatchley (1926) mentions that *A. robustus* is found beneath bark of red and black oaks, apparently hibernating. Matsuda (1977) states that this species is associated with *Quercus* sp. Froeschner (1942) reports adults of *Aradus robustus* being collected from October to May with one nymph collected on March 16. *A. robustus* was found by Torre-Bueno (1935) under the bark of a hemlock log and on and under the bark of a beech log. He observed nymphs from July 19 through August 16, and adults from July 3 through about August 28. These authors make no references to any fungal associations, mating, or flight by this species.

Except for one female found under bark, most of the specimens we collected were on the fungus *Irpex lacteus* (Fr.) Fr. (Basidiomycetes: Polyporaceae). The fungus was found in mixed deciduous forests on the exterior of small hardwood branches which had fallen to the forest floor. These branches ranged from 2.5 to 10.2 cm in diameter. Overholts (1953) lists many host trees for *I. lacteus*, but the biology of the species is virtually unknown (Robert L. Gilbertson, pers. comm.).

One adult *A. robustus* was observed on May 5 with its stylets imbedded in *I. lacteus*, apparently feeding. Mating was observed five times on the fungus from April 19 through July 13. Mating was usually observed during and up to five days after periods of rain. During mating the male and female were in the typical copulatory position for the Aradidae with the male beneath and slightly to one side of the female, as discussed by Usinger and Matsuda (1959). Nymphs of instars two through five were commonly found on the fungus, often in association with adults. Although *I. lacteus* is

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present year round, no specimens of *A. robustus* were found on the fungus after August 18.

Late instars of *A. robustus* were found as early as April 24, which suggests that at least some individuals of this species may overwinter as immatures. Heliövaara (1982) has found that another species in this genus, *Aradus cinnamoneus,* overwinters in crevices in bark on their host trees and within 30 cm of the base of the host trees in litter. One specimen of *Aradus robustus* was collected in December in northern Florida from mixed hardwood litter and others from Arkansas were collected under bark in March and April, suggesting that similar habitats may serve as overwintering sites for this species.

Linsley and Usinger (1942, 1944) record dispersal flights for twelve other species of *Aradus* in May and June in California. We collected one adult female specimen of *A. robustus* flying, evidently in dispersal, in a bottomland mixed pine-hardwood forest in March.

Parshley (1922 a&b) reports *A. robustus* from Quebec, Ontario, Northwest Territories, Maine, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Connecticut, Pennsylvania, Delaware, District of Columbia, Maryland, North Carolina, Tennessee, Florida, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, North Dakota, Missouri, Nebraska, Kansas, and Texas. Blatchley (1926) records *A. robustus* from Oklahoma and Froeschner (1942) has found *A. robustus* to be rather rare in Missouri. While there are many records from northern and eastern United States, there are only a few records from the southeastern United States. Note that since *I. lacteus* occurs commonly in the eastern United States and in Canada (Overholts, 1953), *I. lacteus* and *A. robustus* have broadly sympatric distributions.

Our collections and material examined at the University of Arkansas at Fayetteville extend the range of this species to include portions of Arkansas and Mississippi and provide additional records for Missouri and Florida. The material examined in this study is deposited at the University of Arkansas at Fayetteville and in the S.J. Taylor collection.

Locality data are as follows:

ARKANSAS: Arkansas Co., 4 mi E. of Ethel, Lot #13, 31 July 1969, (R.L. Brown); Columbia Co., under bark, April 1968, (I. Lee); Crawford Co., Lee Creek/Hwy 59, on 5 July 1986, (R.A.B. Leschen); Crittenden Co., from trash, 10 March 1955; Faulkner Co., near Lake Conway spillway, under bark, 11 March 1985, (S.J. Taylor); Garland Co., Camp Clear Fork, on *I. lacteus,* 15 June 1986, 19 June 1986, (R.A.B. Leschen); Logan Co., Mt. Magazine, on *I. lacteus,* 12 May 1986, 18 August 1986, (R.A.B. Leschen); Cove Lake, on *I. lacteus,* 5 May 1986, 12 May 1986, (R.A.B. Leschen); Pope Co., 19 May 1970, (R. Flanagan); Pulaski Co., Little Rock, Maumelle Pk., flying, 10 March 1985, (S.J. Taylor);

Washington Co., grass, 19 March 1972, (R. Stevenson); 1 mi NE of Lake Wedington, on *I. lacteus,* 19 April 1986, 24 April 1986, (R.A.B. Leschen); 1 mi NE of Lake Wedington, on *I. lacteus,* 5 May 1986, (S.J. Taylor and R.A.B. Leschen); Lake Wedington, on *I. lacteus,* 16 May 1986, 19 May 1986, 13 July 1986, 5 August 1986, (R.A.B. Leschen).

MISSISSIPPI: Holmes Co., sweeping, 22 April 1975, (H. Greenbaum).

MISSOURI: Green Co., James R./Hwy 125, *I. lacteus,* 24 May 1986, (R.A.B. Leschen).

FLORIDA: Leon Co., Tallahassee, berlese mixed hardwood litter, 17 December 1976, (C.W. O'Brien and Wibmer).

ACKNOWLEDGMENTS

We are grateful to Jay Justice (Arkansas Mycological Society) for confirmation of the identification of the host fungus. We thank Merrill H. Sweet (Texas A&M Univ.), R.T. Allen (Univ. of Arkansas), Christopher Carlton (Univ. of Arkansas) and two anonymous reviewers for reviewing the manuscript.

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RANGE EXTENSION AND BIOLOGY OF *ENDOMYCHOBIUS FLAVIPES* (HYMENOPTERA: PTEROMALIDAE)[1,2]

Richard A.B. Leschen[3], Robert T. Allen[4]

ABSTRACT: A new distribution from Arkansas is reported for *Endomychobius flavipes*. *E. flavipes* parasites were reared from host larvae *Endomychus biguttatus* from collections made during the spring of 1986. A total of 20 adult wasps emerged from three beetle prepupae.

While pursuing a survey and rearing study of mycophagous Coleoptera during 1986-87, we reared the parasitic wasp *Endomychobius flavipes* (Ashmead) (Fig. 1) from larvae of the fungus beetle *Endomychus biguttatus* (Say) (Coleoptera: Endomychidae). Ashmead (1896) described *E. flavipes* from one male and six female adult wasps reared from the "supposed larva" of *E. biguttatus*. Ashmead's specimens were from the Washington, D.C., area and had been given to him by Mr. E.A. Schwarz. Ashmead included no other information on the biology of the parasite or the beetle. Our search of the literature revealed no additional information on the biology or distribution of *E. flavipes*.

The Arkansas specimens of *E. biguttatus* from which *E. flavipes* were reared were collected at Lake Wedington, 12 miles west of Fayetteville (Washington County) on May 5 and 13, 1986. Additional *E. biguttatus* larvae and adults were collected from early May through June 3, 1986 from Lake Wedington (Washington County), Cove Lake and Mt. Magazine (both in Logan Co.), Arkansas. After an apparent hiatus during the summer months, beetle larvae and adults were collected from October 4, 1986, through March 5, 1987 from Lake Wedington and Markham Hill, Fayetteville, Arkansas. But only five of the six *E. biguttatuss* larvae collected on May 5 and 13 produced *E. flavipes*.

The *E. biguttatus* larvae were collected while they fed on the hymenium or gill layers of the common split-gill fungus, *Schizophyllum commune* (Fr.). This fungus is a tough basidiomycete that occurs on trees and branches throughout the year. It has a double row of ridges or gills that are infolded under dry conditions and exposed for spore release when moist conditions prevail.

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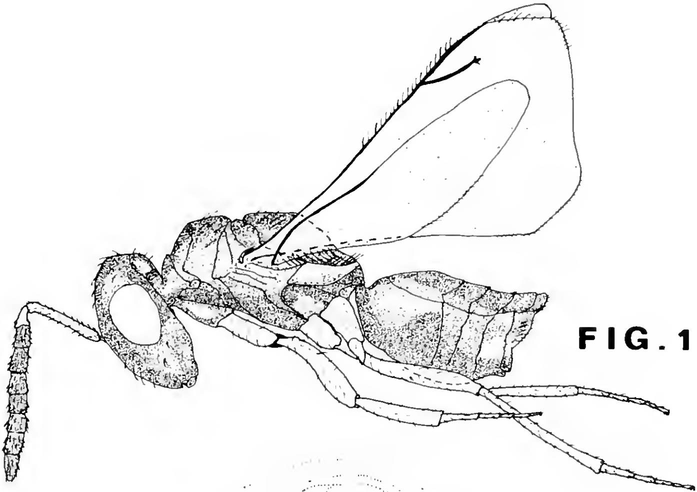

FIG. 1

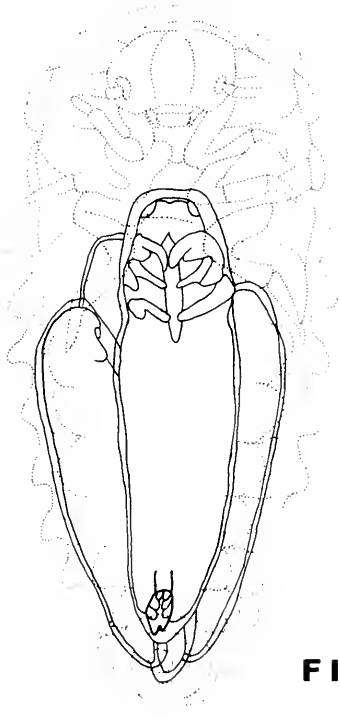

FIG. 2

Fig. 1. *Endomychobius flavipes*, adult, lateral view

Fig. 2. *Endomychus biguttatus* beetle prepupa with four *Endomychobius flavipes* pupae inside.

Early instar *E. biguttatus* and *S. commune* fungi were brought to an open-air insectary and placed in mason jars filled with 4 to 6 cm of moist, sterile sawdust. Organdy cloth was placed over the jar mouths, and the jars were checked periodically for emergence of adult beetles and parasitic Hymenoptera.

Prepupae of *E. biguttatus* dropped to the surface of the sawdust layer in the jar and did not bury themselves in the substrate. Non-parasitized prepupae shed exuvia to pupate, and parasitized prepupae turned dark brown and lay motionless on the sawdust. Upon autopsy of two late instar *E. biguttatus* larvae, one contained 4 pupae and the other 6 sub-adult *E. flavipes* collected May 5 and May 16, respectively. All of the parasites were in parallel alignment to the larval body axis with their heads directed anteriorly (Fig. 2). Adult wasps that were allowed to mature emerged from one or two holes that had been chewed at a random position in the *E. biguttatus* prepupal case.

From field collections of May 5 and 13 one adult endomychid beetle emerged June 14, 31 days after collection. *Endomychobius flavipes* adults emerged on three different days from the remaining three separate endomychid prepupae: May 25 - 6, June 1-7, June 11-7. Emergence occurred 20 to 28 days after collection of the endomychid beetle larvae. The number of parasites per prepupa ranged from 4 to 7. Of the 19 adult wasps captured (one escaped), there was a 5:14 male to female sex ratio. The mean length of the males and females was 1.27 mm and 1.86 mm, respectively. These lengths are substantially larger than the .56mm male length and the 1.0mm female length reported by Ashmead (1896).

The rarity of *E. flavipes* is probably an artifact due to the lack of rearing studies. Because its host *E. biguttatus* occurs over much of eastern North America (White 1983), one might assume that *E. flavipes* is also present in this same area.

ACKNOWLEDGMENTS

We thank Jay Justice, President, Arkansas Mycological Society, for confirmation of the fungus, and E.E. Grissel and M.E. Schauff at the Smithsonian Institution for confirmation of *Endomychobius flavipes*. Specimens were placed in the University of Arkansas Entomology Museum collection and the National Museum of Natural History Collection.

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ECTOPARASITES AND OTHER ASSOCIATES OF SOME MAMMALS FROM MINAS GERAIS, BRAZIL[1]

John O. Whitaker, Jr.[2], James M. Dietz[3]

ABSTRACT: One marsupial, two carnivores and 8 species of cricetid rodents from Brazil were examined for ectoparasites. Some of the major parasites found were laelapid mites *Androlaelaps fahrenholzi, A. rotundus, A. pachyptilae, Laelaps paulistensis, L. thori, L. mazzai, L. castroi, Mysolaelaps heteronychus, Mysolaelaps* sp., *Gigantolaelaps goyanensis, G. vitzhumi, G. wolffsohni,* and the macronyssid mite, *Argitus oryzomys.* Eleven species of chiggers were found of which 5 have already been described as new *(Serratacarus dietzi, S. lasiurus,* and *Microtrombicula rhipidomysi, Kymocta lutui,* and *Colicus brasiliensis)* and two more are in the process of being described. More abundant lice (Anoplura) found were *Hoplopleura travasso, H. fonsecai, H. angulata,* and *H. affinis.* A few fleas, ticks and other mites were also reported.

While studying the biology of the maned wolf, *Chrysocyon brachyurus,* James Dietz had the opportunity to collect ectoparasites from a number of mammals from the state of Minas Gerais, Brazil. Some of the parasites collected were new species or new for Brazil. This paper presents information resulting from these collections.

METHODS AND MATERIALS

Mammals were hand picked using a dissecting microscope. Parasites were preserved in alcohol and later placed in Nesbitt's solution containing acid fuchsin stain for 3-5 days, then mounted in Hoyer's solution and finally ringed with Euparal.

Representative specimens have been or will be deposited in the Research Branch, Biosystematics Research Center, Ottawa, Ontario; in the Stovall Museum (Univ. Oklahoma, laelapid mites); in the collection of Alex Fain (smaller mites); at the University of Hawaii (chiggers); at the Department of Biology, University of Northern Iowa (ticks); and in the collections of the authors. Skins and skulls of the mammals are in the Museum, Michigan State University, East Lansing.

RESULTS

Results are given below for some of the species, and for the cricetid rodents in Table 1. For the latter group only the more abundant or otherwise noteworthy forms are specifically mentioned in the text.

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MARSUPIALIA: DIDELPHIDAE

Monodelphis domestica

One individual was taken (29 March 1979) at Faz das Pedras, Serra da Canastra National Park, 25 km west Sao Roque de Minas, Minas Gerais, Brazil. From it were collected 23 chiggers including two species, 16 individuals of *Parasecia aitkeni* (Brennan and Jones, 1960) and 7 of *Trombewingi bakeri* (Fonseca, 1955).

RODENTIA: CRICETIDAE

Akodon (Thalpomys) reinhardti

Eight individuals of this species were taken (Table 1). The most abundant associate taken, totalling 19 individuals on one host, was the hypopial mite, *Dermacarus* of the *hypudaei* group. Members of this group form a closely related complex with the hypopi being very similar, whereas the adults may be quite different. Individuals thus must be cultured to the adult form for determination of its relationships to other *Dermacarus hypudaei. Androlaelaps fahrenholzi* (Laelapidae) and a chigger, currently being described by M.L. Goff and Whitaker, were the other more abundant forms.

Bolomys lasiurus lasiurus

A total of 47 individuals of the Cane Mouse, *B.l. lasiurus,* was examined during the present study (Table 1). The most abundant ectoparasites of this species were the laelapids *Androlaelaps rotundus* and *Androlaelaps fahrenholzi,* the chigger *Quadracetas pazca* and the louse *Hoplopleura affinis. Androlaelaps rotundus* was not mentioned by Furman (1972), although it was the species we most commonly encountered on *B. lasiurus* (total of 372 individuals). Furman (1972) indicated that *Laelaps dearmasi* (Furman & Tipton, 1961) was common on *Zygodontomys brevicauda* in Venezuela. Furman (1972) indicated that *Z. brevicauda* was the host most heavily infested in Venezuela by this parasite. Twenty specimens of *Eulaelaps* were found but need further study. Johnson (1972) found *Hoplopleura nesoryzomydis* to be the typical sucking louse of *Zygodontomys brevicauda* in Venezuela, but we found *H. affinis* to be the anopluran on *B. lasiurus* in Brazil.

Calomys laucha tenor

This is one of the Vesper mice; often referred to the genus *Hesperomys.* Nine individuals were examined for parasites. Chiggers, *Parasecia aitkeni* and *Quadraseta pazca,* the laelapid *Laelaps mazzai,* and lice, *Hoplopleura* sp., possibly new, in the *H. hesperomydis* complex, were the most abundant parasites of this host. Furman (1972) found *Laelaps mazzai* primarily on *Calomys hummelincki* from Venezuela.

Nectomys squamipes

Only two individuals of this Neotropical water rat were taken (Table 1). No lice were found on *Nectomys squamipes* although the types of *Hoplopleura quadridentata* (Neumann) were from this host and this louse was recorded from this host in Venezuela (Johnson, 1972b). *Gigantolaelaps goyanensis* was commonly found on this host and only occasionally on others and *A. fahrenholzi* was occasional on this host in Venezuela (Furman, 1972). Two species of chiggers, *Arisocerus hertigi* and *Parasecia aitkeni* were also taken. Jones et al. (1972) recorded *Amblyomma* sp. on *N. squamipes* from Venezuela, but we found no ticks on this host.

Oryzomys fornesi

A total of 27 individuals of this rice rat were examined. The most abundant parasites on our sample of this species were the laelapids, *Gigantolaelaps wolffsohni, Laelaps castroi, Androlaelaps fahrenholzi* and *Mysolaelaps parvispinosus* (Table 1), and a chigger described on the basis of this material, *Colicus brasiliensis* Goff, Whitaker, & Dietz, 1983. Also, 7 individuals of a sucking louse, *Hoplopleura travossosi* Werneck, 1932, were found. *Laelaps paulistanensis, G. wolffsohni* and *Androlaelaps fahrenholzi* were commonly found on species of *Oryzomys* in Venezuela (Furman, 1972). *Mysolaelaps microspinosus* Fonseca and *M. parvispinosus* Fonseca were found on species of *Oryzomys* in Venezuela.

Oryzomys subflavus

A macronyssid, *Argitis oryzomys,* the laelapids *Laelaps castroi* and *Gigantolaelaps vitzhumi,* and a newly described chigger, *Colicus brasiliensis* (Goff, Whitaker & Dietz, 1983), were the most abundant parasites taken on the three individuals of this rice rat examined (Table 1). Also taken were seven lice, *Hoplopleura* sp., which may represent a new species.

Laelaps paulistanensis was taken from species of *Oryzomys* in Venezuela (but mainly from *Rhipidomys),* whereas the specimens from our material appeared to be *L. castroi. Gigantolaelaps vitzthumi* was not taken there *on Oryzomys,* although several other species of the genus were, especially *G. amazonae* (Furman), *G. canestrinii* Fonseca, *G. gilmorei* Fonseca, *G. inca* Fonseca, *G. intermedia* Furman, *G. oudemansi* Fonseca, *G. peruviana* (Ewing), and *G. tiptoni* Furman (Furman, 1972). *Argitis oryzomys* Yunker & Saunders (1973) was described from *Oryzomys concolor* from Venezuela.

Oxymycteris roberti

Only five individuals of this burrowing mouse were examined (Table 1), but *Androlaelaps fahrenholzi* and *Laelaps paulistanensis* among the laelapids, and lice, *Hoplopleura fonsecai,* were the more abundant parasites.

Also, 7 staphylinid beetles were taken. Beetles of this group have been found on a number of different hosts. Eighteen lice were taken on *Oxymycteris roberti,* but we find no record of lice on this host in either Johnson (1972) or Ferris (1951). They were identified as *Hoplopleura fonsecai* by K.C. Emerson. This louse was described from *Oxymycteris "judex"* from Humboldt, Santa Catharina, Brasil (Ferris, 1951). *Oxymycteris judex* is now recognized as *O. hispidus judex* (Cabrera, 1960). Johnson (1972) recorded *H. fonsecai* from *Oxymycteris rutilans* from Uruguay, and Ronderos and Capri (1965) recorded it from the same host from Argentia.

Rhipidomys masticalis

The main ectoparasites found on this climbing mouse were the laelapid mites, *Laelaps paulistanensis, L. thori,* and *Mysolaelaps heteronychus,* lice, *Hoplopleura angulata,* and chiggers, *Microtrombicula rhipidomysi* described as a new species by Goff, Whitaker & Dietz (1983). Numerous individuals of *Laelaps paulistanensis* and of *Mesolaelaps heteronychus* were also taken from *Rhipidomys* from Venezuela (Furman, 1972), but *L. thori* was not recorded from there. Furman (1972) reported *L. surcomata* from *Rhipidomys* from Venezuela.

Hoplopleura angulata was found on several species of *Rhipidomys* from Venezuela, and this louse is the typical anopluran louse of *Rhipidomys* (Johnson, 1972).

CARNIVORA: CANIDAE

Chrysocyon brachyurus

Parasite data are available from 5 maned wolves. The wolves were examined alive for larger ectoparasites and released. All were from Gameleira, 26 km W (3), Onession, 11 km NE (1), and Gurita, 7 km SE Sao Roque de Minas (1). Three species of parasites were found, two species of ticks, and 3 maggots from the ear of one wolf. A total of 56 ticks, *Amblyomma tigrinum,* was found on four of the wolves. All were adults. Three nymphal ticks, *Amblyomma cajennense,* were taken on two of the wolves. *Amblyomma cajennense* is most commonly reported from domestic animals, but Jones et al (1972) reported it from several hosts from Venezuela. *Amblyomma tigrinum* is generally on carnivores and likewise was taken on several Venezuelan hosts. The maggots were of the screw-worm, *Cochliomyia hominivorax* (Diptera: Calliphoridae), an obligatory parasite of great economic importance which affects numerous species, but especially livestock.

Dusicyon vetulus

Skin scrapings were made of one individual of this South American fox in which were found 22 mange mites, 18 adults and 6 immature *Sarcoptes scabiei.*

DISCUSSION

The most widespread mite on these mammals from South America, *Androlaelaps fahrenholzi,* is also the most widespread North American mite. It was found on 6 of the 8 rodent species examined from Brazil. Another common mite is *Laelaps paulistanensis.* It occurred on four of the rodent species. Those that occurred on three were *Mysolaelaps heteronychus* and *Androlaelaps projecta.* Other parasites occurred on only one or two host species.

The genus *Psylloglyphus* Fain, 1966 (Family Winterschmidtiidae) had not been taken in the New World until recently, but Fain and Beaucournu (1986) described *Psylloglyphus (Tetrapsyllopus) micronychus* from fleas from a South American rodent, *Ctenomys* sp. The specimens of *Psylloglyphus* near *reticulatus* taken during the present study thus constitute the second South American record of this genus, and if this species is indeed *P. reticulatus,* is the first record of the genus being found in both the Old and the New world. *Psylloglyphus reticulatus* was originally described from Zaire (Fain and Beaucournu, 1976). Most previous records of the genus are from fleas, although one species was described from *Hemimerus* (Hemimeridae), an African dermapteran parasitic on *Cricetomys* Fain & Beaucournu, 1976), and there are some previous records from mammals (Uchikawa and Suzuki, 1980).

Five new species and a new genus of chigger have already been described from this material. The new genus *Serratacarus* with two new species, *S. dietzi* and *S. lasiurus,* was described from *Bolomys lasiurus* by Goff and Whitaker (1984). *Microtrombicula rhipidomysi, Kymocta lutui,* and *Colicus brasiliensis* were described, the first two from *Rhipidomys mastacalis* and the third from *Bolomys lasiurus* (Goff, Whitaker, & Dietz, 1983). In addition, a new genus and new species is being described from *Calomys laucha* and *Akodon reinhardti,* and another new species is being described from *Oryzomys fornesi. Kymocta brasiliensis* was previously described from a single specimen, which has since disappeared. This species will be redescribed. Other chiggers not previously reported from Brazil are *Quadraseta pazca, Arisocerus hertigi* and *Parasecia aitkeni.* Six species of lice were found, including two apparently new, one from *Calomys laucha* and one from *Oryzomys subflavus.* Of the other four, two have previously been reported from Brazil, *H. travassoi* and *H. fonsecai* (Ferris, 1951).

TABLE 1. ECTOPARASITES FOUND ON SOME CRICETID RODENTS FROM MINAS GERAIS STATE, BRAZIL.

	No.	Percent	No.	Average
Akodon (Thalpomys) reinhardti	(n = 8)			
Mites				
Dermacarus — hypudaei group	1	12.5	19	2.4
Androlaelaps fahrenholzi	4	50.0	6	0.8
Androlaelaps projecta	2	25.0	2	0.3
Prolistrophorus sp.	1	12.5	1	0.1
Tyrophagus sp. (nymph)	1	12.5	1	0.1
Chiggers				
n. gen #1, n.sp. #4,	1	12.5	5	0.6
Parasecia aitkeni	1	12.5	1	0.1
Flea				
Polygenis rimatus rimatus	1	12.5	1	0.1
Bolomys lasiurus lasiurus	(n=47)			
Mites				
Androlaelaps rotundus	46	97.9	372	7.9
Androlaelaps fahrenholzi	25	53.2	104	2.2
Eulaelaps sp.	5	10.6	20	0.4
Dermacarus hypudaei group	9	19.1	14	0.3
Psylloglyphus near *reticulatus*	5	10.6	12	0.3
Prolistrophorus sp., perhaps *hirstianus*	5	10.6	11	0.2
Androlaelaps projecta	7	14.9	9	0.2
Mysolaelaps parvispinosus	1	2.1	8	0.2
Tyrophagus putrescentiae	2	4.3	2	0.04
Hypoaspis miles	4	8.5	4	0.08
Prolistrophorus paraguayensis?	1	2.1	1	0.02
Cheyletus malaccensis	1	2.1	1	0.02
Radfordia subuliger?	1	2.1	1	0.02
Fleas				
*Polygenis tripus**	9	17.0	12	0.3
Polygenis axius axius	1	2.1	2	0.04
Polygenis rimatus rimatus	1	4.3	1	0.04
Lice				
Hoplopleura affinis	16	34.0	72	1.5
Ticks				
Amblyomma sp.	2	4.3	3	0.1

	No.	Percent	No.	Average
Chiggers				
Quadracetas pazca	7	14.9	47	1.0
Kymocta brasiliensis	5	10.6	11	0.3
Serratacarus dietzi	1	2.1	1	0.02
Serratacarus lasiurus	1	2.1	1	0.02
Parasecia aitkeni	1	2.1	1	0.02
Calomys laucha tenor	(n=9)			
Mites				
Laelaps mazzai	6	66.7	25	2.8
Chiggers				
Parasecia aitkeni	4	44.4	52	5.8
Quadrasetus pazca	3	33.3	23	2.6
n. gen. #1, no. sp. #4	1	11.1	1	0.1
Lice				
Hoplopleura sp. (new species)?	2	22.2	8	0.9
Nectomys squamipes	(n = 2)			
Mites				
Gigantolaelaps goyanensis	2	100.0	14	7.0
Androlaelaps fahrenholzi	2	100.0	13	6.5
Laelaps manguinhosi	1	50.0	1	0.5
Mysolaelaps heteronychus	1	50.0	1	0.5
Chiggers				
Arisocerus hertigi	1	50.0	6	3.0
Parasecia aitkeni	1	50.0	6	3.0
Oryzomys fornesi	(n=27)			
Mites				
Gigantolaelaps wolffsohni	19	70.4	42	1.6
Laelaps castroi	9	33.3	39	1.4
Androlaelaps fahrenholzi	5	18.5	20	0.7
Mysolaelaps parvispinosus	8	29.6	19	0.7
Hypoaspis miles	2	7.4	4	0.1
Androlaelaps rotundus	1	3.7	2	0.1
Laelaps paulistanensis	1	3.7	2	0.1
Prolistrophorus paraguayensis (?)	1	3.7	1	0.04
Radfordia subuliger?	1	3.7	1	0.04
Tyrophagus putrescientiae	1	3.7	1	0.04
Chiggers				
Calicus brasiliensis	5	18.5	19	0.7
Arisocerus hertigi	1	3.7	3	0.1

	No.	Percent	No.	Average
Trombewingi bakeri	1	3.7	1	0.04
Parasecia sp.	1	3.7	1	0.04
Lice				
Hoplopleura travassoi	6	23.1	7	0.3
Oryzomys subflavus	(n = 3)			
Mites				
Argitis oryzomys	1	33.3	32	10.7
Laelaps castroi	2	66.7	32	10.7
Gigantolaelaps vitzthumi	3	100.0	24	8.0
Androlaelaps fahrenholzi	1	33.3	7	2.3
Mysolaelaps heteronychus	1	33.3	5	1.7
Androlaelaps projecta	1	33.3	2	0.7
Chiggers				
Colicus brasiliensis	2	66.7	13	4.3
Lice				
Hoplopleura sp. (new species)?	1	33.3	7	2.3
Oxymycteris roberti	(n =5)			
Mites				
Androlaelaps fahrenholzi	4	80.0	42	8.6
Laelaps paulistanensis	1	20.0	9	1.8
Androlaelaps pachyptilae	2	40.0	5	1.0
Eulaelaps sp.	1	20.0	1	0.2
Dermacarus nr. *hypudaei*	1	20.0	1	0.2
Lice				
Hoplopleura fonsecai	3	60.0	18	3.6
Coleoptera (Staphylinidae)	3	60.0	7	1.4
Rhipidomys masticalis	(n=11)			
Mites				
Laelaps paulistanensis	11	100.0	173	15.7
Mysolaelaps heteronychus	7	63.6	47	4.3
Laelaps thori	6	54.5	44	4.0
Radfordia sp.	1	9.1	1	0.1
Tyrophagus putrescentiae	1	9.1	1	0.1
Chiggers				
Microtrombicula rhipidomysi	1	9.1	16	1.5
Lice				
Hoplopleura angulata	9	81.8	113	10.3
Flea				
Craneopsylla minerva minerva	1	9.1	1	0.1

*includes 1 individual "probably *P. tripus*"

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NOTES ON SOME ECTOPARASITES FROM MAMMALS OF PARAGUAY[1]

John O. Whitaker, Jr.[2], D. Brian Abrell[3]

ABSTRACT: Ectoparasites were identified from a small collection of mammals from Paraguay. Apparently, most had not been reported previously from there. New records include 12 species of mites other than chiggers, 8 of chiggers, 1 flea, 2 sucking lice, 4 biting lice, 1 hemipteran, and 5 streblid flies.

There are few records of ectoparasites from mammals of Paraguay. Those of which we are aware are the following: Fain (1973), in his summary of information on neotropical listrophorids and chirodiscids, reported *Prolistrophorus paraguayensis* Fain 1970 from *Oryzomys ratticeps,* but Fain (1979) reported no atopomelids from Paraguay. Radovsky (1967) reported *Steatonyssus joaquimi* (Fonseca), and Rudnick (1960) reported *Periglischrus iheringi* Oudemans from *Vampyrops* sp. from Paraguay. Wenzel et al. (1966) reported *Trichobius furmani* Wenzel from *Glossophaga soricina* and *Megistopoda proxima* (Séguy) from Paraguay. Most of the chiggers reported upon here have been recently described by Goff & Whitaker (1984a,b) and Goff, Whitaker and Barkley (1984).

During 1981 and 1982 Abrell, while working in Paraguay, collected ectoparasites from a small collection of mammals. No dissecting microscope was available so examination was with a magnifying glass, and few of the smaller forms could be collected. Parasites were preserved in alcohol, cleared and stained in Nesbitt's solution, mounted in Hoyer's solution, and ringed with Euparal. Specimens have been deposited in the collections of the various workers mentioned in the acknowledgments, and representative specimens of most are being deposited in the U.S. National Museum.

The purpose of this paper is to report the results of these collections.

RESULTS AND DISCUSSION

MARSUPIALIA

DIDELPHIDAE

Didelphis albiventris Lund

One individual was examined; it yielded 1 flea, presently unidentified, and 12 ticks, *Ixodes loricatus.*

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EDENTATA

DASYPODIDAE

Chaetophractus villosus (Desmarest)

The one individual examined yielded 4 ticks, one adult identified as *Amblyomma pseudoconcolor,* the rest identified as *Amblyomma* sp., but likely the same.

Euphractus sexcinctus (Linnaeus)

Two individuals were examined and yielded 7 sticktight fleas, *Tunga penetrans* Linnaeus, 1758; and 53 ticks, *Amblyomma* sp., at least the adults among them *A. pseudoconcolor.*

Tolypeutes matacus (Desmarest)

One individual was examined; it yielded 22 ticks, *Amblyomma* sp., at least the adults among them *A. parvum.*

MYRMECOPHAGIDAE

Tamandua tetradactyla (Linnaeus)

One individual was examined; it yielded 160 mites, *Psoralges libertus* Trouessart (Psoroptidae), and 15 larval and nymphal ticks, *Amblyomma* sp.

PRIMATES

CEBIDAE

Aotus trivirgatus (Humboldt)

Two night monkeys were examined, but yielded only sucking lice, totaling 62, all *Aotiella aotophilus* (Ewing, 1924).

CHIROPTERA

MOLOSSIDAE

Molossus molossus (Pallas)

Five individuals were examined; they yielded the following: *Parkosa flexilis* (Chirodiscidae), 82 individuals; and *Chiroptonyssus haematophagus* (Macronyssidae), 3 individuals. Saunders (1975) found this species in Venezuela most commonly on *Molossus.*

Molossus temmincki (Burmeister)

Ten individuals were examined and yielded 20 individuals of *Chiroptonyssus venezolanus,* 3 of *C. haematophagus,* 6 of *Hesperoctenes vicinus,* and 23 individuals of the chigger *Loomisia peruviansis* (Goff, Whitaker & Barkley, 1984). *Hesperoctenes vicinus* is known only from Paraguay; its probable host is *Molossus ater* (Ueshima, 1972).

PHYLLOSTOMIDAE

Artibeus lituratus (Olfers)

The 26 individuals examined yielded the following ectoparasites:

Chirodiscidae: *Parkosa flexilis:* 22 on one individual; **Spinturnicidae:** 101 individuals of *Periglischrus iheringi* on 18 hosts. This parasite was very common on *Artibeus* in Venezuela also (Herrin & Tipton, 1975); **Streblidae:** *Megistopoda aranea,* 6, on 4 host individuals. The primary host is thought to be *Artibeus jamaicensis* although it is occasionally taken on *A. lituratus* (Wenzel, Tipton & Kiewlicz, 1966). **Macronyssidae:** *Chiroptonyssus venezolanus,* 10 on 5 individuals, *Macronyssoides kochi,* 1. Saunders (1975) found *M. kochi* to be common on *Artibeus jamaicensis* in Venezuela. **Uropodidae, 1: Chiggers:** sp. #10, 8 on 4 individuals; sp. #11, 2 on 3 individuals; **Ticks:** 2 *Ornithodorus* sp. The two chiggers appear to represent new taxa and are being studied by M. Lee Goff.

Carollia perspicillata (Linnaeus)

Two individuals examined each yielded one streblid fly, *Trichobius joblingi,* a common parasite of this bat in South America (Wenzel, 1976).

Desmodus rotundus (E. Geoffroy)

Two vampire bats were examined. One yielded 10 protonymphs of the macronyssid mite, *Radfordiella desmodi,* and 2 unidentified macronyssid protonymphs; the other yielded two streblid flies, *Trichobius parasiticus,* primarily a parasite of this host (Wenzel, Tipton, & Kiewicz, 1966).

Sturnira lilium (E. Geoffroy)

The 6 individuals examined yielded 17 spinturnicid mites, *Periglischrus iheringi,* on 4 individuals; Streblidae: *Aspidoptera falcata,* 3 individuals, and 6 individuals of *Megistopoda proxima. Aspidoptera falcata* is known from *Sturnira lilium* from Venezuela (Wenzel, 1976), and *M. proxima* is known from Panama, Paraguay and Venezuela (Wenzel et. al., 1966).

CARNIVORA

CANIDAE

Cerdocyon thous (Linnaeus)

Thirty-nine ticks were found on the one individual examined. Adults were identified as *Amblyomma parvum;* many nymphs and larvae of *Amblyomma* sp. were included which may have been the same species.

PROCYONIDAE

Nasua nasua (Linnaeus)

One individual examined, which had 15 *Laelaps manguinhosi,* 97 ticks, *Amblyomma* sp., of which at least the adults were *A. parvum;* 3 mallophagans *Neotrichodectes pallidus;* 3 laelapid mites, *Gigantolaelaps mattogrossensis;* and 5 macronyssid mites, *Ornithonyssus* sp.

RODENTIA

CAVIIDAE

Galea musteloides Meyen

One individual was examined of this guinea pig. On it were found two species of biting lice: 25 individuals of *Gliricola quadrisetosus* and 3 of *Macrogyropus heteronychus;* 75 chiggers, *Paratrombicula enciscoensis,* described as a new genus, new species by Goff & Whitaker, 1984; 9 individuals of *Cavilaelaps bresslaui* (Laelapidae), and 105 ticks.

CRICETIDAE

Akodon nigrita (Lichtenstein)

Three individuals apparently of this species were examined. The specimens were originally identified as *A. lasiotus,* which does not occur in Paraguay. The only species of *Akodon* known to occur in Paraguay other than *A. varius* is *A. nigrita;* thus we assume our specimens to be of this species. Efforts to obtain the specimens from Paraguay for reexamination were unsuccessful. Results were as follows: 1 louse, *Hoplopleura* sp.; 52 chiggers, 45 individuals of *Paratrombicula enciscoensis* described as new by Goff and Whitaker (1984b), 5 of *Paraguacarus abrelli* described as new by Goff & Whitaker (1984), 1 of *Quadraseta brennani,* and 1 of *Andalgalomacarus paraguayensis;* and laelapid mites as follows: *Androlaelops rotundus,* 23, and *Androlaelaps fahrenholzi,* 13.

Thus the major parasites of *A. nigrita* in Paraguay are *Paratrombicula enciscoensis, E. rotundus,* and *A. fahrenholzi. Androlaelaps fahrenholzi* is the most widespread mite of the new world and is found on far more hosts than any other species. *Androlaelaps rotundus* varies in some characters indicated in the original description.

Akodon varius Thomas

Six individuals were examined and the following forms were found: 5 lice, *Hoplopleura* sp.; 248 chiggers, *Paratrombicula enciscoensis,* 1 of each of the chiggers *Andalgalomacarus paraguayensis* and *Paraguacarus callosus;* Laelapids: *Androlaelaps rotundus,* 28; and *Androlaelaps fahrenholzi,* 17; and 3 fleas, *Polygenis* sp.

The same three parasites are the dominant ones on this host as on *A. nigrita:* the chigger, *P. enciscoensis,* and the laelapids, *A. torundus* and *A. fahrenholzi.*

Andalgalomys pearsoni (Myers)

Three individuals of this species were examined, but only chiggers, totalling 52 of 6 species, were found, as follows: 24 individuals of *Andalgalomacarus paraguayensis* described by Goff and Whitaker (1984b) as a new genus and new species, 12 of *Paratrombicula* *enciscoensis*, 9 of *Paraguacarus abrelli*, 3 each of *Microtrombicula pearsoni* and *Quadraseta brennani* both described as new by Goff & Whitaker (1984b), and 1 of *Paraguacarus callosus*.

Calomys callosus (Rengger)

Only 1 individual was examined. On it were found 2 mites, near *Tyrophagus*, and 8 chiggers: 4 individuals described as a new genus and species. *Paraguacarus callosus* by Goff & Whitaker (1984a), 1 of *Paraguacarus abrelli*, 2 of *Eutrombicula batatas* (Linnaeus, 1758), and 1 unidentified chigger.

Calomys laucha (Olfers)

Three individuals were examined; two species of ectoparasites were found, 20 individuals of *Laelaps mazzai* and seven chiggers, all *Paratrombicula enciscoensis*.

Graomys griseoflavus (Waterhouse)

On the one individual were found 3 *Hoplopleura* sp. and 8 chiggers, *Paratrombicula enciscoensis*.

Holochilus chacarius Thomas

Two individuals were examined and yielded 30 lice, *Hoplopleura contigua* Johnson, 1972; 101 ticks, *Amblyomma* sp.; 2 psoralgids, *Marsupialges misonnei;* and 2 laelapids, *Gigantolaelaps mattogrossensis*. *Marsupialges misonnei* was described from *Didelphis marsupialis* and from *Marmosa murina* from French Guiana, both marsupials. This is only the second record for this parasite so we have included it. However, we suspect it is either accidental or a contaminant on *Holochilus*.

ARTIODACTYLA

TAYASSUIDAE

Tayassu tajacu (Linnaeus)

The two individuals examined yielded 60 mallophagans, *Macrogyropus dictoylis* (Macalister, 1869), all on 1 host; and 43 ticks, *Amblyomma cajeunense*.

DISCUSSION

There are few records of ectoparasites from Paraguay, but literature is scattered and not readily available. However, the following species apparently have not previously been taken in Paraguay.

Chiggers (Trombiculidae)
- *Andalgalomacarus paraguayensis* Goff & Whitaker, 1984b
- *Eutrombicula batatas* (Linnaeus, 1758)
- *Loomisia peruviansis* Goff, Whitaker & Barkley, 1983
- *Microtrombicula pearsoni* Goff & Whitaker, 1984b
- *Paraguacarus abrelli* Goff & Whitaker, 1984b
- *Paraguacarus callosus* Goff & Whitaker, 1984a
- *Paratrombicula enciscoensis* Goff & Whitaker, 1984b
- *Quadraseta brennani* Goff & Whitaker, 1984b

Other Mites:

Chirodiscidae
- *Parkosa flexilis* (Pinichpongse, 1963)

Laelapidae
- *Androlaelaps fahrenholzi* (Berlese, 1911)
- *Androlaelaps rotundus* Fonseca, 1935
- *Cavilaelaps bresslaui* Fonseca, 1935
- *Gigantolaelaps mattogrossensis* (Fonseca, 1935)
- *Laelaps manguinhosi* Fonseca, 1935
- *Laelaps mazzai* Fonseca, 1939

Macronyssidae
- *Chiroptonyssus haematophagus* (Fonseca, 1935)
- *C. venezolanus* (Vitzthum, 1932)
- *Macronyssoides kochi* (Fonseca, 1948)
- *Radfordiella desmodi* Radovsky, 1967

Psoroptidae
- *Marsupialges misonnei* Fain, 1963
- *Psoralges libertus* Trouessart, 1896

Fleas (Siphonaptera)
- *Tunga terasma* Jordan, 1937

Sucking Lice (Anoplura)
- *Aotiella aotophilus* (Ewing, 1924)
- *Hoplopleura contigua* Johnson, 1972

Biting Lice (Mallophaga)
- *Gliricola quadrisetosus* (Ewing, 1924)
- *Macrogyropus dicotylis* (Macalister, 1869)
- *Macrogyropus heteronychus* (Ewing, 1924)
- *Neotrochidectes pallidus* (Piaget, 1880)

Flies (Diptera):

Streblidae
- *Aspidoptera falcata* Wenzel, 1976
- *Megistopoda aranea* (Coquillett, 1899)
- *T. joblingi* Wenzel, 1966
- *Trichobius parasiticus* Gervais, 1844

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TELOMERINA BERINGIENSIS, A NEW SPECIES OF SPHAEROCERIDAE (DIPTERA) FROM YUKON AND ALASKA.[1]

S.A. Marshall[2]

ABSTRACT: *Telomerina beringiensis* is described and its relationships to other *Telomerina* species discussed.

Marshall and Roháček (1984) revised the Holarctic genus *Telomerina* Rohacek to include twelve species, and provided a cladogram for those species. At that time four species (*T. orpha* Marshall and Rohacek, *T. cana* Marshall and Roháček, *T. eburnea* Roháček, and *T. paraflavipes* (Papp)) were recognized as a monophyletic group sharing distinctively shaped spermathecae with wrinkled bodies, and a characteristically shaped male fifth sternite with 2 large posterior, setose lobes. *Telomerina beringiensis* n. sp. shares these and all other characters required for inclusion in this clade, and furthermore shares at least one unique character (posteromedial area of male sternite 5 with flat, bifid spinules) with the eastern North American *T. cana,* suggesting a sister-group relationship between these two species. *Telomerina beringiensis* differs from related species most obviously in having a broad, sinuate paramere and a relatively long third costal sector, but can also be separated from all congeners using details of the male fifth sternite, surstylus, distiphallus, and spermathecae.

Telomerina beringiensis n. sp.

Description: Body length 1.2-1.4mm; brown, pruinose except facial cavity. Postocellar bristles present; orbital setulae large, in a long row extending below eye. Interfrontal bristles in 3-4 long, subequal pairs, anterior pair shortest. Eye height 1.3-1.4 times genal height. Dorsocentral bristles in 2 pairs, anterior pair short; acrostichal setulae long, in 6 rows, prescutellar pair enlarged. Scutellum 1.3 times as wide as long, scutellar bristles as long as scutellar width. Katepisternum with a posterodorsal bristle and a minute setula in front of posterodorsal bristle. Mid tibia with an anteroventral bristle below middle and a weak ventral bristle at apex, these bristles stronger in female. Hind tibia with a dense patch of short anterodorsal hairs near apex. Wing with pale, whitish membrane; costa brownish, other veins pale. Second costal sector shorter than third (0.7 to 0.8 times as long in females, 0.8 to 0.9 times as long in males (3 of each sex measured); R_{2+3} straight, not apically curved.

Male abdomen: Sternite 5 with a large patch of flat, bifid spinules posteromedially; posterior lobes short, densely setulose (Fig. 3). Epandrium with posterior bristles longest and with 4 or 5 anteroventral bristles. Surstylus pale, basally constricted, with long hairs on anterior swelling;

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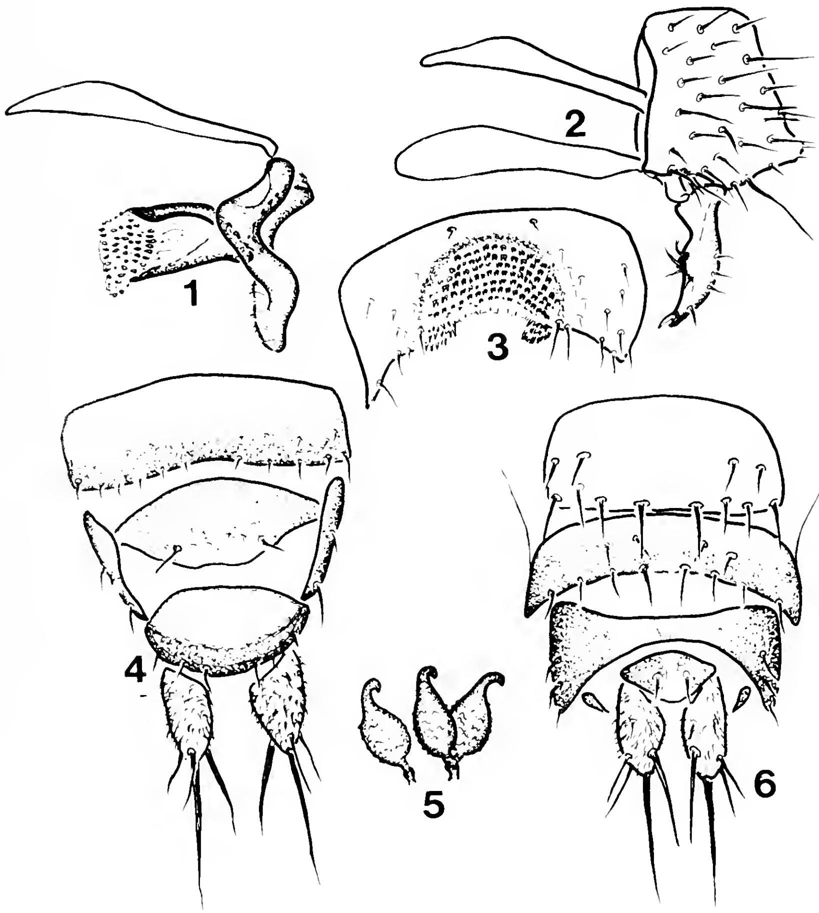

Figs. 1-6. *Telomerina beringiensis.* 1. Aedeagus and associated structures of male, left lateral; 2. Terminalia of male, left lateral; 3. Sternite 5 of male; 4. Terminalia of female, ventral; 5. spermathecae; 6. terminalia of female, dorsal.

apically darkened, weakly bifid and with a stout, pale apical bristle (Fig. 2). Aedeagal complex large, parameres broad, sinuate; anterior surface finely setulose (Fig. 1). Basiphallus broad and flat, much shorter than distiphallus. Distiphallus simple, composed of dorsal sclerite and ventral membranous part distally covered with distinct, thorn-like spicules (Fig. 1).

Female abdomen: Tergite 7 wider than tergite 6; sparsely haired and darkly pigmented on posterior half except for small posteromedial pale notch. Epiproct short, pale. Cercus broad, with thin apical bristle (Fig. 6). Sternite 8 pale on posterior half and with long posterolateral bristles (Fig. 4). Hypoproct dark, setulose along posterior margin; bare and pale on anterior portion.

Holotype ♂: CANADA. Yukon: Forestry Camp near Dawson City, on bear feces 13.vii.1985, S. Marshall.

Paratypes: CANADA. Yukon: Dempster Hwy, Tombstone Mtn. Campground, in copula on fox feces, 12.vii.1985, S. Marshall (1♂, 1♀); Dempster Hwy. km. 141, on grizzly bear feces along Blackstone River, 11.vii.1985, S. Marshall (1♀); Dawson City, dead wolf along hydro line, 13.vii.1985, S. Marshall (1♂); Moose Creek Campground, mushroom, 3.vii.1985, S. Marshall (1♀). UNITED STATES. Alaska: Alaska Hwy., 12miN Tok, carrion, 14-20.vii.1985, S. Marshall (2♂, 2♀); 12miSummit, 86miENE Fairbanks, Hwy. 6, 909m., carrion, tundra, 6-13.viii.1984, S&J. Peck (3♂, 2♀); Denali Nat. Pk., Primrose Pass, 3000', 22-26.vii.1984, S&J. Peck, tundra, carrion (2♂, 4♀); Eagle Summit, 54miSW Circle, Rt. 6, 1105m, carrion, tundra, 6-13.viii.1984, S.&J. Peck (5♂, 7♀); Caribou Mt., Dalton Hwy. mi. 98, 30.vii-3.viii.1984, carrion, tundra, 2300' S.&J. Peck (1♂); Grayling Lake, Dalton Hwy. mi. 152, 31.vii-3.viii.1984, carrion, meadow-tundra S.&J. Peck (1♂); Dietrich, Dalton Hwy. mi. 209, 31.vii.3.viii.1984, carrion, scrub spruce taiga, S.&J. Peck (2♀).

The holotype and 2 paratypes are in the Biosystematics Research Centre, Ottawa. Other paratypes are in the University of Guelph collection.

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RESTRICTION OF THE SOUTH AMERICAN GENUS *ACROLYTTA* (COLEOPTERA: MELOIDAE)[1]

Richard B. Selander[2]

ABSTRACT: *Acrolytta neivai* (Denier) is transferred to *Lytta* Fabricius, *A. nigropicta* (Denier) to *Picnoseus* Solier, and *A. weyrauchi* Kaszab to *Spastomeloe* Selander.

In preparation for a systematic revision of the species of *Acrolytta* Kaszab it is convenient to remove from the genus three species that are clearly not congeneric with the type species, *A. binotatithorax* (Pic).

Lytta neivai Denier

Lytta neivai Denier, 1940:799.
Acrolytta neivai, Kaszab, 1963:341.

This species is known definitely only from the holotype, a female, collected at Joinville, on the coast of Santa Catarina, Brazil, in 1919 and sent to Denier for description by T. Borgmeier. According to Denier (1940:800), the specimen is in the "Instituto de Experimentacão Agricola, Rio de Janeiro."

Kaszab (1959) did not include *L. neivai* in *Acrolytta* when he described the genus, but he later (Kaszab, 1963) referred to it as a member of the genus in describing *A. weyrauchi.* Yet the large size of the type of *L. neivai* (length 23 mm), its coloration (reddish yellow), the form of its pronotum (elongate, campanuliform), and its relatively wide elytra (2x as wide as the pronotum) are hardly consistent with assignment of the species to *Acrolytta,* and it is significant that in describing the species Denier compared it with *Epispasta abbreviata* (Klug) (as *Lytta*) rather than with any of the several species of *Acrolytta* then assigned to *Lytta* Fabricius.

A female of a meloid species representing a new genus, presumably of *Lyttina,* from Chapada, Mato Grosso, Brazil, in the collection of the Carnegie Museum, agrees with Denier's description of *L. neivai* in all particulars, except that the color is yellow rather than "luteo-rubra." Whether it is conspecific with the type of *L. neivai* is questionable, but it appears very likely that the two specimens represent the same genus. In any event. Kaszab's transfer of *L. neivai* to *Acrolytta* is unacceptable. Pending further study, I propose to return Denier's species to the genus *Lytta.*

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Picnoseus nigropictus (Denier), new combination

Lytta nigropicta Denier, 1932:87, 2 figs.
Acrolytta nigropicta, Kaszab, 1959:111.

The original description of this species was based on five or more adults collected by M.P. Gómez at Nanogasta and Guanchin, La Rioja, Argentina. Denier specified 1928 as the year of collection at Guanchin (which is spelled Huanchin on the specimen labels and in Denier's article). Nanogasta and Guanchin are in the Department of Chilecito, about 15 km S and 15 km W, respectively, of the city of Chilecito.

In the original description Denier wrote "Tipo en mi colección" but referred to the remainder of his material as "co-tipos." A female in the Denier collection in the Museo de La Plata is labeled "Holotipo//Nonogasta/ Rioja Gómez//C. Bruch dedit 1921." In addition, I have examined two specimens in the Bruch collection in the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," in Buenos Aires, both labeled as cotypes. Notwithstanding Denier's designation of cotypes, it is evident that he regarded the specimen in his collection as *the* type, and on this account a lectotype designation does not seem necessary.

Denier's species was included by Kaszab (1959) in his genus *Acroyltta* without comment. However, the species clearly belongs neither to *Lytta* nor to *Acrolytta* but to *Picnoseus* Solier, a pyrotine genus heretofore recorded only from Chile.

Spastomeloe weyrauchi (Kaszab), new combination

Acrolytta weyrauchi Kaszab, 1963:341.

Although Kaszab suggested that this species stands nearest *Lytta neivai* (as *Acrolytta*), his description of the unique holotype (male) leaves little doubt but that *A. weyrauchi* is congeneric with *S. formosus* Selander, the type species of the meloine genus *Spastomeloe* Selander (1985). Kaszab gave the type locality as "Lomas Marcons, 540 Km zwischen Nasca [*sic*] and Yauca, 350 m," Peru. Highway distances shown on the Mapa Fisico Politico Vial - Perú, Tercera Edicion, 1983 (Librería Internacional del Peru S.A., Lima) indicate that the Km 540 marker (from Lima) on highway #1 between Nazca and Yauca is near Puerto de Lomas, in Arequipa. On the other hand, "Marcons" is perhaps a misspelling of Marcona, the name of a mining center in Ica, near its border with Arequipa. Either way, the type locality is (in straight-line distances) about 650 km NW of the type locality of *S. formosus* at Las Yaras, Tacna, Peru, and 1300 km SE of the type locality of *S. singularis* Selander at Las Lomas, Piura, Peru.

Kaszab described the lighter color of the head, pronotum, and elytra of his type specimen as dark red, without indicating a difference in shade or intensity among these areas. Uniformity in this respect is characteristic of the unique type specimen of *S. singularis,* but the color is orange. In *S. formosus* the head and pronotum might be described as dark red, but the light color of the elytra is pure orange, not at all reddish. There are additional differences in the coloration of the venter of the body and the black margining of the pronotum that would seem to distinguish *S. weyrauchi* from both of the other species of the genus. The differences, however, are of the degree and nature that one might expect to arise in isolated populations, and I would not be surprised to find that *S. weyrauchi* is conspecific with either *S. singularis* or *S. formosus* or, for that matter, that it represents an intergrade population. However, since Kaszab provided no figures of the type specimen and no information regarding the genitalia, I am inclined for the present simply to add *S. weyrauchi* to *Spastomeloe* as a third nominal species.

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NOTES ON *ANACHARIS MELANONEURA* (HYMENOPTERA: FIGITIDAE) AND *CHARITOPES MELLICORNIS* (HYMENOPTERA: ICHNEUMONIDAE) PARASITIZING *MICROMUS POSTICUS* (NEUROPTERA: HEMEROBIIDAE)[1]

Ronald D. Cave, Gary L. Miller[2]

ABSTRACT: Laboratory observations were made on the biologies of the figitid, *Anacharis melanoneura*, and the ichneumonid, *Charitopes mellicornis*, parasitizing a brown lacewing, *Micromus posticus*. Mean egg/larval and pupal developmental times of *A. melanoneura* were 11.2 and 6.6 days, respectively, at 28°C. Mean larval and pupal developmental times of *C. mellicornis* were 5.7 and 5.5 days, respectively. The first *C. mellicornis* larva to hatch killed, but did not consume, the remaining eggs in the clutch and then fed upon the *M. posticus* larva.

The brown lacewing, *Micromus posticus* (Walker), is a common, aphidophagous predator occurring throughout the eastern United States. Its use as a biological control agent has been proposed because of its potential for rapid population growth (Miller and Cave 1987). However, population growth could be slowed in the field by the predator's own natural enemies. The ichneumonid *Charitopes mellicornis* (Ashmead) is the only species listed as parasitizing *M. posticus* (Carlson 1979). Selhime and Kanavel (1968) reported a species of the figitid genus *Anacharis* attacking *Micromus subanticus* (Walker), but not *M. posticus*, in Florida and provided brief notes on the parasitoid's biology. In an unsprayed cotton field in Alabama, Miller and Cave (1987) found 6% of the *M. posticus* cocoons were parasitized by *C. mellicornis* and *Anacharis melanoneura* Ashmead.

Anacharis melanoneura ranges from Virginia to Florida and west to Louisiana and Texas (Burks 1979). Our collection of this species is the first record in Alabama. According to Burks (1979), it is the only known *Anacharis* species in the southeastern United States. The only other reported host for *A. melanoneura* is *Hemerobius stigma* Stephens (Miller and Lambdin 1985). However, the *Anacharis* sp. found attacking *M. subanticus* by Selhime and Kanavel (1968) may have been *A. melanoneura* since no other species of *Anacharis* are known in the region. Miller and Lambdin (1985) illustrated the larval, pupal, and adult stages of *A. melanoneura*.

The known distribution of *C. mellicornis* is from Massachusetts to South Carolina and west to Minnesota and Iowa (Carlson 1979). Our collection of

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this parasitoid in Alabama is a new state record and extends the southern range of the species. Only three other species of *Charitopes* are known from North America, none of which is apparently sympatric with *C. mellicornis* (Carlson 1979). No other hosts besides *M. posticus* have been listed in the literature for *C. mellicornis*. However, species of *Charitopes* in the western United States are known to attack *Hemerobius* spp. (Deyrup and Deyrup 1978). The adult female of *C. mellicornis* was illustrated by Townes (1969).

The purpose of this paper is to report laboratory observations on the biologies of *A. melanoneura* and *C. mellicornis* parasitizing *M. posticus*.

METHODS AND MATERIALS

Eggs and larvae of *M. posticus* were collected from an unsprayed cotton field in Elmore Co., AL, in August, 1984 and reared in the laboratory with cotton aphids, *Aphis gossypii* Glover, as prey. Larvae and pupae of *C. mellicornis* and *A. melanoneura* were collected in the same field during the first week of September. Field-collected hosts parasitized by either of the two parasitoids were placed individually in plastic cups (30 ml) with a moistened cotton ball and held at 28°C, ca. 70% RH, and 14:10 L:D photoperiod. As female parasitoids emerged, they were placed individually in cups with conspecific males and suitable hosts. A drop of 10% honey water was placed on the inside of each cup as a food source for the adult parasitoids.

First-, second-, and active third-instar *M. posticus* larvae were exposed to *A. melanoneura* for 24 h. After exposure, larvae were placed singly in cups with cotton aphids and allowed to develop. Fresh hosts were given to the adult parasitoids until they died. Exposed hosts were observed daily for parasitoid emergence.

Charitopes mellicornis adult females were provided 1-5 quiescent third-instar larvae or < 1-day-old pupae of *M. posticus*. Preliminary experiments revealed that females did not oviposit on active larvae. Oviposition behavior of females was observed during the day with a dissecting microscope. Parasitized hosts were replaced with fresh, unparasitized ones daily. The number of eggs laid daily was recorded. Parasitized hosts were placed individually in cups containing a moistened cotton ball and observed daily for parasitoid egg hatch and larval development.

Parasitoids and *M. posticus* were identified by the authors. Original descriptions (Ashmead 1887, 1889), Townes (1969), Burks (1979), Carlson (1979), and Miller and Lambdin (1985) were consulted in determiing the parasitoid species. Voucher specimens are deposited in the Entomology Collection of Auburn University and in the collection of the senior author.

RESULTS AND DISCUSSION

Anacharis melanoneura attacked only second- and early third-instar *M. posticus*. Miller and Lambdin (1985) noted that *A. melanoneura* oviposited only in late second- and third-instar *H. stigma* and either ignored or simply palpated first-instars. Selhime and Kanavel (1968) stated, however, that first-instar *M. subanticus* were successfully parasitized by the *Anacharis* sp. they studied.

Egg incubation and larval development of *A. melanoneura* within the host together lasted 7-8 days ($\bar{x}$=7.5, n=4). During this time, the host larvae developed and spun cocoons but did not transform to pupae. After feeding internally, the parasitoid larvae emerged through the ventral integument between opposing legs of the host. Only one larval *A. melanoneura* emerged per host. After emergence, the third-instar parasitoids continued to feed until their hosts' cadavers were entirely consumed. This period of external feeding and development lasted 2-5 days ($\bar{x}$=3.7, n=6). Larvae then pupated without forming cocoons and remained as pupae for 5-8 days ($\bar{x}$=6.6, n=9). These larval developmental times are similar to those observed by Miller and Lambdin (1985) for *A. melanoneura* parasitizing *H. stigma,* although the temperature to which they subjected their organisms was 6-8°C cooler than ours. Pupal developmental time was slightly shorter in our study.

Adult *A. melanoneura* remained inside the host's cocoon for 24 h, then emerged to feed on the honey water solution. Longevity of the reared adults was 1-9 days ($\bar{x}$=4.9, n=7).

Female *C. mellicornis* deposited their eggs on quiescent third-instar hosts except for one instance when eggs were laid on a 1-day-old pupa. During oviposition, the female inserted her ovipositor through the host's two-layered cocoon and maneuvered the ovipositor until the tip made contact with the host. Upon contact, she attached 1-9 eggs ($\bar{x}$=4.1, n=11) to the host's integument. All the females we observed deposited their eggs during a single period on a host and did not return to parasitized hosts later on to lay more eggs. Newly laid eggs are pearly white and 0.76 mm long by 0.18 mm wide (Fig. 1A). Although as many as five suitable hosts were concurrently available, female parasitoids always laid their eggs of any given day in just one host cocoon, except for one instance in which two cocoons received 1 and 4 eggs each from a single female in a 24 h period.

Egg hatch occurred in 24 h. The first-instar larva is 0.64 mm long and the conspicuous head capsule has a pair of prominent, conical antennae (Fig. 1B). A band of grey setae encircles each segment. Immediately after eclosion, the first emergent larva killed, but did not consume, the unhatched eggs and then began to feed externally on the *M. posticus* larva. The eggs destroyed by the first emergent larva were not necessarily inviable. We

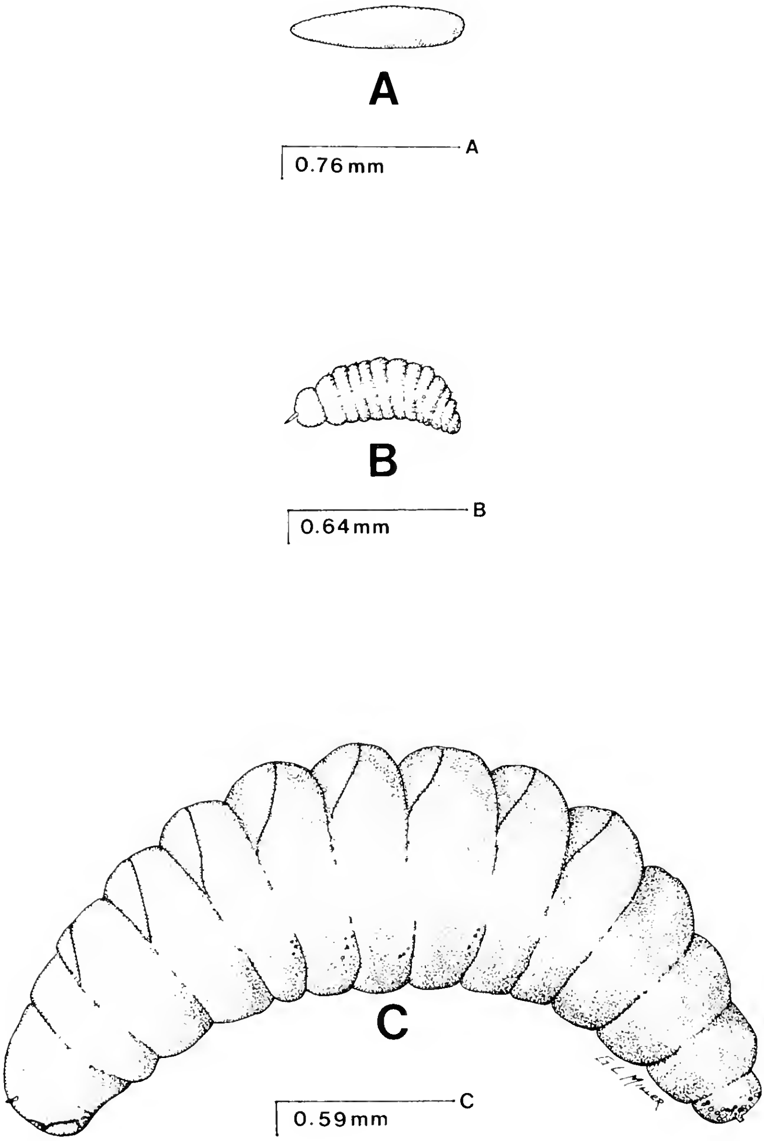

Fig. 1. *Charitopes mellicornis.* A. Egg; B. First-instar larva; C. Third-instar larva.

divided a clutch of 8 eggs into two groups of two and six eggs each and placed the groups on separate hosts. The first egg to hatch in each group destroyed the rest of the eggs in its respective group and then began to feed on the *M. posticus* larva. We also separated two eggs of another clutch and both eggs subsequently hatched. We observed this fratricidal behavior in every case (n=8) in which two or more eggs were laid on the same host. The first larva to emerge apparently benefits from this fratricidal behavior by having more food resource available to it. However, by depositing all their eggs on one host and all but one egg being subsequently destroyed, females appeared to be wasting eggs, especially since other suitable hosts were available. It is not known if superparasitism by this species occurs in the field. We never found more than one *C. mellicornis* larva or pupa within a host cocoon in the field. Nevertheless, superparasitism by *C. mellicornis* may be a laboratory artifact caused by the restriction of females to small arenas. Thus, the phenomena of superparasitism and fractricidal behavior by this parasitoid need to be investigated further.

Developmental time for larval *C. mellicornis* was 5-7 days ($\bar{x}$=5.7, n=9). This period included 2-3 days spent spinning a silken white cocoon within the host's cocoon. Thus, the larva fed on the host for only 3-4 days. Third-instar larvae are 14-segmented and 2.60 mm long (Fig. 1C). The integument is finely scabrous with a few setae and rounded protuberances on each segment. Many of these protuberances are clustered around the last abdominal segment. Compared to the first-instar, the head capsule is indistinct and the antennae are greatly reduced. Unlike *A. melanoneura, C. mellicornis* did not consume the entire host, but left the shriveled integument after consuming all the body fluids.

The pupal stage of *C. mellicornis* lasted 4-10 days ($\bar{x}$=5.5, n=11), after which the adult chewed an emergence hole through both cocoons. Adults lived as long as 14 days. Mating was not observed and the progeny of all females (reared from field-collected specimens) were all males.

The parasitoid fauna of Nearctic Hemerobiidae continues to be overlooked, although parasitoids may limit the effectiveness of these predators (Cole 1933). Parasitism of immature brown lacewings may be as low as 5% (Deyrup and Deyrup 1978) or as high as 60% (Selhime and Kanavel 1968). Biological control programs that take advantage of brown lacewings as aphid predators should therefore examine the role that parasitoids play in the population dynamics of these predators.

ACKNOWLEDGMENTS

We express our appreciation to Jim Cane and Lacy Hyche for their critical reviews of the manuscript.

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A SPIRACULAR ABNORMALITY IN *ANASTREPHA STRIATA* LARVA (DIPTERA: TEPHRITIDAE) FROM COSTA RICA[1,2]

Stanley R. Jones, Ke Chung Kim[3]

ABSTRACT: The abnormal posterior spiracular system of an *Anastrepha striata* larva collected from *Psidium guajava* is compared to those of typical systems. Abnormalities include four spiracular openings and five interspiracular processes instead of the usual three and four, respectively.

Although some species-specific differences and some intraspecific variations do exist, the posterior spiracles of third stage larval Tephritidae demonstrate highly consistent similarity in gross morphology (Phillips, 1946; Baker *et al.* 1944). Each larva bears a right and left stigmatic plate, each of which possesses three spiracular openings oriented at characteristic angles. In addition, each spiracular plate bears four sets of interspiracular processes, 1 dorsal, 2 lateral, and 1 ventral. Because of the consistency of these structures, they are important taxonomically and are typically figured in larval descriptions. No major deviations from the typical gross posterior spiracular pattern have previously been described for third stage tephritid larvae. For the schizophoran Diptera as a whole, very little has been reported on abnormalities of the posterior spiracles and associated structures. Bates (1934) reported an abnormality in the peristigmal gland cells of *Rhagoletis pomonella* Walsh, and Gammal-Eddin (1961) reported an abnormality in the posterior spiracles of *Stomoxys calcitrans* Lin. This paper reports the occurrence of an unusual structural pattern in the posterior spiracular system of *Anastrepha striata* Schiner.

Twenty-two third stage larvae of *A. striata* were collected from *Psidium guajava* L. on 8 June, 1986 at the Estacion Experimental, Fabio Baudrit, Universidad de Costa Rica, Costa Rica. Several of these were prepared for light microscopy by excising the head and 7th and 8th abdominal segments, soaking these in 10% KOH for 12 hrs, staining in acid Fuschin for 2 min., dehydrating in an ethyl alcohol series, transferring to xylene, then mounting

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on glass slides with Canada Balsam. Upon examination, one larva was found to possess four spiracle openings and five sets of interspiracular processes on the right spiracular plate (Fig. 1A). The right spiracular system of a typical larva is shown in Figure 1B. Table 1 lists minimum-maximum measurements taken from five typical larvae, compared with measurements from the aberrant larva. All measurements were taken with an ocular micrometer from the morphological characters shown in Figure 1B.

Despite the occurrence of an extra spiracular opening on the aberrant larva, the dimensions of the right spiracular plate were no larger than those of typical larvae. All measurements taken from the aberrant larva were well within the range of normal variation. All four spiracle openings and five interspiracular processes appeared fully and normally developed in every respect. The most noticeable difference between the aberrant and typical spiracular systems, besides the obvious possession of an extra spiracle opening and interspiracular process, occurred in the pattern or alignment of the spiracular openings. Spiracle openings 1 and 2 of typical *A. striata* larvae are generally parallel, while the 3rd deviates from this orientation (Fig. 1B). This typical spiracle opening pattern does not occur in the aberrant larva due

A

Figure 1A. Aberrant pattern of the right spiracular system taken from a third stage larva of *Anastrepha striata*.

to the space required to accommodate the 4th spiracular opening. It is impossible to determine from spiracle opening orientation or degree of development which opening is the additional one.

The probability of observing such a spontaneous mutation is very low, particularly in a single collection from infested guava fruit. This observation is considered significant because it shows the presence of spiracular mutation within *Anastrepha* species.

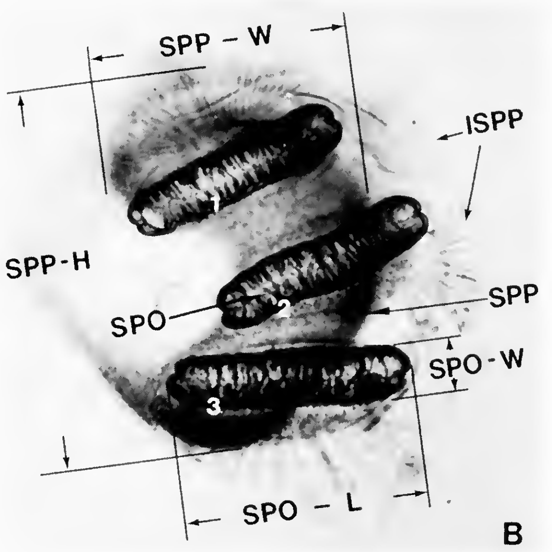

Figure 1B. Typical pattern of the right spiracular system taken from a third stage larva of *Anastrepha striata*. SPO-L spiracular opening length; SPO-W spiracular opening width; SPP-W spiracular plate width; SPP-H spiracular plate height; ISPP interspiracular processes, number of branches counted 0.14 mm from base.

Table 1. Comparison of minimum-maximum measurements taken from the right spiracular system of a typical and aberrant *Anastrepha striata* larva (all measurements in mm; N 5 for typical larvae). TYP Typical; ABT aberrant; SPO-L spiracular opening length; SPO-W spiracular opening width; SPP-W spiracular plate width; SPP-H spiracular plate height; ISPP interspiracular processes, number of branches counted 0.14 mm from base.

	SPO-L		SPO-W		SPP-H		SPP-W		ISPP	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
TYP	0.114	0.145	0.021	0.052	0.229	0.281	0.197	0.229	9	23
ABT	0.114	0.135	0.021	0.031	0.249		0.187		10	20

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A TERMINOLOGY FOR FEMALES WITH COLOR PATTERNS THAT MIMIC MALES[1]

Donald F.J. Hilton[2]

ABSTRACT: A portion of the female population in certain insects, especially some species of Odonata, have color forms which mimic the male color pattern. A confusing series of names have been applied by various authors to these male-mimicking females. This terminology is reviewed and a suggestion is made to use androchromatypic for male-mimicking females and gynochromatypic for females with the usual female color pattern.

Certain insect species have a portion of the female population with a color pattern that mimics male coloration. This has been described for a few butterflies (e.g. Clarke *et al.* 1985) and several Odonata, in particular species of *Ischnura* (Zygoptera: Coenagrionidae) and *Aeshna* (Anisoptera: Aeshnidae). Most of the published accounts have involved species of *Ischnura* in which the color patterns are further complicated by the fact that immature females are orange-brown and then change to green-black when they become sexually mature. In addition, old females often develop a greyish-white pruinosity that completely obscures the green-black ground coloration. Until these age-related color changes were understood, early publications often considered female populations to consist of two or more color forms. Grieve (1937) and Lyon (1915) reviewed this literature and also documented the gradual change from orange-brown to green-black coloration as *I. verticalis* females mature. I will ignore the terminology used for these age-related color forms and deal only with those terms that were applied to mature females.

There have been a number of such terms including andromorphic, homochrome, homoeochromatic, isochromatic and isomorphous for females with the male color pattern and heterochromatic, heterochrome, heteromorphic and heteromorphous for females which have the typical female color pattern. Until Johnson (1964), the most frequently used terms were some form of homochromatic and heterochromatic. In his study of the inheritance of female dimorphism in *I. damula,* Johnson (1964) examined the question of terminology and suggested using andromorphic (male-mimicking females) and heteromorphic ("typical" females) in order to avoid confusion with the cytogenetic meaning of the word heterochromatic. More recently, Garrison and Hafernik (1981), Hinnekint (1986) and Robertson (1985) have also employed andromorphic and heteromorphic for female color forms of *I. gemina, I. elegans* and *I. ramburi,* respectively.

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In my opinion, none of these terms is satisfactory. The suffix -morphic implies a morphological difference whereas it is one of color only. The prefixes homo- and hetero- mean similar and different, but don't specify similar to, or different from, what. For these reasons, I would suggest androchromatypic (from the Greek *aner* (male), *chroma* (color) and *typos* (pattern)) for females with a male-mimicking color pattern and gynochromatypic (from the Greek *gyne* (female)) for females with the usual female coloration.

Pasteur (1982) provided a classification for various mimicry systems. He didn't specifically deal with the case of females that have a male-mimicking color pattern. However, this situation is an example of automimicry which is itself a type of intraspecific mimicry where both model and mimic are different individuals within the species. Furthermore, Pasteur (1982) stated that when females mimic males this is a category of Wicklerian-Barlowian mimicry that is known as reproductive conjunct automimicry. In this case conjunct means that the model, mimic and dupe all belong to the same species and dupe "implies that (a) the animal perceived signals, (b) the signals were deceptive, and (c) the animal displayed active or passive behavior in response to the deception." (Pasteur 1982). For the species of *Ischnura* described above, the male is the model and dupe while the androchromatypic female is the mimic.

Hinnekint (1986) showed that in *I. elegans,* crowded conditions increased the number of andromorphic (i.e. androchromatypic) females and Robertson (1985) suggested that such females in *I. ramburi* have an advantage because only one mating is required. Additional copulations (which last 3 h) waste time for the females and may expose them to increased levels of predation. Therefore, by mimicking males in both color and behavior, androchromatypic females may be able to avoid extra matings more easily than gynochromatypic females.

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SYMBIOSIS. AN INTRODUCTION TO BIOLOGICAL ASSOCIATIONS. V. Ahmadjian & S. Paracer. 1986. Univ. Press of New England. 212 pp. $32.50.

An introductory text for students, instructors, & research workers on the broad perspective of symbiosis and "parasitism".

THE SUCKING LICE OF NORTH AMERICA. AN ILLUSTRATED MANUAL FOR IDENTIFICATION. K.C. Kim, H.D. Pratt, & C.J. Stojanovich. 1986. Penn. State Univ. Press. 241 pp. $39.50.

The main body of this manual consists of illustrated keys to all known North American Anoplura, including 9 families, 19 genera, and 75 species. The male and female of each species are illustrated and briefly described with important taxonomic characters. Also included are chapters on collecting and preservation techniques, morphology and diagnostic characters, biology and immature stages, public health & veterinary importance, and parasite-host and host-parasite listings.

INSECT NEUROCHEMISTRY AND NEUROPHYSIOLOGY. A.B. Borkovec & D.B. Gelman, eds. 1986. Humana Press. 484 pp. $69.75.

A written account of 68 invited lectures, contributed papers, and posters presented at the second International Conference on Insect Neurochemistry and Neurophysiology, Univ. of Maryland, August 4-6, 1986.

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This fourth volume of a continuing series contains taxonomic, nomenclatural, and distribution data for 362 genera and 2811 species for the 11 families from Sciaridae to Anisopodidae.

CARABID BEETLES. THEIR ADAPTATIONS AND DYNAMICS. P.J. den Boer, M.L. Luff, D. Mossakowski, & F. Weber, eds. 1986. Gustav Fischer Pub. 551 pp.

A compilation of 36 papers presented at the 17th International Congress of Entomology, Hamburg, 1984, on the biotic and abiotic factors that influence the abundance of individuals in carabid populations and which strategies reduce the probability of extinction.

GYNANDROMORPHISM IN THE WINTER STONEFLY GENUS *CAPNIA* (PLECOPTERA: CAPNIIDAE)[1]

C. Riley Nelson, Richard W. Baumann[2]

ABSTRACT: A bilateral gynandromorph of *Capnia sequoia* is described from a single specimen collected in the San Joaquin Valley of California. This specimen represents the first recorded gynander in the plecopteran family Capniidae despite intensive collecting and observations made on thousands of specimens. Dorsal and ventral drawings are produced for the gynander along with those of normal specimens for comparison. The rarity of gynandromorphism in winter stoneflies is discussed. The term hypoproct is used for the male subgenital plate to distinguish it from the female subgenital plate.

While examining long series of many species of *Capnia* during our ongoing revision of the genus (Nelson and Baumann, 1987), we discovered a single specimen of *C. sequoia* Nelson and Baumann which exhibited bilateral gynandromorphism. Gynanders in stoneflies are rare with detection correlated with the sampling of great numbers of individuals. Only two accounts of plecopteran gynandromorphs are known from the North American literature (Ricker, 1965; Nebeker and Gaufin, 1966). Ricker (1965) described *Paraleuctra dusha* Ricker (Leuctridae) from a specimen he speculated could have been a gynander of *Paraleuctra occidentalis* since it seemed to be a mosaic of male and female parts. Later this species was reported as a nomen dubium by Zwick (1973). Stark et al. (1986) accepted this status in the most recent list of North American stoneflies. A ratio of one gynander per 500 specimens of *Zapada cinctipes* (Banks) and *Prostoia besametsa* (Ricker), both of the family Nemouridae, was given by Nebeker and Gaufin (1966) based on five gynanders per 2500 specimens. As part of our revision, over 18,000 specimens of more than 50 species of *Capnia* were critically examined and only one gynandromorph was found although various developmental aberrations were noted.

Additional reports of gynandromorphism have been made for specimens from other regions. Aubert (1958) noted gynanders in *Leuctra prima* Kempny and *L. fusca* (Linnaeus) from southern Europe. Two additional gynandromorphic specimens, one of *L. digitata* Kempny and one of *L. fusca* (Linnaeus) were examined by Klotzek (1971) along with a mention of another nemourid, *Nemurella pictetii* Klapalek in the possession of P. Zwick. A single record for gynandromorphism in the family Notonemouridae was reported by Illies (1961) for *Austronemoura chilena* Aubert from South

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America. Based on these records, gynandromorphs have been reported in all the families of the Euholognatha except Scopuridae and Taeniopterygidae. Stanger (1982) makes no mention of gynanders or any malformations in her revision of *Taenionema* despite having examined large numbers of specimens. No cases of gynandromorphism are known from the Systellognatha nor from the Antarctoperlaria (Zwick, 1973). This could be construed as evidence for the monophyly of the Euholognatha if a true tendency for gynandromorphic expression and viability exists. Long series of individuals of the systellognaths that come to light traps could be quickly scanned to possibly detect malformations in that lineage.

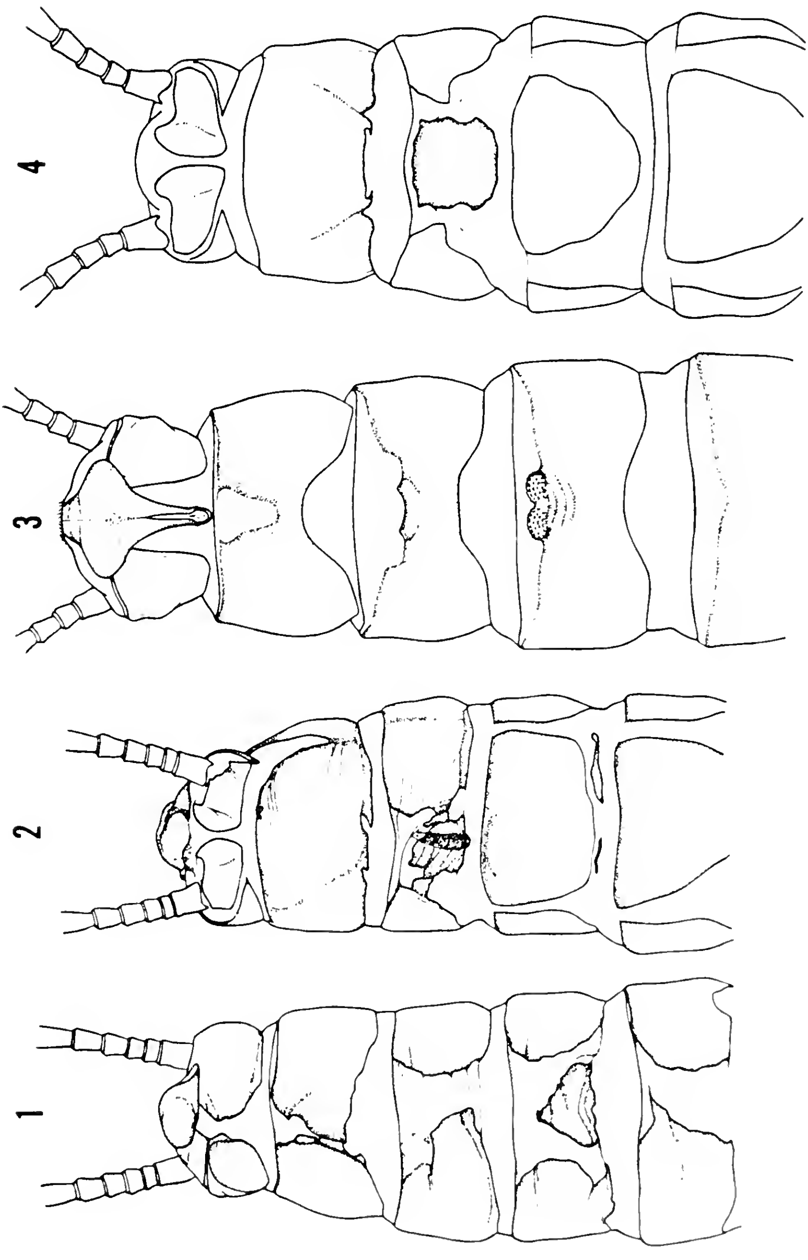
The gynander reported in this paper was collected from the mouth of Mill Creek in Fresno County, California on 17 February 1978 by L. Gilbert. Dr. Donald J. Burdick of Fresno State University made the specimen available to us for use during our revision. The species *C. sequoia* lives in smaller tributaries of the San Joaquin River system from the Tuolumne River south to the Tule River. This species is uncommon in collections resultant from both scant collecting in its range and small populations where it does occur. A total of 62 known specimens of this species exist in collections (Nelson and Baumann, 1987).

The specimen is bilaterally gynandromorphic on abdominal segments six through eleven with the right side bearing male features and the left side those of a female. In *Capnia* there is often a marked sexual dimorphism of the length of the wings but in this specimen the wings are of the same length on both halves of the body. No noticeable differences in symmetry exist anterior of abdominal segment one. In general habitus the specimen is of normal size and no structural aberrations that might have hindered movement are apparent. The specimen is somewhat teneral, with the male side more advanced in the tanning process than the female side. The male side is also more densely covered with setation.

Some key differences in the morphology of the male and female of *C. sequoia* occur in the extent of sclerotization of the abdominal segments. The characters used in the differentiation of species in *Capnia* are located on the dorsum of the abdomen of males and the venter of females. The mosaic of characters in the gynander present a unique opportunity to study the segment by segment homology in the genus and examine the often disparate, ambiguous (and confusing) terminology that has resulted from separate study of each of the sexes individually.

Dorsum. In normal females, abdominal terga two through eight are interrupted medially by a broad band of membrane while terga two through nine of the male are undivided, having a band of sclerotization covering the dorsum of each segment. Terga nine and ten of the female are undivided (without a medial membranous area) while tergum ten of the male is distinctively divided forming a medial membranous area upon which the epiproct rests (Fig. 3). The gynander embodies a curious mosiac of the differences between the two sexes, with terga two through nine divided near the mid-line as in the female but with the male side ending abruptly near the mid-line (Fig. 1). The junction between the sclerotization on the female side and the medial membrane is very similar to that of a normal female while the junction between the male tergal sclerites and the membrane is malformed and resembles neither sex directly. One of the substantial differences between the tergal sclerotization of the male and female of *C. sequoia* is the lack of tergal knobs on the dorsum of the abdomen in the female. In the gynander these tergal knobs on segments seven and nine are expressed only on the male side (Fig. 1). The male epiproct on segment eleven is suprisingly well-developed on the right side, extending past the midline toward the female side resulting in the tip being basically normal in form although it is twisted to the left of the specimen (Fig. 1). However, just to the left of the tip of the epiproct the male features disappear and the female characters of a simple lobe-like segment eleven are expressed. A basal pad of sensilla is present on the base of the epiproct (ventral view) on the right side as in normal males (Fig. 3) and is absent on the left side (Fig. 1). The interface of the two sides relative to the epiproct is membranous and open and one is able to examine the internal structure of the epiproct by looking in from the female side.

Venter. The venter of the two sides of the gynander are basically similar from the head to segment seven of the abdomen. Sternum seven is somewhat darker on the left (female) hind margin due to internal sexual organs showing through the exoskeleton (Fig. 2). The subgenital plate of the female is evident on the left side of sternum eight including the heavily darkened sclerotization of the internal vaginal cavity (Figs. 2 and 4); no differentiation is noted on the male portion of sternum eight. Lateral notches are present on the anterior margin of sternum nine as in normal female specimens (Fig. 4). These notches are absent in males. The notch normally on the right side of the body is expressed near the midline in the gynander (Fig. 2). The hind margin of sternum nine is rounded and more heavily sclerotized on the right side as in male specimens and square and less sclerotized on the left side as in female specimens. The right posterior margin of sternum nine is notched, separating the sternum and tergum by a significant band of membrane, as in males. The left side of sternum nine is separated from tergum nine by a narrow suture, as in normal females. The paraprocts are both similar to those of a female although some malformation of the paraproct of the right side is observable with an incompletely formed medial margin, resembling half of



Figs. 1-2. *Capnia sequoia* gynandromorph; 1, dorsal; 2, ventral. Figs. 3-4. *Capnia sequoia;* 3, normal male, dorsal; 4, normal female, ventral.

the fusion plate (Hanson, 1946). The cerci are identical on both halves of the gynander. No sexual dimorphism with respect to cerci is apparent in normal specimens.

DISCUSSION

Agnew (1979) reported that most gynanders in Ephemeroptera are predominantly female with some male areas, with the male areas never comprising more than half of the individual. He further mentioned that the mosaic distribution of maleness and femaleness in gynanders of Ephemeroptera were compatible with an interpretation that gynanders arise from an XX female zygote with early loss of an X in one cell line. The tissue having lost the X chromosome would thus be XO, and would produce male structures. The specimen reported in this paper as well as those reported previously in Plecoptera differ with those seen by Agnew in that all tend to be more or less bilateral gynandromorphs. Despite this difference of bilateral or mosaic expression, the mechanism for the appearance of gynanders in Plecoptera could be the same as for Ephemeroptera. The difference probably results from less mixing of cleavage nuclei during the syncytial divisions in Plecoptera (as in *Drosophila*) than in Ephemeroptera.

A unique opportunity was offered by this bilateral gynandromorph for studying homology of sclerites between the two sexes. The segment numbering systems of the two halves of the gynander were consistent with accepted usage in the literature for each sex (Hanson, 1946; Brinck, 1956; Harper and Stewart, 1984), however, usage of the term subgenital plate for each of the sexes should be clarified. In females of *Capnia* and other Plecoptera the term subgenital plate is used to designate the medial portion of sternum eight. This usage is clear and valid since this plate overlies the gonopore. In males of *Capnia,* the term subgenital plate is used in conjunction with sternum nine which is basal to the paraprocts. This confusion of definitions of the term subgenital plate for the two sexes is unnecessarily ambiguous since more specific terms have been proposed in the literature for the subgenital plate of the male (e.g. hypoproct, Baumann, 1975; hypandrium, Crampton, 1918). The usage of the term hypoproct to designate this sclerite is preferred in combination with parallel terms of epiproct and paraproct to signify those sclerites surrounding the anus which are so useful in the taxonomy and classification of Plecoptera.

ACKNOWLEDGMENTS

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VITELLOGENIN DISPARITY IN *PHORMIA REGINA* (DIPTERA: CALLIPHORIDAE)[1]

William R. Belzer[2]

ABSTRACT: In *Phormia regina,* female fat body was stimulated to provide for normal vitellogenesis by hormones from either male or female corpora allata. Male fat body failed to provide that synthetic support even though exposed to female hormones by glandular transplants and intersex parabiosis. The present results, from an *in vivo* oocyte assay with natural hormone sources, are consistent with earlier data (obtained with synthetic hormone and electrophoretic assay) which suggest that a sexual disparity in fat body responsiveness (rather than a disparity in circulating hormones) accounts for the disparity in vitellogenin production by the sexes of this species.

Insect follicles sequester selected hemolymph proteins (vitellogenins) and concentrate them in the yolk of developing oocytes (Hagedorn and Kunkel 1979; Bownes 1986). The vitellogenins, synthesized by fat body and released into circulation, are major hemolymph constituents in many female insects, but are minor or absent in the male circulation (Hagedorn and Kunkel 1979). The blowfly, *Phormia regina,* conforms to that generalization (Mjeni and Morrison 1973). In *Phormia,* as in many other insects (Bownes 1986), juvenile hormone from the corpus allatum drives the selective synthesis of vitellogenins used in vitellogenesis (yolk deposition) (Mjeni and Morrison 1973). Sexual disparity in vitellogenin production emanates from gender difference in circulating hormones, as in some vertebrates (Wallace and Bergink 1974), or from disparate synthetic responses by male and female tissue to the same hormone. For *Phormia* the former seems unlikely: typical vitellogenin disparity develops between allatectomized males and females when treated with the same analog of juvenile hormone (Mjeni and Morrison 1976). The present study tests that electrophoretic evidence obtained with synthetic hormone (Mjeni and Morrison 1976) through very different *in vivo* techniques that employ natural hormone sources.

MATERIALS AND METHODS

Each experiment used a cohort of flies that emerged, and were segregated by sex, during a two hour span, and fed a protein-free diet of 0.1M sucrose *ad libitum* till surgery on the fourth day after eclosion. *Ad lib.* access to selected diets was given during each ensuing experiment. Rearing methods were after Belzer (1978), allatectomy and shams after Thomsen (1942), and anesthesia

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was CO_2. Corpora allata from males were transplanted into allatectomized females by grasping the donor gland with fine forceps and implanting it into a hole cut in the recipient's thorax. The cuticle was replaced and waxed to prevent loss of the transplant. Parabiotic flies, whose hemolymph exchange is through a thoracic nexus (Green 1964), were prepared according to Dethier, Solomon and Turner (1965). Females, with mouths waxed shut to preclude feeding, were placed in parabiosis with either a male or female that would subsequently be permitted to feed *ad lib.* on protein (0.1M sucrose brought up to 20% (wt/vol) yeast extract). Each feeding member of a parabiotic pair received three implanted female corpora allata when parabiosis was established. Feeding solutions were prepared and changed daily. Inspection, through a dissecting microscope, of the progress of vitellogenesis in exposed ovaries *in situ* served as an assay of prior vitellogenin synthesis (cf. Roth and Porter 1964; Wallace and Bergink 1974); a calibrated ocular allowed measurement of occyte length and yolk accumulation. Experimental conditions were constant 3200 luces, 65% relative humidity, and 24°C. Data were statistically analyzed by the Mann-Whitney U test (Siegel 1956).

RESULTS

Terminal oocyte length in newly emerged females measured 0.04mm (Fig. 1a). After 14 days of protein-free diet, none exceeded 0.14mm (Fig. 1b). Preliminary studies established that yolk is first visible in the posterior pole when terminal oocyte length reaches 0.21mm; mature oocytes are 1.05mm long and filled with dense yolk. *Ad lib.* protein feeding supported full maturation of oocytes in normal females (Fig. 1c; cf. Belzer 1978) but not in allatectomized females (Fig. 1d). Neither sham surgery (Fig. 1e), nor allatectomy followed by implantation of a male corpus allatum (Fig. 1f), impaired oocyte development with this diet. Two of those allatectomized females, with male corpus allatum, were spared and mated; each deposited viable eggs two days later. Feeding female members of parabiotic pairs managed egg development that was statistically indistinguishable from normal females' (cf. Fig. 1g and 1c). Their aphagic female parabionts (Fig. 1h) managed significantly less ($p = 0.05$) oocyte growth (cf. Fig. 1h and 1g), but in all oocytes that exceeded 0.21mm the proportion and density of yolk deposition that was achieved was indistinguishable from that in eggs of normal protein-eating females that were sacrificed when oocytes were of comparable lengths (cf. Fig. 1h and 1i). Oocyte growth in aphagic females in parabiosis with feeding males (Fig. 1j) was significantly less ($p = 0.01$) than that occuring in aphagic females in parabiosis with feeding females (Fig. 1h); more pertinently, yolk deposition in oocytes that exceeded 0.21mm in the former was virtually nonexistent and significantly less (p

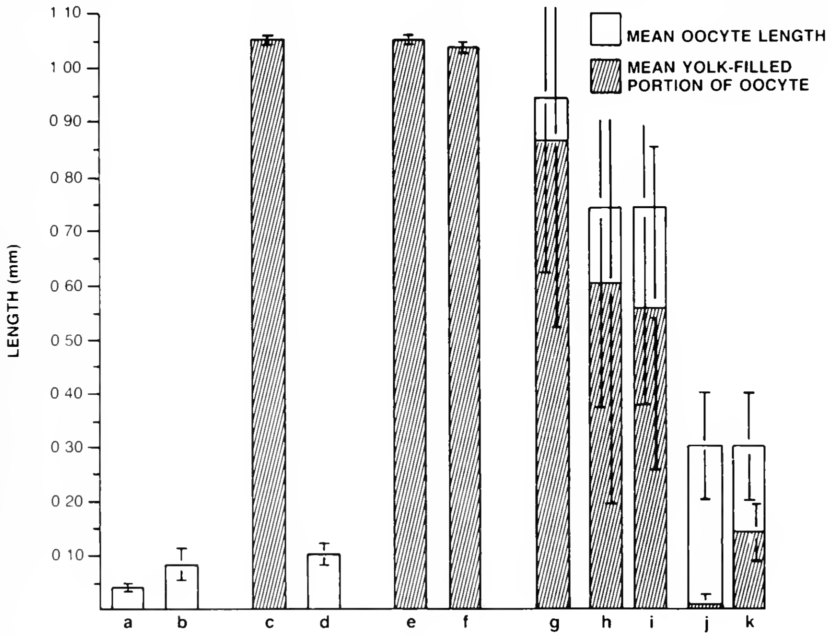

Figure 1. Terminal Oocyte Length and Yolk Accumulation in Various Female *Phormia;* bars = S.D.

(a) Newly emerged, N = 20. (b) Unoperated, fed only sucrose, N = 20, day 14. (c) Unoperated, fed protein, N = 20, day 10. (d) Allatectomized, fed protein, N = 20, day 10. (e) Sham allatectomy, fed protein, N = 20, day 10. (f) Allatectomized with implanted male corpus allatum, fed protein, N = 18, day 10. (g) Feeding member of parabiotic pair, N = 20, day 14. (h) Aphagic member in parabiosis with feeding female of group g, N = 17, day 14. (i) Unoperated, fed protein, N = 10, sacrificed when oocytes reached lengths comparable to group h. (j) Aphagic member in parabiosis with feeding male, N = 7, day 14. (k) Unoperated, fed protein, N = 10, sacrificed when oocytes reached lengths comparable to group j.

= 0.001) than the amount of yolk deposited in oocytes of comparable size in normal protein-eating females (cf. Fig. 1j and 1k).

DISCUSSION

In parabiotic pairs, the fat body of the feeding member should dominate the types of proteins synthesized and released into circulation, by virtue of its preferential access to dietary amino acids. Of circulating proteins, it is the sequestered vitellogenin that provides the dense reflective appearance of dipteran yolk (Roth and Porter 1964; cf. Wallace and Bergink 1974). While fat body of female flies in the present experiments provisioned the oocytes of aphagic female parabionts with dense yolk deposits, the fat body of males failed to do so, even though both were exposed to hormones from implanted female corpora allata and hemolymph exchanged from female parabionts (see studies on dye and isotope transport between parabiotic flies - Green 1964). Incidentally, vitellogenesis in aphagic females, relying on feeding parabiotic males for their hemolymph proteins, could not be improved by implanting into the males several corpora allata, or corpus allatum-cardiacum complexes, from protein-fed females entering various stages of vitellogenesis (Belzer, unpublished). Thus, while natural hormones seem interchangeable between the sexes (as evidenced by the normal vitellogenesis, including oviposition of viable eggs, achieved in allatectomized females with a male corpus allatum transplant), the fat bodies of the two sexes seem to differ in their synthetic responsiveness to female hormones.

Sexual disparity in a tissue's metabolic response to a sexually neutral hormone is common among animals, and it has been demonstrated *in vitro* for primary tissue cultures of cockroach, mosquito and locust fat body (Wyss-Huber and Luscher 1972; Hagedorn and Kunkel 1979). The results of experiments with juvenile hormone analog (Mjeni and Morrison 1976), and with natural hormone in the present study, are consistent with such a circumstance in *Phormia.* The present study helps to allay possible concern that results obtained with hormone analog could have been artifactitious.

While the results of these two diverse approaches to the problem are consistent with one another, potential for uncontrolled variables (such as unknown hormone interactions) that are ever present in the *in vivo* systems of these two approaches argues for the development of purified fat body cell cultures (as envisioned by Hagedorn and Kunkel 1979) so that more completely controlled *in vitro* studies might be designed to further assess and characterize synthetic parameters of fat body in *Phormia.*

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PHEROMONES OF SOCIAL BEES. J.B. Free. 1987. Cornell Univ. Press 218 pp. $29.95.

A textual study of the many different pheromone systems employed by social insects and which control almost all of their activities.

ADVANCES IN INSECT PHYSIOLOGY. VOL. 19. P.D. Evans & V.B. Wigglesworth, eds. 1986. Academic Press. 434 pp. $78.00.

This latest volume of a continuing series contains five contributions on calcium regulation, midgut function, reabsorption in hindgut, proctolin, and regulation of successive steps in insect reproduction.

HISTORY OF THE HOPE ENTOMOLOGICAL COLLECTIONS IN THE UNIVERSITY MUSEUM OXFORD, WITH LISTS OF ARCHIVES AND COLLECTIONS. A.Z. Smith. 1986. Clarendon Press, Oxford, 172 pp. $29.95.

The Hope Entomological Collections are of international importance. This book traces the history of the collections up to the present time and provides a comprehensive list of donors and of archives in the Hope library.

ANATOMICAL DRAWINGS OF BITING FLIES. B. Jobling. 1987. British Museum (Natural History) & Wellcome Trust. 119 pp. $9.95.

356 previously unpublished drawings of high scientific and artistic quality, of representative species of biting flies. Species included are the sandfly, *Phlebotomus papatasi;* the mosquito, *Aedes aegypti;* the blackfly, *Simulium* sp.; the deerfly, *Chrysops caecutiens;* and the stablefly, *Stomoxys calcitrans.*

THE JUMPING SPIDERS (ARANEAE: SALTICIDAE) OF THE VIRGINIA PENINSULA[1]

C.L. Stietenroth, N.V. Horner[2]

ABSTRACT: Thirty species representing 18 genera of Salticidae are recorded from the Virginia Peninsula. Habitat and natural history information for each species is presented. Some salticids on the peninsula occupy diverse habitats while other species appear to confine themselves to more restricted environments. The most abundant salticid was *Hentzia palmarum*. *Metaphidippus galathea* and *Platycryptus undatus* were most widely distributed species. Salticids reported in Virginia for the first time are *Phidippus princeps, P. otiosus, Thiodina sylvana, Sitticus fasciger* and *Zygoballus sexpunctatus.*

A few studies concerning the spider fauna of Virginia have been published. The earliest record of occurrence was by John Banister between 1678 and 1692 (Ewan and Ewan, 1970). More recently, McCaffrey and Hornsburgh published three studies concerning spiders in apple orchards in central Virginia. Their assessment of spider populations in an unsprayed orchard was published in 1977 followed (1978) by laboratory feeding studies performed to evaluate potential effects of predaceous spiders on insect residents of apple orchards. Later (1980), a comparison was made between the spider populations in abandoned and commercial orchards; 68 species were identified.

Dowd and Kok (1981), and McPherson *et al.* (1982) considered spider and other arthropod predation on the curculionid beetle, *Rhynocyllus* sp., in a soybean cropping system in Virginia. Holsinger (1982) reported on the spider cave-fauna in Burnsville Cove. The efficiency of limb-beating for capturing various spider families in apple orchards is discussed by McCaffrey and Parrella (1984).

In the above listed works, the Salticidae have been given little attention. George and Elizabeth Peckham are the acknowledged early authorities on the Attidae (Salticidae). Their classic publications appeared in 1889 and 1909. Using this literature as a base, a faunal record of the jumping spiders (Salticidae) of the Virginia Peninsula, including natural history data and new state records, is presented.

The Virginia Peninsula is located on the eastern coastal plain of Virginia. It is bordered to the east by Chesapeake Bay and to the south by the James River. The Colonial Parkway served as a convenient northern boundary for the collecting area. The study area encompassed approximately 250 square miles. Vegetatively, the peninsula is a broad-leaved and needle-leaved forest consisting primarily of oak (*Quercus* sp.), hickory (*Carya* sp.) and pine (*Pinus* sp.). Other common deciduous trees include black cherry (*Prunus serotina*

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Ehrhart), sweet-gum (*Liquidambar styraciflua* L.), maple (*Acer rubra* L.) and holly (*Ilex* sp.). Prevalent shrubs and vines composing the forest understory are bayberry (*Myrica* sp.), honeysuckle (*Lonicera* sp.) and smilax (*Smilax* sp.). The peninsula has a flat terrain with local relief formed by terrace and alluvial embayments. Geologically, the land consists of quarternary and upper tertiary non-resistant sedimentary rock (U.S. Dept. of Interior Geological Survey, 1970) resulting in yellowish sandy loam soil (Paullin, 1932). Numerous ecotopes exist on the peninsula from forests and open fields to marshes and sand beaches. Each of these, in turn, furnish a multitude of microhabitats.

MATERIALS AND METHODS

Collecting Methods. The Salticidae are known to dwell in a wide variety of habitats ranging from man-made structures to fields and forests. Twelve collecting sites were chosen at random across the Virginia Peninsula. These sites included many diversified habitat areas. Each site was visited approximately four times from mid-May to October 1983.

A sweep net was used to collect spiders from tall grasses and lower ground cover, such as honeysuckle (*Lonicera* sp.) and wild grape (*Vitis* sp.). Using a wooden stick to strike small branches of trees and shrubs, spiders were dislodged and captured on a white canvas cloth covering a 57 cm diameter metal ring (umbrella net). Specimens were collected from pines (*Pinus* sp.), black cherry (*Prunus serotina* Ehrhart), sweet-gum (*Liquidambar styraciflua* L.), red maple (*Acer rubra* L.) and a variety of oaks (*Quercus* spp.). Saplings of these as well as low shrubs, especially bayberry (*Myrica,* sp.), were common habitats for many salticids. Larger trees were stripped of loose bark and examined for presence of salticids and their hibernacula. Man-made structures, such as picnic shelters, houses, sheds and brick piles, were carefully examined for salticids.

All salticids were captured in clear plastic vials on which locality, habitat, date and method of capture were recorded. Spiders were then transported to the laboratory for identification.

Laboratory rearings. Immature spiders were housed in glass or plastic tubes, ranging from 1 x 9 to 2 x 13 cm, stoppered with cotton. This provided air to the spider and allowed easy access for feeding and watering. Water, which the spiders readily accepted, was administered with a glass pipette at least once a week. Specimens were fed approximately twice a week. Fruit flies (*Drosophila* sp.) and meal worms (*Tenebrio* sp.) served as major food items. A strip of paper with collecting data was placed inside the tubing. This also gave the spiderling a rough surface for molting. Egg deposition and molting dates were recorded daily. The spiders were kept under artificial lights and maintained at room temperature.

Laboratory examination. Mature spiders, either captured in the field or raised in the laboratory, were killed and preserved in glass vials with 70% ethyl alcohol (ETOH). All specimens were microscopically examined, identified and labeled. The specimens are stored in the Invertebrate Collection at Midwestern State University.

RESULTS

Habitat distributions of salticids on the peninsula shows a diversity for some species while others appear to be confined to more restricted environments. Habitat determination for each reported species (in numbers greater than three) was based on 50% or greater occurrence in a particular ecotope. Table 1 lists the species found in each habitat. Approximately one-third (seven species) of the salticids were found in multiple habitats. Six species were found only on trees and three species in open fields. Man-made structures and dense shrubbery and vines each harbored two different species. In all of these habitats, the greatest concentrations of spiders were found in sunny areas, perhaps allowing the salticids to maximize their keen eyesight for capturing prey.

Collection sites offering the widest variety of habitats harbored the most diverse salticid populations. For example, site one, furnishing all available types of habitat, had 16 species. At the other extreme, four species were collected at site two, a sandy beach lacking man-made structures and dense vegetation.

Species Accounts

Natural history data, including habitat, molting and egg deposition appear in the following species accounts.

(1) ***Admestina tibialis*** (C.L. Koch). -A single immature specimen was found on a pine sapling on 1 October.

(2) ***Ballus youngii*** Peckhams. -On 5 January 1984, a single immature specimen was found under tree bark in a hibernaculum. Peckham and Peckham (1909) report Young as stating, "These spiders are found at this season (November) under the bark of trees.... The spider is so nearly of the bark color, and so small, that we often overlook the speck in the center of the envelope, supposing it to be merely the empty tube or cell of some young spider." This may explain our few records of *B. youngii* on the peninsula.

(3) ***Eris aurantia*** (Lucas). -Eight of the 13 specimens captured were taken from sundry vines and shrubs. Three males reared in the laboratory matured on 21, 22 and 24 June. Other adult males were collected between 27 June and 3 August. Adult females were found between 14 July and 17 August. An immature female collected on 13 July molted to maturity 17 July. One male was taken while eating a jumping plantlouse (Homoptera:

Psyllidae). Immature specimens reared in the laboratory molted and matured at approximately the same time as counterparts in the field. The data indicate that *E. aurantia* males matured prior to the females, with the first mature male appearing on 21 June and the females following nearly a month later on 14 July.

(4) ***Eris militaris*** (Hentz), *sensu* Maddison, 1986. -Kaston (1981) reports this species is common in shrubbery and tall grasses. Of the nine specimens captured, four were dislodged from saplings, one was swept from ground coverings and four were found overwintering under tree bark in hibernacula on 5 January 1984. One male reared in the lab matured on 30 August. Two adult males were obtained on 23 August and 28 September. On 28 September and 18 October mature females were found. All four of the overwintering spiders were adult females discovered at various sites. Aggregations of hibernating adult males and penultimate females in numbers up to 40 have been recorded by Kaston (1981).

(5) ***Habrocestum pulex*** (Hentz). -Two of the four specimens were found on man-made structures (a picnic table and bricks). One adult male was found on 8 June. A penultimate male molted on 18 June. A pair of adults was observed in close proximity on the bark of a fallen tree and collected on 23 June.

(6) ***Hentzia mitrata*** (Hentz). -All *H. mitrata* taken were dislodged from several types of deciduous trees. This is consistent with observations by Kaston (1981). Mature females were captured between 6 June and 3 August. One reared female matured on 3 October. Only two mature males were collected (13 June and 11 July).

(7) ***Hentzia palmarum*** (Hentz). -This common spider was found on a variety of shrubs and vines, most frequently bayberry. Mature and immature spiders of both sexes were captured throughout the collecting period from May to October. Immatures reared in the lab molted and matured at different times. One adult female was found overwintering on 5 January 1984.

The highest concentration (65%) of *H. palmarum* was at three sites located in the immediate vicinity of water. Presumably the spiders were feeding on some type of aquatic insect.

(8) ***Lyssomanes viridis*** (Walckenaer). -Habitat data indicate that *L. viridis* preferred broad-leaved trees close to the ground. Mature females were obtained between 15 June and 22 August. No males were found. One female, captured on 11 July, laid two groups of eggs. The first was deposited on 21 July, and contained 20 eggs 0.7 mm in diameter. The eggs were scattered inside a very lightly spun sac. Spiderlings, 1.0 mm in length, hatched on 20 August. They did not survive past the first instar. A second egg sac containing 32 eggs was deposited on 6 August but none of the eggs hatched. This tightly woven egg sac appeared more conventional, with eggs clumped together inside.

Great numbers of young *Lyssomanes* were noticed in the field on 8, 17, 22, and 23 August at various sites. Many of these were returned to the lab for rearing. Despite their acceptance of food and water, none of the spiderlings survived to maturity. These life history observations correspond to those of Richman and Whitcomb (1981) of this species on *Magnolia* in Florida.

The above represents the second record of *L. viridis* in Virginia. In 1979, Shear reported this spider in Williamsburg. Prior to this its northern known limit was Alamance County, North Carolina. According to Galiano (1980), this species is distributed throughout the southeastern United States.

(9) ***Maevia*** sp. -Four immature specimens of *Maevia* were found between 13 June and 17 August in varied habitats. Since they did not survive to adults, specific identification was not possible. Based upon general morphology and distribution, they were probably *M. inclemens* (Walckenaer).

(10) ***Marpissa lineata*** (C.L. Koch). -Three females, collected between 8 June and 22 July, were captured: one on a picnic table, one under a box and one hanging dead on an orb web.

(11) ***Marpissa pikei*** (Peckhams). -Kaston (1981) reports this species as readily swept from tall grasses, especially along seashores. Two mature males swept from grassy fields were both taken at one location on 22 August.

This long-bodied spider was observed to rest by extending the first two pair of legs anteriorly and the hind pairs posteriorly. Stretching out in this position probably allows the spider to blend in with grass blades, providing protection from predators.

(12) ***Metacyrba taeniola*** (Hentz). -Four specimens (three males and one female) were discovered either on or in a house between 14 June and 20 July.

(13) ***Metaphidippus exiguus*** (Banks). -This species dwells on young conifers. Some were obtained from various other saplings and shrubs. Wayne Maddison, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (letter dated 14 March 1984), indicates that all members of the *M. flavipedes* group (including *M. exiguus*) prefer pine. Two immature females molted to maturity on 20 and 29 June. Mature females were taken in late September and early October. Even though 13 females were collected, only three adult males were found.

(14) ***Metaphidippus galathea*** (Walckenaer). -The majority of the specimens (32 of 53) were collected in grassy fields. The remaining were found on trees and shrubs. Four males reared in the lab matured on 29 July, 3 October, and two on 6 October. All females captured were mature. Horner and Starks (1972) reported more than one-half of the specimens collected in the fall in Oklahoma were mature males and females.

M. galathea was the most widely distributed salticid found on the peninsula. Maddison (personal communication) suggests this spider is a field dweller. Sixty percent of the *M. galathea* found were in grass with the remainder dwelling on a variety of other plants.

(15) ***Metaphidippus protervus*** (Walckenaer). -Twenty-seven individuals were collected from a variety of small trees, vines and shrubs. Only three were males, all found in June. Mature females appeared between 18 August and 29 October. On 18 August, eight males were taken at a single location from sassafras saplings.

Maddison (personal communication) found *M. protervus* commonly dwelling in forest understory. The data concur with our findings.

(16) ***Phidippus audax*** (Hentz). -Two mature spiders were collected, one on a house, the other on a vine, on 30 April and 7 July, respectively. Three overwintering immature specimens were found under tree bark on 4 January 1984. Two molted to maturity in approximately one month, a male followed by a female.

P. audax was frequently observed on leaves of shrubs, scanning adjacent leaves for prey, but not captured.

(17) ***Phidippus clarus*** Keyserling. -Six specimens were taken while sweeping weedy fields. Two of each sex were collected from honeysuckle vines and conifers. Adult females were found on 2, 15, and 22 August. On 17 August, a mature male and five females were discovered at three different sites. One captured penultimate male molted on 16 July. A female was caught with prey, an assassin bug (Hemiptera, Reduviidae).

Phidippus clarus was found on the peninsula more often than any other species of *Phidippus*. This may be due to the easily surveyed habitat occupied by *P. clarus*. Some *Phidippus* are known to dwell high in trees and may have escaped capture.

(18) ***Phidippus mystaceus*** (Hentz). -None of this species was found during the major collecting period. During winter collections, three females were found, each at a separate location, and were preserved. Three others were found in adjacent hibernacula and taken to the lab for observation. Approximately three weeks later one was observed outside the hibernaculum, one female was found dead in the hibernaculum, and of the remaining two, one was eventually cannibalized by the other. An egg sac of the surviving female was discovered on 19 March 1984. Second instar spiderlings were initially observed out of the sac on 20 April 1984.

Kaston (1981) reports *P. mystaceus* as rare. Collection records of this study also indicate the species is scarce. Since it was found overwintering but not in summer collecting, its presumed rarity may be attributed to successful camouflage.

(19) ***Phidippus princeps*** (Peckhams). -Two penultimate males were

collected on 18 and 29 October, one by sweeping a field and the other on a shrub. Both spiders molted between mid-December and early January, 1984.

This is the first record of *Phidippus princeps* in Virginia. Richman and Cutler (1978) report records of the species from Massachusetts, New York, Kentucky, Connecticut, Iowa, Missouri, Minnesota and Texas.

(20) ***Phidippus otiosus*** (Hentz). -Two specimens were obtained: an adult female found on holly, 20 July, 1983 and on 10 October, a mature male discovered on a magnolia tree.

This species represents a new record for Virginia. The spider has been reported from Alabama, Florida, Georgia, Maryland and Washington, D.C. (Richman and Cutler, 1978).

(21) ***Phidippus whitmani*** Peckhams. - Kaston (1981) reports males of this species hopping about on exposed rock surfaces. A single mature male was captured on 15 June while it was jumping in a sunny area of leaf litter. Several penultimate male spiders were captured on leaf litter and thought to be *P. whitmani.* They never matured, and positive identification could not be made. These were the only salticids consistently found on leaf litter.

(22) ***Platycryptus undatus*** (DeGeer), *sensu* Hill, 1979. -Of the 18 specimens examined only three were taken during summer collecting. Two were discovered on pine bark and the third on a shed. The remaining 15 were found overwintering in varying numbers in hibernacula under the bark of upright pine trees between 2 and 5 January 1984. From one to nine spiders were observed under single sections of bark. Examination of hibernacula retrieved in the field revealed: a single mature female; two instances of mature pairs; and a group of six composed of five adults (two males; three females) and one immature spider. Worley and Pickwell (1931) reported similar instances in Nebraska.

The apparent scarcity of this spider in the warmer months compared with its relative abundance in the winter was probably due to camouflage. The preferred habitat for *P. undatus* was pine tree bark which the spider's coloration closely matches. This species was probably overlooked during the spring and summer.

(23) ***Sarinda hentzi*** (Banks). -One penultimate male was dislodged from bayberry on 27 June. The apparent scarcity of this and other ant mimicking species may have resulted from mistaking the spiders for ants.

(24) ***Sitticus fasciger*** (Simon). -A single female was found on a man-made structure. This is a new record for this species in Virginia. Richman and Cutler (1978) report this spider from Ontario, Canada, New York, New Jersey, Pennsylvania, Wisconsin and Minnesota.

(25) ***Thiodina sylvana*** (Hentz). -This species inhabited most types of

vegetation except grasses. One mature female was collected on 6 July and four were collected on 17 and 23 August. Adult males were found throughout the summer from 31 May to 17 August. Two penultimate males matured in the lab on 23 August and 10 September. *Thiodina sylvana* spiderlings were extremely abundant in the field beginning in early July. The young spiders were easily recognized by the large black spots on the cephalothorax. Numerous specimens were returned to the lab for rearing. The spiderlings readily accepted food and water. Several became penultimate but none survived to maturity.

This is the first record of *Thiodina sylvana* in Virginia. Richman and Cutler (1978) suggest a range from North Carolina south to Florida.

(26) ***Tutelina elegans*** (Hentz). -A single mature female was beaten from honeysuckle growing on the banks of the James River on 7 July.

(27) ***Tutelina similis*** (Banks). -This species was found living on many types of vegetation, excluding grasses. Of four females captured prior to August, only one was mature. Two males were captured on 13 July. One male was feeding on an ant (Hymenoptera: Formicidae) when captured.

(28) ***Zygoballus rufipes*** Peckhams. -Seven of the 10 specimens caught were swept from fields overgrown with weeds and grasses. Two males were observed together on spearmint and one on pine bark. Mature males were found throughout the summer and fall from 8 June to 18 October. A penultimate male molted on 20 September. One female was collected mature on 18 July. Another molted 25 July and deposited an egg sac with seven eggs on 1 August. Since she was not mated, none of the eggs hatched. This species and *bettini* were described separately by the Peckhams. Edwards (1980) indicates they are synonymous based upon the genitalia. He concludes that *rufipes* is the correct species, since it has priority.

(29) ***Zygoballus nervosus*** (Peckhams). -All nine specimens captured were swept from open fields. On 17 October, five adult females and one male were taken from the same field. Other mature males were collected between 27 July and 18 October.

(30) ***Zygoballus sexpunctatus*** (Hentz). -Six adults, three of each sex, were found in fields between 14 June and 17 October. This presents a new record for Virginia.

DISCUSSION

Our study has revealed the presence of 18 genera and 30 species of salticids from the Virginia Peninsula (Table 1). However, based on known ranges of certain Salticidae species (Richman and Cutler, 1978), it is possible that other species occur on the peninsula.

Table 1. Salticid spiders from the Virginia Peninsula, habitat and site occurrence.

Species	No. of Specimens Collected	**Habitats	No. of Sites Located
Admestina tibialis (C.L. Koch)	1*	#	1
Ballus youngii (Peckhams)	1*	#	1
Eris aurantia (Lucas)	13	d	5
Eris militaris (Hentz)	9	b	3
Habrocestum pulex (Hentz)	4	b,c	3
Hentzia mitrata (Hentz)	8	b	5
Hentzia palmarum (Hentz)	93	d	8
Lyssomanes viridis (Walckenaer)	6	b	5
Maevia inclemens (Walckenaer)	1	#	1
Marpissa lineata (C.L. Koch)	3	#	1
Marpissa pikei (Peckhams)	2	#	1
Metacyrba taeniola (Hentz)	4	c	1
Metaphidippus exiguus (Banks)	16	b	8
Metaphidippus galathea (Walckenaer)	53	a,b,d	10
Metaphidippus protervus (Walckenaer)	27	b,d	6
Peckhamia sp.	2*	#	1
Pellenes sp.	1*	#	1
Phidippus audax (Hentz)	5	b,c,d	2
Phidippus clarus Keyserling	10	a,b,d	1
Phidippus mystaceus (Hentz)	6	b	1
Phidippus otiosus (Hentz)	2	#	1
Phidippus princeps (Peckhams)	2	#	1
Phidippus whitmani Peckhams	1	#	1
Platycryptus undatus (DeGeer)	18	b	10
Sarinda hentzi (Banks)	1*	#	1
Sitticus fasciger (Simon)	1	#	1
Thiodina sylvana (Hentz)	14	c,d	7
Tutelina elegans (Hentz)	1	#	1
Tutelina similis (Banks)	6	b,d	2
Zygoballus rufipes Peckhams	10	a	6
Zygoballus nervosus (Peckhams)	9	a	3
Zygoballus sexpunctatus (Hentz)	6	a	4
TOTAL	336		

*Immature specimens.
**a = open fields, b = saplings and/or under tree bark, c = man-made structures, d = vines and shrubs.
#Insufficient data to establish habitat.

Hentzia palmarum was the most frequently captured salticid (93 specimens, 8 sites). *Metaphidippus galathea* (53 specimens, 10 sites) and *Platycryptus undatus* (18 specimens, 10 sites) had wide distribution over the collecting area (Table 1).

Despite active collecting from May to October 1983, 14 species were represented by three or fewer specimens (Table 1). Four were larger

Phidippus species, known to live in trees. Upper tree limbs proved difficult to survey and this may have resulted in erroneous distribution data for these species. Conversely, minute genera such as *Admestina* and *Ballus* and ant-mimicking spiders may have been overlooked. Prolonged collecting might reveal a higher incidence of some species.

New salticid records for Virginia include *Phidippus princeps*(Peckhams), *P. otiosus* (Hentz), *Thiodina sylvana* (Hentz) *Sitticus fasciger* (Simon) and *Zygoballus sexpunctatus* (Hentz).

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BOOKS RECEIVED AND BRIEFLY NOTED

BEES AND THEIR KEEPERS. R.F. Trump. 1987. Iowa State Univ. Press. 171 pp. $17.95.

The author's careful catalogue of scientific data about the honeybee and honey production is explained through homespun anecdotes and colorful observations in a casual, story-telling narrative style.

THE BEHAVIOURAL ECOLOGY OF ANTS. J.H. Sudd & N.R. Franks. 1987. Chapman & Hall. 206 pp. $55.00 cloth, $23.00 paper.

This book is concerned with how eusociality, in which one individual forgoes reproduction to enhance the reproduction of a nestmate, could evolve under natural selection, and why it is found only in some insects: termites, ants, and some bees and wasps.

BUMBLEBES. O.E. Prys-Jones & S.A. Corbet. 1987. Cambridge Univ. Press. 86 pp. $24.95.

Number six in a series of British Naturalists' Handbooks. This small book deals with the natural history and identification of true bumblebees (*Bombus*) and cuckoo bumblebees (*Psithyrus*).

HOVERFLIES. F.S. Gilbert. 1986. Cambridge Univ. Press. 66 pp.

Number five in a series of British Naturalists' Handbooks. This small book deals with the natural history and identification of hoverflies.

THE BIOLOGY OF THE HONEY BEE. M.L. Einston. 1987. Harvard Univ. Press. 281 pp. $29.95.

This broad treatment of honey bee biology probes the dynamics of the honey bee's social organization, including the complex infrastructure of the nest, the highly specialized behavior of workers, queens, and drones, and the remarkable ability of the honey bee colony to regulate its functions.

THE ULTRASTRUCTURE AND PHYLOGENY OF INSECT SPERMATOZOA. B.G.M. Jamieson. 1987. Cambridge Univ. Press. 320 pp. $54.50.

Knowledge of sperm diversity can be useful in many fields. The primary aim of this work is to make available a critical resume of all research reports on the sperm of the Uniramia: Onychophora, Myriapoda, and Hexapoda, including the Insecta.

AN UNDERWATER LIGHT TRAP FOR COLLECTING BOTTOM-DWELLING AQUATIC INSECTS[1,2]

R.G. Weber[3]

ABSTRACT: A small, submerged light trap for collecting aquatic insects is described. It is designed especially for use on the bottom in still or moving water and is constructed of common materials. Among the insect taxa it has collected in quantity are EPHEMEROPTERA: Ephemerellidae, Heptageniidae, Leptophlebiidae, and TRICHOPTERA: Hydroptilidae. These families have not previously been reported from submerged light traps.

Submerged aquatic (subaquatic) light traps capture a wide variety of immature and mature acquatic organisms (Baylor and Smith, 1953; Hungerford *et al.,* 1955; Espinosa and Clark, 1972). Several workers have commented on the ability of such traps to collect larger numbers of some organisms than other sampling methods indicate are present (Husbands, 1967; Washino and Hokama, 1968; Weber, 1985). Small traps described in the literature have been round in cross section and were designed to capture insects swimming in the water column above the bottom (Hungerford *et al.,* 1955; Carter and Paramonov, 1965; Husbands, 1967; Washino and Hokama, 1968; Espinosa and Clark, 1972; Brown, 1976).

When placed on the bottom, round traps tend to roll about from wave action, current and substrate topography. Also, when on the bottom, the funnel used as a gate in a round trap requires that smaller, non-swimming animals travel a considerable distance across smooth, upward-angled material to enter the trap. This could result in reduced catches of such animals. A desire to specifically collect bottom-dwelling insects in both still and moving water led to development of the flat trap described here. It was designed primarily for use on the bottom, to reduce problems with rolling, and the entrance gate was built to allow easier access into the trap than is provided by a funnel.

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MATERIALS AND METHODS

The trap's body, illustrated in Figure 1A, B, is a flat, 1-liter can 4 5/8 inches (11.7 cm) wide x 6 7/8 inches (17.5 cm) long x 2 3/8 inches (6 cm) thick. A 7/16 inch (1.1 cm) hole is bored in the center of the can's top to hold the light unit. A rectangular opening 3 inches (7.6 cm) wide is cut in the can's bottom to receive the entrance gate. A galvanized wire for support of the power cord is strung from end to end, held by sheet metal screws as shown in Figure 1A. When all openings have been cut, the inside of the trap is given a coat of gloss white, oil-based paint to improve light output and retard rusting.

The entrance gate is constructed from 1/8 inch (3.2 mm) and 1/4 inch (6.3 mm) clear acrylic plastic sheet. Details of gate construction are shown in Figure 2. The acrylic is cut to size with a table saw, and the gate is temporarily assembled with tape. The pieces of the gate are welded together by applying solvent[4] to joints. When all solvent has evaporated, about 45 minutes, the tape is removed and the gate is permanently installed in the painted trap using silicone rubber as adhesive.

Power is provided by two 1.5 volt "D" cells in a plastic holder (Radio Shack # 270-386; Figure 1 C), which is wired to the light unit with 8 feet (3.8 m) of plastic-covered, 22 gauge stranded, 2-conductor wire. Near the trap this wire is tied to the galvanized support wire. No switch is necessary; a battery is removed to break the circuit. All electrical connections should be soldered with rosin core solder and must be thoroughly covered with waterproof material to avoid problems with electrolysis, which will quickly destroy bare wires. A covering of either "5-minute"-type epoxy or silicone rubber will provide adequate protection; plastic tape will not.

The lamp used as the attractor is a clear 3 volt bulb of the "grain-of-wheat" type, drawing 23 mA (Chaney Electronics #C22505[5]). A pair of batteries will operate a lamp of this amperage for at least 24 nights; the lamps last indefinitely. This style of lamp has 2 protruding wire leads which are soldered directly to solid copper wires thrust lengthwise through a #00 neoprene stopper. A 9mm x 30mm shell vial is put over the lamp onto the end of the stopper. When the light unit is in place in the trap the neoprene stopper supports it (Figure 1B). The complete trap can be built for about $6 per unit, exclusive of batteries.

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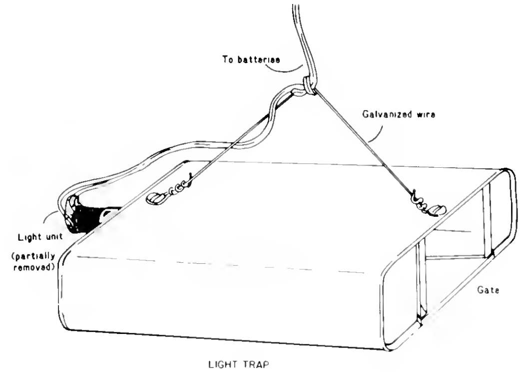
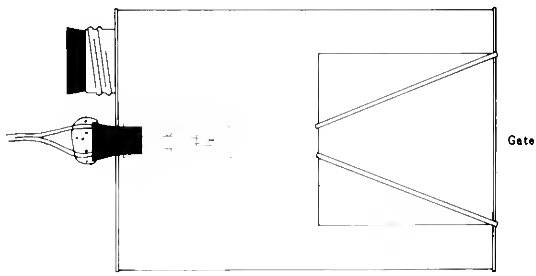
[4]Use either methylene chloride, or a proprietary acrylic solvent such as "Weld-On 3" (Industrial Polychemical Service, Gardena, California, 90247), available where acrylic plastic sheet is sold.

[5]Chaney Electronics, Denver, Colorado, apparently is out of business and these lamps are no longer available. Radio Shack carries a *1.5 volt* lamp of the same size, style and amperage (#272-1139) which may be substituted. Light output is the same as the Chaney lamps. To use this lamp, change the battery holder to Radio Shack #270-403; a single "D" cell holder.



A.
WHOLE VIEW

B.
TOP VIEW



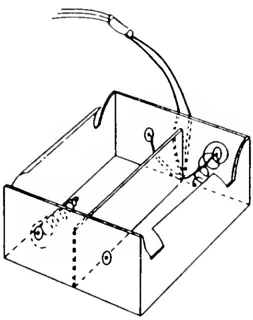


FIGURE 1.

Submerged Light Trap Details

C.
BATTERY HOLDER

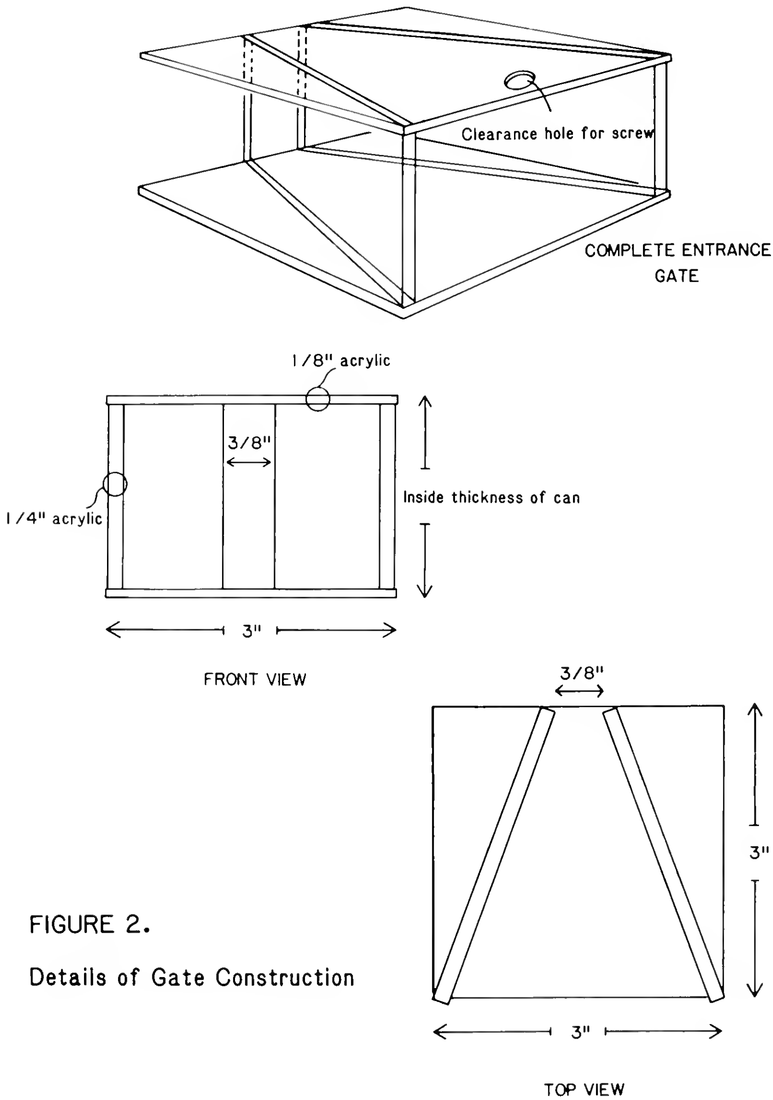


FIGURE 2.

Details of Gate Construction

DISCUSSION

In use, traps are filled with habitat water while upright, then submerged, and positioned horizontally. Normally, this allows a bubble of air to remain trapped in the container. The bubble permits emergence of adults, and allows some survival of surface-breathing forms if their numbers are not too great. If necessary, small rocks may be used to position and anchor traps. The batteries are installed in the holder, which is either laid on shore, or fastened to a stake beside the trap. Use of a stake helps prevent trap loss due to unexpected flooding, or wave action.

At the end of a trapping session traps are taken from the water with the gate upward, to retain the catch. The lamp is checked to make sure it is still on, which indicates it operated during the trapping period. Water and trapped insects are poured out the container's original opening into a pan for sorting. The original screw cap, or a neoprene stopper may be used to close the opening during trapping.

This trap design has been effective in a variety of lentic and lotic habitats, capturing both mature and immature insects. Mature insects taken are those which normally swim beneath the surface, e.g. Dytiscidae, Notonectidae, and Corixidae. Immature forms include larvae, naiads, nymphs and pupae. Appreciable numbers of motile dipteran and trichopteran pupae are taken. These pupae frequently moult to adults after they have entered the trap, as indicated by presence of adults plus pupal exuviae. Corixidae are especially attracted; 1,791 nymphs and adults were captured in one trap during a single night. Larvae of several dipteran families also respond well to the trap. Maximum one-night catches for single traps included 680 Chironomidae, 614 Chaoboridae, and 38 Ceratopogonidae. In some habitats small fish enter the traps and feed on trapped insects. Where fish are present it may be desirable to fix a piece of 1/4 inch (6.3 mm) mesh screen over the entrance of the gate to exclude them. The alternative used here was to dissect trapped fish and examine their stomach contents.

Table 1 presents a listing of insect taxa captured with the subaquatic trap described here. It includes references to previous reports of taxa captured in subaquatic traps. The trap has not only collected insects from many families reported in the literature as entering subaquatic light traps, but has extended the list. New records are COLEOPTERA: Noteridae; DIPTERA: Simuliidae, Tabanidae; EPHEMEROPTERA: Ephemerellidae, Heptageniidae, Leptophlebiidae; TRICHOPTERA: Hydroptilidae, and PLECOPTERA. The Simuliidae, Tabanidae and Plecoptera were collected in small numbers (<5 individuals) in only one of the habitat types trapped. The other families were collected in quantity (>10 individuals) in several habitats.

Table 1. Taxa of aquatic insects captured in subaquatic light traps.

Taxon	This Trap	Other Traps
Coleoptera		
Dytiscidae	+	Hungerford *et al.*, 1955; Carter & Paramonov, 1965; Espinosa & Clark, 1972; Brown, 1976
Elmidae		Hungerford *et al.*, 1955
Gyrinidae		Hungerford *et al.*, 1955
Haliplidae	+	Hungerford *et al.*, 1955; Espinosa & Clark, 1972
Hydrophilidae	+	Hungerford *et al.*, 1955; Washino & Hokama, 1968; Espinosa & Clark, 1972; Brown, 1976
Limnebiidae		Hungerford *et al.*, 1955
Noteridae	+	
Diptera		
Ceratopogonidae	+	Hungerford *et al.*, 1955; Washino & Hokama, 1968
Chaoboridae	+	Baylor & Smith, 1953; Hungerford *et al.*, 1955
Chironomidae	+	Hungerford *et al.*, 1955; Washino & Hokama, 1968
Culicidae	+	Hungerford *et al.*, 1955; Husbands, 1967; Washino & Hokama, 1968; Brown, 1976; Weber, 1985
Simuliidae	+[a]	
Tabanidae	+[a]	
Tipulidae		Washino & Hokama, 1968
Ephemeroptera	+[b]	Espinosa & Clark, 1972[b]
Baetidae	+	Washino & Hokama, 1968
Caenidae		Hungerford *et al.*, 1955
Ephemerellidae	+	
Heptageniidae	+	
Leptophlebiidae	+	
Hemiptera		
Belostomatidae		Hungerford *et al.*, 1955; Washino & Hokama, 1968; Espinosa & Clark, 1972; Brown, 1976
Corixidae	+	Hungerford *et al.*, 1955; Carter & Paramonov, 1965; Washino & Hokama, 1968; Espinosa & Clark, 1972; Brown, 1976
Gerridae		Hungerford *et al.*, 1955; Brown, 1976
Mesoveliidae		Hungerford *et al.*, 1955
Nepidae		Hungerford *et al.*, 1955
Notonectidae	+[b]	Hungerford *et al.*, 1955; Washino & Hokama, 1968; Espinosa & Clark, 1972; Brown, 1976
Pleidae		Hungerford *et al.*, 1955
Veliidae		Hungerford *et al.*, 1955
Odonata		Hungerford *et al.*, 1955[b]; Espinosa & Clark, 1972[b]; Brown, 1976[b]
Plecoptera	+[ab]	
Trichoptera	+[ab]	Hungerford *et al.*, 1955[b]
Hydroptilidae	+	
Leptoceridae		Baylor and Smith, 1953

[a]Less than 5 individuals.
[b]Specimens identified only to order.

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THE MAYFLY, *DOLANIA AMERICANA*, (EPHEMEROPTERA: BEHNINGIIDAE) IN ALABAMA[1]

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ABSTRACT: Nymphs of *Dolania americana* were collected from the Blackwater River, Escambia County, Alabama. The collection represents a new state record. Substrate conditions were similar to those previously reported for the species. The collections indicate that the species may occupy sites in lower order watercourses.

The rarely collected mayfly, *Dolania americana* Edmunds and Traver, has been reported from five areas scattered along the Coastal Plain of the southeastern United States from Louisiana to North Carolina (Edmunds and Traver 1959; Schneider 1966; Tsui and Hubbard 1979; Finn and Herlong 1980; Benke *et al.* 1984). Kondratieff and Harris (1986) did not report this species from Alabama.

On November 17, 1985 one *Dolania americana* nymph was collected from the Blackwater River at Escambia County Rd. 4, 1.6 km E Bradley, Escambia County, Alabama. A subsequent attempt to collect nymphs at the same site in December 1985 was unsuccessful, but a third attempt on March 9, 1986 yielded three additional specimens. The nymphs were collected by straining sand from the stream bottom through a 3.2 mm mesh screen. The four nymphs obtained ranged in length from 13.3 to 14.8 mm. The three specimens taken in March showed darkening of the cuticle characteristic of pre-emergent nymphs.

All four specimens were obtained in the upper 10 cm of clean shifting sand. The water depth at the time of both collections was approximately 20 cm. The current speed in the microhabitat where nymphs were found was sufficient to cause continual slow shifting of the sand on the bottom. No *Dolania* nymphs were taken in microhabitats where organic detritus and leaf litter had accumulated; although nymphs of the gomphid, *Progomphus obscurus* (Rambur), were present at all sites. Most stretches of the Blackwater River near this site range from 10-15 m in width. However, the site from which *Dolania* were obtained was a widened portion up to 20 m and was shallower than adjacent narrower stretches. The adjacent bottomland trees do not form a closed canopy over the stream at this site. A short distance north of the bridge the river forks into several small streams. Suitable *Dolania* habitat is therefore probably not present north of the

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collecting site.

Although the presence of *Dolania* at this site is of little zoogeographic significance because of the proximity of previously known Florida sites downstream (Peters and Peters 1977), the collections document the occurrence of the species in Alabama and indicate that it occurs at sites in lower order watercourses than those from which it had previously been reported. It is therefore possible that the species may be present in similar unperturbed shifting sand streams on the southeastern Coastal Plain.

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AN ANNOTATED LIST OF THE CURVIPALPIA (TRICHOPTERA) OF ALABAMA[1]

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ABSTRACT: Distributional records for 93 species of caddiflies in the infraorder Curvipalpia from Alabama are presented, along with information on seasonal occurrence, habitat and relative abundance. Hydropsychidae is best represented (47 species), followed by Polycentropodidae (32 species), Philopotamidae (11 species) and Psychomyiidae (3 species). Of the species reported, 74 represent new state records.

The caddisfly fauna of the southeastern United States has received considerable attention in recent years and a diverse fauna of the infraorder Curvipalpia (*sensu* Weaver, 1984; Weaver and Morse, 1986) (=superfamily Hydropsychoidea of Ross, 1967 and Schmid, 1980) is now known. Etnier and Schuster (1979) reported 91 species of Curvipalpia in Tennessee, while in North and South Carolina, Unzicker *et al.* (1982) compiled 107 species. However, in Mississippi only 46 species were reported by Lago *et al.* (1982). In the entire southeast, about 130 species are likely to occur (Morse, personal communication). Despite these studies in neighboring states, the caddisfly fauna of Alabama is just beginning to be understood. Harris (1986) provided a checklist of the Hydroptilidae of the state. The present study continues the description of the Alabama fauna by listing the known Philopotamoidea (Philopotamidae) and Hydropsychoidea (Polycentropodidae, Psychomyiidae and Hydropsychidae) of the state.

In 1981, extensive collecting, primarily using black-light traps, was initiated in the state. This effort has resulted in the collection of 93 species of Curvipalpia, nine of which were described during the course of the study (Lago and Harris, 1983, 1985, 1987; Schuster and Hamilton, 1984; Gordon *et al.*, 1986). The richness of the Curvipalpia fauna in Alabama is indicative of the range of physiographic regions represented in the state. These include the East Gulf Coastal Plain, Piedmont Plateau, Valley and Ridge, and Appalachian Plateau, including the Highland Rim Plateau and Cumberland Plateau subregions (Sapp and Emplaincourt, 1975).

Annotated List of the Curvipalpia of Alabama

In the following checklist of the 93 species of Curvipalpia known to

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occur in Alabama, each species is followed by numerically coded county records. These counties and their location, within the state and with a physiographic province, are depicted in Figure 1. General information on distribution, habitat, abundance and dates of collection are also included. Numbers presented for specimens examined generally refers to males only. Detailed locality and collection information will be provided in an overall summary of the caddisfly fauna of the state, to be published later. This checklist represents over 600 collections made between 1981 and 1986. Specimens are deposited in the insect collections of the Departments of Biology at the University of Alabama and the University of Mississippi.

PHILOPOTAMOIDEA

Philopotamidae

Chimarra augusta Morse. 17. Rare in state, in Piedmont Plateau. May-July. Specimens examined - 9.

C. aterrima Hagen. 1, 5, 8-12, 14-22, 25-29, 31-34, 39, 42, 45, 51, 53, 58, 65, 66. Widespread and common in state. March-October. Specimens examined - 826.

C. falculata Lago & Harris. 64-67. Rare, restricted to lower Coastal Plain. May. Specimens examined - 5.

C. florida Ross. 36, 42, 51-53, 64-67. Common in small Coastal Plain streams. March - September. Specimens examined - 1743.

C. moselyi (Denning). 11, 12, 19-25, 31, 32, 34-36, 39, 41, 45, 53-55, 60, 63-67. Widespread in state, but never collected in large numbers. April - October. Specimens examined - 435.

C. obscura (Walker). 1-6, 8-22, 25-27, 31-34, 38-41, 45, 49, 50, 53, 54, 58, 66. Widespread and common in state. April - October. Specimens examined - 4148.

C. parasocia Lago & Harris. 9-11, 20, 24-26, 34, 35, 39, 41, 67. Uncommon, primarily in streams of western Alabama. April - August. Specimens examined - 155.

Dolophilodes distinctus (Walker). 1, 6, 8, 10-12, 14, 17, 18, 25, 28, 29, 45. Uncommon in small streams of northern Alabama (above fall line). February, May-October. Specimens examined - 53.

D. major (Banks). 17. Collected from a single headwater stream in the Piedmont Plateau. May. Specimens examined - 3.

Wormaldia moesta (Banks). 5, 8, 10, 17, 18, 20, 22, 25, 28, 51, 67. Primarily collected in small, often intermittent, streams throughout the state. February, April - June, October. Specimens examined - 45.

W. shawnee (Ross). 5. Only state record, the Little River in the southern Appalachians. May. Specimens examined - 5.

HYDROPSYCHOIDEA

Psychomyiidae

Lype diversa (Banks). 1-6, 8-12, 14-20, 22-27, 29, 31, 36, 39, 42, 51, 52, 64-67. Widespread, but uncommon in state. March - October. Specimens examined - 328.

Psychomyia flavida Hagen. 1, 5, 14, 15, 17-21, 25, 26, 28, 29, 31, 32, 34, 36, 41, 51, 53, 54, 63, 64. Widespread and common in state. April - October. Specimens examined - 517.

P. nomada (Ross). 1. Only known from a single stream in the Highland Rim Plateau. June. Specimens examined - 14.

Polycentropodidae

Cernotina calcea Ross. 1, 3, 4, 8, 9, 10, 11, 13, 16, 20, 25, 26, 31, 34, 36, 38-41, 43, 45, 49, 50, 52-55, 58, 60, 63 - 67. Widespread and common in state, most abundant in large Coastal Plain rivers. May, September. Specimens examined - 927.

C. spicata Ross. 5, 6, 9, 11-14, 18, 20, 21, 24-26, 31, 32, 34, 35, 39, 40, 43, 45, 58, 64-67. Widespread and common in state, most numerous in large Coastal Plain rivers. April - September. Specimens examined - 440.

C. truncona Ross. 58, 64, 65, 67. Primarily collected in Coastal Plain ponds and lakes. April - June. Specimens examined - 16.

Cyrnellus fraternus (Banks). 1-6, 9-11, 13-20, 23-26, 33-43, 45, 49, 50, 52-54, 58, 60, 63-67. Widespread and common in state, particularly in large rivers and reservoirs. April - October. Specimens examined - 2800.

Neureclipsis crepuscularis (Walker). 1, 3-5, 9, 11, 13, 14, 16, 18, 20, 22, 24, 25, 27, 31, 33-41, 49-51, 53, 55, 63-67. Widespread and common in state. March - October. Specimens examined - 589.

N. melco Ross. 12, 21, 23, 25, 34-36, 52, 53, 66, 67. Most common in rivers and streams of Coastal Plain. March - September. Specimens examined - 559.

Nyctiophylax affinis (Banks). 1, 4-6, 8-12, 14, 16-18, 21, 22, 25-29, 34-36, 38, 39, 41, 45, 51-53, 58, 63, 64, 66, 67. Widespread in state, but never collected in large numbers. April - October. Specimens examined - 219.

N. banksi Morse. 4, 5, 8-11, 13, 14, 17, 18, 20, 25, 26, 53, 66. Widespread in state, but uncommon. May - October. Specimens examined - 135.

N. celta Denning. 1, 5, 14, 16, 17, 20, 25, 31, 32, 34, 35, 41, 54, 64, 66, 67. Widespread and common in state. May - October. Specimens examined - 1890.

N. denningi Morse. 1, 2, 6, 8-15, 17, 18, 20, 22, 23, 25, 26, 28, 29, 31, 32, 39, 45, 50. Widespread in state but most common above the fall line. April - September. Specimens examined - 1458.

N. moesta Banks. 1, 4, 5, 8, 14, 19, 20, 25. Uncommon, collected only in northern Alabama. April - June, September, October. Specimens examined - 225.

N. morsei Lago & Harris. 66, 67. Rare, primarily found in small Coastal Plain streams. April - June. Specimens examined - 49.

N. serratus Lago & Harris. 1, 3, 8-12, 14, 17, 22, 23, 25, 31, 36-40, 42, 45, 51-53, 65-67. Widespread in state, but most abundant in small Coastal Plain streams. April - September. Specimens examined - 218.

Phylocentropus carolinus Carpenter. 1, 9, 17, 24, 25, 27, 28, 31, 32, 34, 39, 51, 53-55, 67. Widespread in small streams of state but never collected in large numbers. April - September. Specimens examined - 141.

P. lucidus (Hagen). 10, 12, 17, 22, 23, 25, 31, 36, 51, 60, 66. Uncommon, collected in small streams throughout the state. April - September. Specimens examined - 31.

P. harrisi Schuster & Hamilton. 51, 66. Only known from two small streams of the Coastal Plain. April, May. Specimens examined - 2.

P. placidus (Banks). 4, 17-20, 22-28, 31, 35, 37, 39, 42, 45, 51-55, 58, 60, 65-67. Most widespread and common *Phylocentropus* in state. March - November. Specimens examined - 181.

Polycentropus barri Ross & Yamamoto. 31. Only records from the Tallapoosa River and one of its tributaries. May. Specimens examined - 2.

P. blicklei Ross & Yamamoto. 2, 5, 6, 10-12, 17-19, 23, 25, 66, 67. Widespread in state, but most common in northern Alabama; never collected in large numbers. March, May, June, September. Specimens examined - 42.

P. carlsoni Morse. 18. Only known from two small headwater streams of the Valley and Ridge. June. Specimens examined - 2.

P. centralis Banks. 1, 2, 5, 6, 9-11, 15. Collected at scattered localities in north Alabama, but most abundant in the Highland Rim Plateau. May, June. Specimens examined - 144.

P. cinereus Hagen. 1-3, 5, 6, 8-12, 14, 16-18, 20, 22, 23, 25, 27, 31, 32, 34, 39, 50, 51, 53, 65-67. Widespread and common in state. April - June, September. Specimens examined - 292.

P. clinei (Milne). 52, 66, 67. Rare, primarily in small Coastal Plain streams. March - May. Specimens examined - 6.

P. confusus Hagen. 1, 2, 5, 6, 8, 10-15, 17-22, 25, 28, 29, 31, 34, 39, 45, 51, 53. Widespread and common in state. April - October. Specimens examined - 1028.

P. crassicornis Walker. 10, 20, 22, 25, 39, 45, 51, 53, 66, 67. Widespread, but uncommon in state. March - June. Specimens examined - 43.

P. elarus Ross. 4, 5. Only records from two small streams in the Cumberland Plateau. June. Specimens examined - 2.

P. floridensis Lago & Harris. 66. Rare, in small Coastal Plain streams. April - May. Specimens examined - 8.

P. nascotius Ross. 67. Rare, in small Coastal Plain streams. June, August. Specimens examined - 4.

P. n. sp. (nr. *chelatus*). 21, 22, 25. Most common in small headwater and intermittent streams of the Cumberland Plateau. March - May. Specimens examined - 17.

P. n. sp. (nr. *elarus*). 6, 8, 10, 14, 20, 22, 25, 39. Primarily collected in small streams of northern Alabama. May, June. Specimens examined - 46.

P. pentus Ross. 25. Only record from a small intermittent stream of the Cumberland Plateau. April. Specimens examined - 1.

P. rickeri Yamamoto. 11. Only record from a small stream of the Cumberland Plateau. June. Specimens examined - 1.

Hydropsychidae

Cheumatopsyche bibbensis Gordon, Harris & Lago. 34. Known only from the type locality on the Cahaba River. October, Specimens examined - 1.

C. burksi Ross. 1, 6, 9, 12, 21, 24, 25, 31, 32, 35, 36, 52, 58, 66, 67. Widespread, but uncommon in state. May - August. Specimens examined - 49.

C. cahaba Gordon, Harris & Lago. 20. Known only from the type locality near the headwaters of the Cahaba River. July. Specimens examined - 1.

C. campyla Ross. 1, 3, 4, 9, 10, 13, 14, 16-18, 20, 25, 29, 31, 32, 34, 36-38, 40, 43, 50, 64. Widespread and common in state. April - October. Specimens examined - 917.

C. edista Gordon. 23-25, 33, 34, 39, 40, 50, 51, 55, 58, 60, 64. Widespread and common in Coastal Plain streams. April - October, Specimens examined - 1178.

C. ela Denning. 4, 17, 20, 25, 26, 34, 40, 41, 49, 50. Collected at scattered localities throughout the state but most abundant in Coastal Plain streams. April - October. Specimens examined - 904.

C. geora Denning. 5, 6, 8, 10, 11, 13, 15, 17, 18, 20, 25, 26, 28, 29, 31, 32, 34, 39, 41, 45, 53, 64. Widespread in state, but most common above the fall line. April - October. Specimens examined - 1956.

C. gracilis (Banks) 8, 20, 25, 34. A common species in small streams of the Cumberland Plateau. May - September. Specimens examined - 126.

C. harwoodi Denning. 1, 17, 18, 20, 25, 31, 32, 39. Primarily in small streams of northern Alabama; uncommon. May - July. Specimens examined - 22.

C. helma Ross. 5, 28. Recorded from the Valley and Ridge and Piedmont Plateau. May, June. Specimens examined - 4.

C. kinlockensis Gordon, Harris & Lago. 8. Known only from the type locality in the Cumberland Plateau. May. Specimens examined - 4.

C. minuscula (Banks). 20, 25, 26, 31, 32, 34, 39, 45, 54, 60, 63-65. A common species along fall line and throughout the Coastal Plain. April - October. Specimens examined - 3812.

C. oxa Ross. 1, 2, 5, 6, 8-10, 14-20, 25-27, 32, 34. Common in the Highland Rim Plateau and lower Appalachians. April - October. Specimens examined - 1318.

C. pasella Ross. 1, 3-6, 8-22, 24-26, 29, 31, 32, 34, 36-41, 49, 51-54, 58, 60, 63-67. Widespread and common in state. April - October. Specimens examined - 6666.

C. petersi Ross, Morse & Gordon. 52, 53, 64, 66, 67. Common in lower Coastal Plain streams. April - September. Specimens examined - 554.

C. pettiti (Banks). 1-6, 8-22, 24-27, 29, 31-40, 45, 49-53, 58, 60, 64-67. Widespread and common in state. April - October, February. Specimens examined - 1688.

C. pinaca Ross. 5, 8, 11, 12, 15, 17, 18, 21-25, 27, 29, 31-33, 36, 39, 42, 45, 51-53, 58, 60, 64-67. Widespread and common in state. March - September. Specimens examined - 1239.

C. sordida (Hagen). 33-35, 39, 41, 42, 43, 45, 58. Collected in northern portion of Coastal Plain; uncommon. April - June, September. Specimens examined - 95.

C. virginica Denning. 2, 25, 33, 36, 39, 42, 51, 52, 64, 66, 67. Widespread, but uncommon on Coastal Plain. March - August. Specimens examined - 58.

Diplectrona modesta Banks. 1, 2, 6, 10, 12, 14, 17, 18, 23, 25, 27, 28, 35, 39, 45, 48, 51, 58, 65, 66. Widespread in state, but never collected in large numbers. April - October. Specimens examined - 169.

Homoplectra doringa (Milne). 25. Collected in intermittent streams of the Cumberland Plateau. April - March. Specimens examined - 21.

Hydropsyche alvata Denning. 10, 25, 29, 33-35, 38, 39, 41, 45, 52, 60, 63-65. Most commonly collected in Coastal Plain streams. April - August. Specimens examined - 986.

H. betteni Ross. 1-3, 5, 6, 8, 10, 11, 14, 15, 17-20, 22, 25-27, 29, 31, 34, 36, 39, 41, 42, 45, 49-51. Widespread in state, but never collected in large numbers. April - October. Specimens examined - 424.

H. decalda Ross. 66. Only records from lower Coastal Plain streams. May, August. Specimens examined - 4.

H. demora Ross. 17, 31, 32. Rare, records from small Piedmont streams. May, June. Specimens examined - 9.

H. depravata Hagen. 1, 4, 5, 14-16, 18-20, 25, 26, 34. Most frequently collected in lower Appalachians. April - October. Specimens examined - 296.

H. dicantha Ross. 5, 6, 18, 25-28, 32, 34. Uncommon, collected at scattered north Alabama localities. April - August. Specimens examined - 123.

H. elissoma Ross. 22-25, 35, 36, 42, 52, 64-67. Uncommon, at numerous Coastal Plain localities. March - August. Specimens examined - 216.

H. fattigi Ross. 17, 31. Rare, in Piedmont streams. May. Specimens examined - 10.

H. frisoni Ross. 4, 13, 14, 20, 24-26, 34, 37, 45. Most common in northern Alabama rivers and large streams. April - October. Specimens examined - 1041.

H. hageni Banks. 20, 25, 26, 34. Common in central Alabama rivers and large streams. April - October. Specimens examined - 1128.

H. incommoda Hagen. 20, 27, 34, 63-65. Collected at scattered localities in state, but most common in large streams of lower Coastal Plain. April - September. Specimens examined - 1242.

H. mississippiensis Flint. 2, 5, 10-12, 15-21, 23-27, 29, 32-36, 39, 41, 44, 45, 49, 51-55, 58, 60, 63-67. Widespread and common in state. March - October. Specimens examined - 2400.

H. orris Ross. 2-4, 8-10, 18, 20, 22, 24-26, 33-37, 39-42, 45, 48-51, 53, 54, 64-67. Widespread and common in state. March - November. Specimens examined - 2629.

H. phalerata Hagen. 11, 29, 32. Rarely collected in state. May - July. Specimens examined - 4.

H. rossi Flint, Voshell & Parker. 1, 2, 5, 9-11, 13, 14, 16, 18, 20, 22, 23-26, 33-36, 40, 41, 45, 50, 60, 63-65, 67. Widespread in state but never collected in large numbers. March - October. Specimens examined - 518.

H. rotosa Ross. 1, 2, 3. Only collected in Highland Rim Plateau, rare. June. Specimens examined - 9.

H. scalaris Hagen. 16, 18, 34. Rare, in Valley and Ridge. May, September. Specimens examined - 7.

H. simulans Ross. 18. Only record from a stream in the southern Appalachians. September. Specimens examined - 1.

H. venularis Banks. 11, 12, 17, 18, 20, 21, 26, 29, 31, 32, 34, 45, 54. Primarily collected above the fall line, but never in large numbers. April - October. Specimens examined - 361.

H. n. sp. (*scalaris* group) 3. Known from two rivers of the Highland Rim Plateau. June. Specimens examined - 40.

H. (*Ceratopsyche*) *cheilonis* (Ross). 1, 14, 16, 18-20, 25, 27, 35. Collected in north-central Alabama. April - October. Specimens examined - 415.

H. (*C.*) *sparna* (Ross). 1, 2, 5, 6, 8-11, 13-20, 22, 25, 27-29, 31-34, 36, 45, 51, 53, 60, 64, 66. Widespread and common in state. April - October. Specimens examined - 911.

Macrostemum carolina (Banks). 1, 5, 6, 9-12, 22-26, 33-35, 41, 43-45, 49, 50, 52-54, 60, 63-67. Widespread and common in state. April - September. Specimens examined - 1312.

M. transversum (Walker). 24, 33, 35, 45, 48. Collected in large rivers along the fall line; uncommon. April - June. Specimens examined - 59.

M. zebratum (Hagen). 5, 31, 34, 54. Collected in small rivers at several scattered localities; most numerous in the Sepulga River on the Coastal Plain. May, June. Specimens examined - 225.

Potamyia flava (Hagen). 25, 34, 35, 40, 41, 49, 51, 53, 64, 66, 67. Widespread and common in Coastal Plain rivers and large streams. April - October. Specimens examined - 1184.

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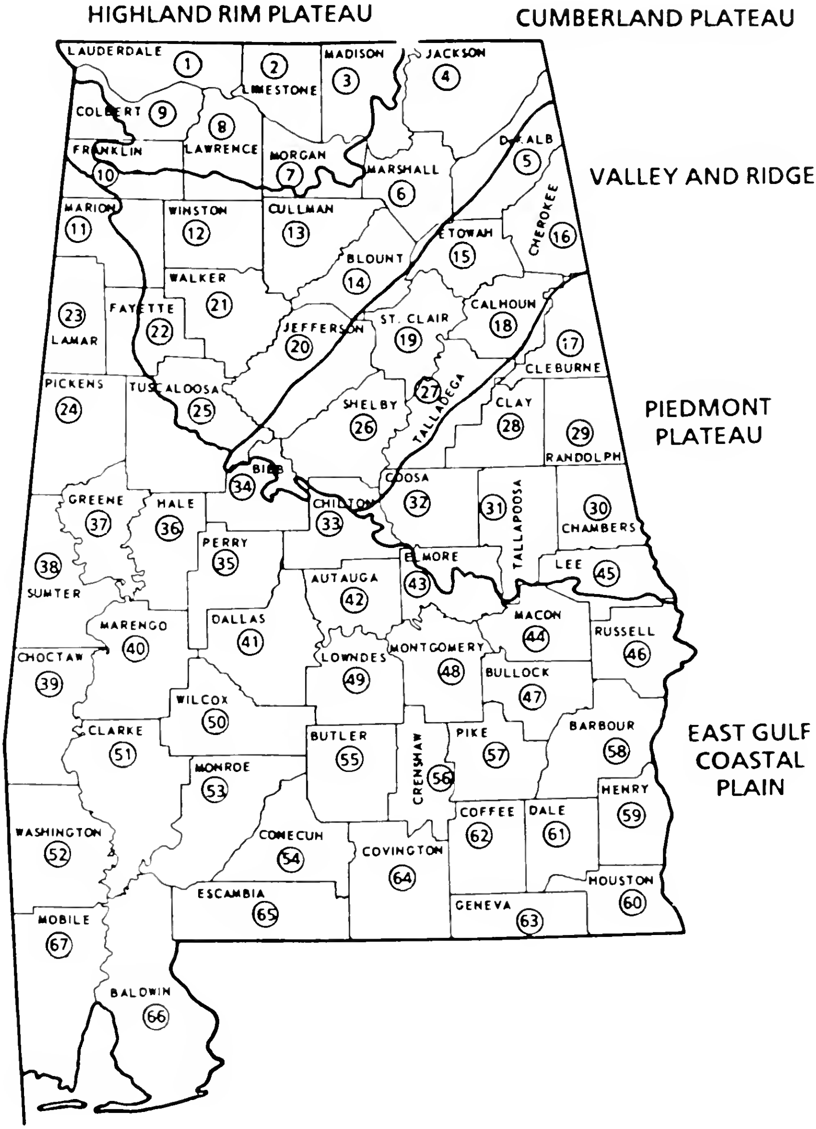
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CUMBERLAND PLATEAU
VALLEY AND RIDGE
PIEDMONT PLATEAU
EAST GULF COASTAL PLAIN
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LIMESTONE 2
MADISON 3
JACKSON 4
DEKALB 5
MARSHALL 6
MORGAN 7
LAWRENCE 8
COLBERT 9
FRANKLIN 10
MARION 11
WINSTON 12
CULLMAN 13
BLOUNT 14
ETOWAH 15
CHEROKEE 16
CLEBURNE 17
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ST. CLAIR 19
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SOCIETY MEETING OF OCTOBER 21, 1987

Insects have received little attention when it comes to endangered species. Appropriately, "Putting the Bugs into Endangered Species Management" was the title of the talk presented by Mr. Clark N. Shiffer to the first membership meeting of the 1987-88 season. Mr. Shiffer is the Herpetology and Endangered Species Coordinator for the Pennsylvania Fish Commission, Bellefonte, PA. Although Mr. Shiffer has been an avid amateur entomologist for many years and his position encompasses aquatic insects, most of his professional activity deals with fishes, amphibians, and reptiles.

Why are insects left out? According to Mr. Shiffer the reasons are many. First is the public attitude toward insects which perceives them as noxious or dispensable. Second, and related to the first, is that legislated priorities reflect the interests of the people; therefore, there are few resources left after mammals, birds, reptiles, amphibians and plants have been dealt with. Finally and perhaps most significantly, there is simply too little known about most species of insects to justify their classification as threatened or endangered. A recent U.S. Fish and Wildlife Service list of endangered and threatened species included only thirteen insects; ten of which were lepidopterans, two coleopterans and one hemipteran. Our ignorance of various species is reflected in another federal list of "endangered" insects for possible consideration which include some species that are actually widespread and fairly common.

Mr. Shiffer has spent many years photographing insects and determining the geographic ranges and habitat preferences of Odonata and Diptera in particular. His collection of slides formed the backdrop for his talk which included many anecdotes about species in Pennsylvania and elsewhere. He discussed the fragile existence of *Ophiogomphys howei* on the Susquehanna River, the discovery of new localities for *Somatochlora incurvata* in northern Pennsylvania, the rescue of a habitat for *Gomphus rogersi,* and his concern for the future of Ten Acre Pond, a habitat that supports many interesting dragon flies but lies in the way of an expanding municipal area. He also showed slides of *Cuterebra fontinella,* a bot fly whose breeding habitat he discovered; the first such record for any bot fly species in eastern North America. The infectious enthusiasm Mr. Shiffer shared with the audience has been captured by Charles Fergus in an article published in Science 82 (June 1982, p. 54).

Among the 14 members and 3 guests at the meeting in Townsend Hall at the University of Delaware was Frank Elia of Day Butterfly House in Pine Mountain, GA. This will be the first museum specializing in live butterflies in the United States. It is located in Calloway Botanical Gardens about 60 miles south of Atlanta. Discussion of topics of local entomological interest before Mr. Shiffer's talk focused on Brood X of the periodical cicada. Some areas around Washington, D.C. and central Pennsylvania were heavily infested while in other areas there were none. In particular Howard Boyd noted that areas of New Jersey that had been heavily infested seventeen years ago were almost totally unaffected this year.

Harold B. White
Corresponding Secretary

November 18, 1987

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VOLUME 98, 1987

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1	Jan. & Feb.	1 - 40	Jan. 8, 1987
2	Mar. & Apr.	41 - 88	May 8, 1987
3	May & June	89 - 152	May 26, 1987
4	Sept. & Oct.	153 - 204	Oct. 21, 1987
5	Nov. & Dec.	205 - 268	Dec. 24, 1987

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