US ISSN 0013-872X

108 JANUARY & FEBRUARY, 1997 NO. 1

ENTOMOLOGICAL NEWS

THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS is published bi-monthly except July-August by The American Entomological Society at the Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pa., 19103-1195, U.S.A.

The American Entomological Society holds regular membership meetings on the fourth Wednesday in October, November, February, March, and April. The November, February and April meetings are held at the Academy of Natural Sciences in Philadelphia, Pa. The October and March meetings are held at the Department of Entomology, University of Delaware, Newark, Delaware.

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(Continued on inside of back cover)

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NEW RECORDS AND SPECIES, AND TAXONOMIC ALTERATIONS IN THE MILLIPED FAMILY PAEROMOPODIDAE (JULIDA)[1]

Rowland M. Shelley[2], Selena B. Bauer[2]

ABSTRACT: Diagnoses are presented for two new paeromopodid milliped species from California — *Paeromopus paniculus*, from the Merced River Valley, Mariposa County, and *Californiulus blechrostriatus*, from the eastern slope of the Sierra Nevada and the desert of Inyo County. *Paeromopus buttensis* is reduced to subspecific status under *P. angusticeps* because of a newly discovered intergrade male from central Sonoma County and reinterpretation of *P. ocellatus* in western Solano County, which is comprised of anatomically intermediate forms and placed in synonymy under *P. a. buttensis*, new status. New localities of *Californiulus dorsovittatus* and *C. yosemitensis* in Lassen, Modoc, and Siskiyou counties connect the formerly disjunct Warner Mountain population of the latter to the main ranges of the genus and family. The southern area of *C. yosemitensis*, extending from Mariposa to Kern counties, is segregated from that from Placer County northward because the species has never been collected in El Dorado, Amador, and Calaveras counties. The distribution of *C. euphanus* in western Washington extends eastward into the western periphery of the Columbia Plateau.

The endemic west-Nearctic diplopod family Paeromopodidae (order Julida) includes the longest millipeds on the North American continent and is comprised of two genera, *Paeromopus* Karsch and *Californiulus* Verhoeff. According to Shelley (1994), it occupies a continuous area along the Pacific Coast and the Sierra Nevada and Cascade Mountains from central California to northern Washington, and occurs in the Warner Mountains, on the contiguous corners of California, Nevada, and Oregon, and from northeastern Oregon and southeastern Washington to western Montana. *Paeromopus* is restricted to California and extends along the Pacific Coast from Humboldt to Monterey counties and the western slope of the Cascades and Sierras from Shasta to Mariposa counties; *Californiulus*, however, inhabits all six states but is absent from coastal California. The recent discovery of substantial new material among unsorted millipeds in six institutions, including a new species from the California desert, prompts publication of supplemental distributional data. With new records from western Modoc, eastern Siskiyou, and northern Lassen counties, the disjunct area of the family and *Californiulus* in the Warner Mountains now connects with the rest of the range in northern California; the ranges of these taxa also expand longitudinally in the south into the deserts of central Inyo County, California, and in the north into the western periphery of the Columbia Plateau, in Yakima County,

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[1] Received June 14, 1996. Accepted July 2, 1996.

[2] North Carolina State Museum of Natural Sciences, P. O. Box 29555, Raleigh, NC 27626-0555.

Washington. As a male is now available, we diagnose a new species for the previously unassignable females of *Paeromopus* from Mariposa County, California, and we reduce *P. buttensis* Chamberlin to subspecific status under *P. angusticeps* (Wood) based on an anatomically intermediate male from Sonoma County and reinterpretation of *P. ocellatus* Loomis, which we place in synonymy under *P. a. buttensis.* No additional samples are available for *P. eldoradus* and *P. cavicolens,* both by Chamberlin, *C. chamberlini* (Brolemann), and *C. parvior* (Chamberlin), so their accounts are as published by Shelley (1994).

Acronyms of sources of the new material are as follows:

AMNH - American Museum of Natural History, New York, New York.
BYU - Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah.
CAS - California Academy of Sciences, San Francisco.
FSCA - Florida State Collection of Arthropods, Gainesville.
LACMNH - Los Angeles County Museum of Natural History, Los Angeles, California.
NCSM - North Carolina State Museum of Natural Sciences, Raleigh.
UCB - Essig Museum of Entomology, University of California at Berkeley.
UCD - Bohart Entomological Museum, University of California at Davis.

Paeromopus angusticeps (Wood)

On the basis of new material, we interpret *P. ocellatus* and a male from a geographically intermediate locality in Sonoma County as intermediate between *P. angusticeps* and *P. buttensis,* so the two most widespread forms of *Paeromopus* are races of a single species. Consequently, the genus is comprised of one widely distributed and three localized species.

Distribution. With this taxonomic change, the range of *P. angusticeps* consists of two branches, one extending along the Pacific Coast from Humboldt to northern Monterey counties and the other extending along the western slope of the Cascades and Sierra Nevada from Shasta to Tuolumne counties (Fig. 11).

Paeromopus angusticeps angusticeps (Wood), NEW STATUS

Figs. 1-2

The southern subspecies, *P. a. angusticeps* occurs around San Francisco/San Pablo and Monterey Bays. The distributional limits are Mill Valley in southern Marin County, Castro Valley, Alameda County, and the literature record from Pacific Grove, Monterey County (Chamberlin 1941). Material was examined from the following new localities; the initials JSB and MRG in this and succeeding accounts denote samples collected by J. S. Buckett and M. R. Gardner.

CALIFORNIA: **Santa Clara Co.,** 6 mi (9.6 km) SE Holy City, M, 29 December 1966, MRG, S. E. Harrison (UCD). **Santa Cruz Co.,** 2 mi (3.2 km) NW Boulder Cr., M, 29 Decmber 1966, MRG, S. E. Harrison (UCD); 3 mi (4.8 km) NNE Soquel, F, 21 April 1972, C. E. Griswold (UCB); Santa Cruz, Empire Cv. on Univ. Calif. Santa Cruz campus, F, 7 August 1962, R. Graham (FSCA); and Mt. Madonna E of Watsonville, M, 4 July 1958, W. J. Gertsch, V. Roth (AMNH).

Remarks. The female from Empire Cave, Santa Cruz County, was the subject of the photo in Shelley (1994, fig. 2). At the time that work was published, the specimen had not been discovered in the FSCA holdings.

Paeromopus angusticeps buttensis Chamberlin, NEW STATUS

Figs. 7-8

Paeromopus buttensis Chamberlin, 1954:232. Buckett, 1964:18.
Paeromopus ocellatus Loomis, 1972:260, figs. 1-5. Shelley, 1994:187-188, figs. 27-28. NEW SYNONYMY.

The northern subspecies, *P. a. buttensis* is the most wide spread representative of the genus. The distribution is essentially as described by Shelley (1994), but the southern coastal limit is in northern Sonoma County, and records are now available from Lake, Nevada, Placer, and Yuba counties (Fig. 11). We place *P. ocellatus* in synonymy here because the subterminal branch of the midlength projection (Fig. 5, mlp) of its anterior gonopod is long and resembles the condition in this subspecies. Material was examined from the following new localities:

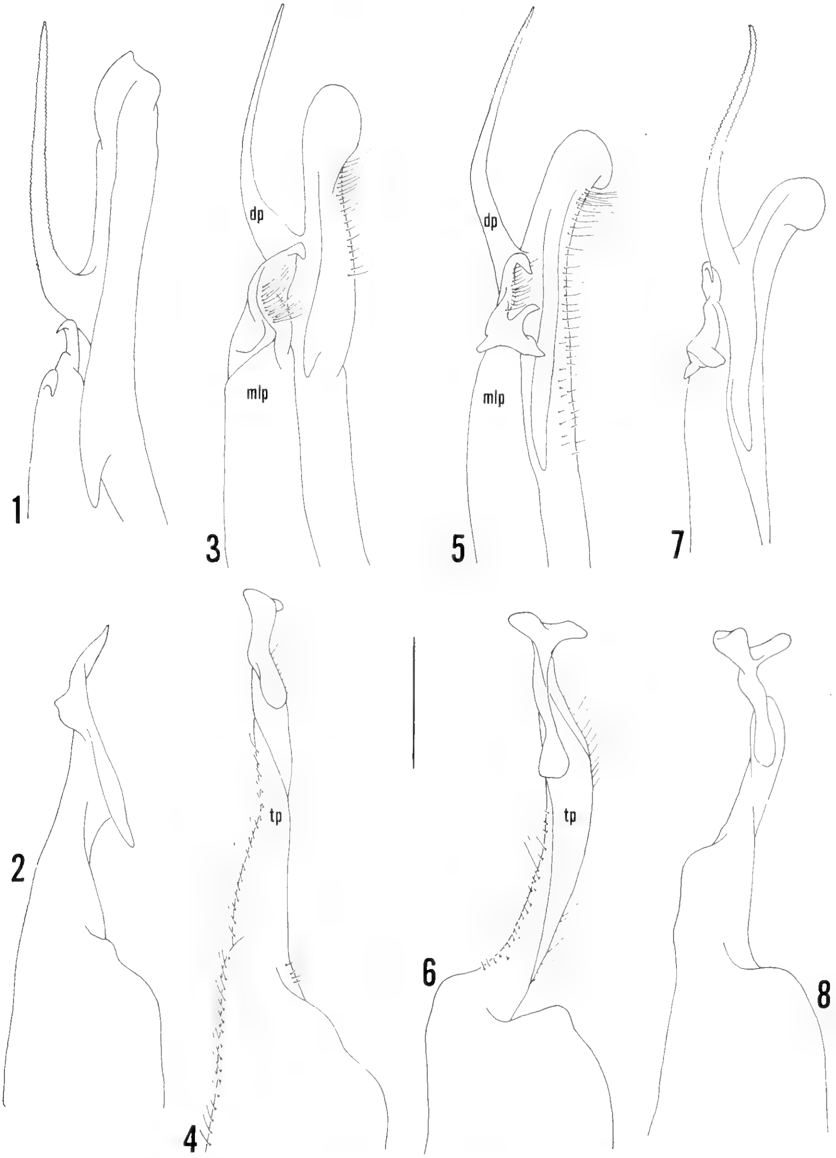
CALIFORNIA: **Amador Co.,** along Consumnes R., SE Latrobe, 2M, 5F, 26 November 1965, MRG (UCD). **Butte Co.,** 6 mi (9.6 km) SE Stirling City, M, 14 May 1967, S. R. Kutcher (UCD); and 2 mi (3.2 km) S Camp Storrie, exact location unknown, M, 20 June 1964, JSB, MRG (UCD). **Calaveras Co.,** Avery & 1 mi (1.6 km) E Avery, 30M, 27F, 26 March 1966, JSB, MRG (UCD). **El Dorado Co.,** 1 mi (1.6 km) E & 1 mi (1.6 km) NE Pacific House, 4M, F, 21 March-2 May 1992, W. D. Shepard (NCSM); 6 mi (9.6 km) S El Dorado, 3M, 2F, 28 November 1964, JSB, MRG (UCD); Camino, F, 19 April 1969, K. Lorenzen (UCD); and Pollock Pines, M, 20 February 1966, R. Denno (UCD). **Humboldt Co.,** Redcrest, M, F, juv., 20 March 1976, and M, 25 November 1977, A. K. Johnson (FSCA); 2.2 mi (3.5 km) N Willow Creek, along CA hwy. 96, F, 10 October 1076, A. K. Johnson (FSCA); and Richardson Grove St. Pk., M, 2F, 20 March 1976, A. K. Johnson (FSCA). **Lake Co.,** 4 mi (6.4 km) NW Middletown, M, F, 21 February 1965, JSB, MRG (UCD). **Mendocino Co.,** 3 mi (4.8 km) N Branscomb, M, 17 May 1975, C. Kellner (UCB); ca. 6 mi (9.6 km) N Branscomb, F, 24 November 1974, T. L. Smith (FSCA); 7 mi (11.2 km) NW Yorkville, M, 2F, 21 December 1964, JSB, MRG (UCD); 9 mi (14.4 km) N Laytonville, 3F, 9 March 1968, JSB, MRG (UCD); 4-6 mi (6.4-9.6 km) N Potter Valley, 4M, 2F, 28 January 1967, JSB, MRG (UCD); 2 mi (3.2 km) W Willitts, 24M, 26F, 25 March 1977, A. K. Johnson (FSCA); and 10 mi (16 km) N Cloverdale, F, 27 January 1967, JSB, MRG (UCD). **Nevada Co.,** Grass Valley, M, 27 May 1967, D. S. Horning (UCD); 1 mi (1.6 km) SW Grass Valley, M, 10 February 1968, JSB, MRG (UCD); and 5 mi (8 km) NW Alta, 11M, 2F, 11 May 1969, D. A. Mead (UCD). **Placer Co.,** 9 mi (14.4 km) N Auburn, 2M, 4 February 1968, MRG (UCD); 15 mi (24 km) N Auburn, 2F, 4 February 1968, MRG (UCD). **Plumas Co.,** 1 mi (1.6 km) N Elephant Butte, exact location unknown, M, 12 July 1964, JSB, MRG (UCD). **Shasta Co.,** Inwood, 2F, 26 May 1967, JSB, MRG (UCD); and 21 mi (33.6 km) W Redding, M, F, 21 December 1966, JSB, MRG (UCD). **Sonoma Co.,** 6 mi (9.6 km) NE Cloverdale, M, 21 December 1964, JSB, MRG (UCD). **Trinity Co.,** 3 mi (4.8 km) SW Douglas City, F, 21 December 1966, JSB, MRG (UCD). **Yuba Co.,** 1 mi (1.6 km) W Strawberry Valley Ranger Sta., 2F, 6 May 1980, J. T. Doyen (UCB).

Paeromopus angusticeps intergrades

Figs. 3-6

In the Sonoma County male, the subterminal branch of the midlength projection (Fig. 3, mlp) of the anterior gonopod is short and apically broad, an intermediate condition between the long, broad projection in *P. a. buttensis* (Fig. 7) and the short, uncinate structure in the nominate subspecies (Fig. 1). On the posterior gonopod, the subterminal process of the terminal projection (Fig. 4, tp) is faint and weakly sinusoid; this condition is somewhat intermediate between that in the nominate subspecies (Fig. 2) and the dactyliform, strongly sinusoid process in *P. a. buttensis* (Fig. 8). *Paeromopus ocellatus* also occupies an intermediate geographical location in western Solano County. We believe it is comprised of intergrade forms because the subterminal branch of the anterior gonopod midlength projection typically combines features of the two races, being long with an uncinate lateral margin (Fig. 5, mlp); the terminal projection of the posterior gonopod is variable but typically weakly convex apically with a slightly sinusoid subterminal process (Fig. 6, tp). In the holotype of *P. ocellatus*, the distal projection of the anterior gonopod bends strongly anteriad at midlength and overhangs the midlength projection (see Shelley 1994. fig. 27, dp). This configuration has not been seen again and is not characteristic of the Solano County population; we consider it an artifact, possibly from Loomis' original dissection. as the distal projection is fragile and easily bent. Material was examined from the following localities:

CALIFORNIA: **Sonoma Co.,** 7 mi (11.3 km) NE Santa Rosa, Los Alamos Rd., M, 26 November 1964, JSB (UCD). **Solano Co.,** 2 mi (3.2 km) W Cordelia, 4M, 4F, 21 December 1964, JSB, MRG (UCD); and 1.7 mi (2.7 km) W jct. Hwy. I-80 and CA hwy. 12, nr. Cordelia. F, 23 December 1967, JSB (UCD).



Figs. 1-8. *Paeromopus angusticeps*. 1-2, *P. a. angusticeps*. 1, right anterior gonopod of male from Stanford, Santa Clara County, anterior view. 2, left posterior gonopod of the same, caudal view. 3-6, *P. angusticeps* intergrades. 3, right anterior gonopod of male from 7 mi (11.2 km) NE Santa Rosa, Sonoma County, anterior view. 4, left posterior gonopod of the same, caudal view. 5, right anterior gonopod of male from 2 mi (3.2 km) W Cordelia, anterior view. 6, left posterior gonopod of the same, caudal view. 7-8, *P. a. buttensis*. 7, right anterior gonopod of holotype, anterior view. 8, left posterior gonopod of the same, caudal view. dp, distal projection; mlp, midlength projection; tp, terminal projection. Setation omitted on figs. 1-2 and 7-8. Scale line = 1.00 mm for all figs.

Paeromopus paniculus, NEW SPECIES

Figs. 9-10

Type specimen. Male holotype (UCD) collected by J. S. Buckett & M. R. Gardner, 8 February 1969, 14.1 mi (22.6 km) E Briceburg (1.5 mi (2.4 km, W El Portal), Mariposa County, California.

Diagnosis. Color pattern consisting of transverse blue gray bands, generally indistinct from base color but becoming slightly lighter and more distinct anteriad; anterior gonopod curved moderately laterad, apical margin sublinear, tooth very short and inconspicuous, barely noticeable in anterior view, only slightly elevated above gonopodal surface, subterminal projection of midlength projection short, barely projecting beyond surface, broadly sublinear apically, angling dorsad, distal projection upright, bowed laterad proximal to midlength, extending well beyond distal extremity of gonopod; posterior gonopod without basal spine on anterior surface medial to terminal projection, with tuft of spinules on caudomedial surface at base of latter, terminal projection upright, with torsion, without subterminal caudomedial lamina, apical lamellae slightly flared, forming calyx with longer medial margin, without subterminal process (Figs. 9-10).

Variation. The tuft on the left posterior gonopod contains about nine spinules, while that on the right contains only three.

Paeromopus paniculus is the species with the longest millipeds on the North American continent, and a 165 mm (6 1/2 in.) long female collected by the first author at Happy Isles in 1990 is the longest individual ever collected. Though possessing mature gonopods and the same total segment number (75), the male holotype may not be fully grown, as it has three legless segments and measures 79.8 mm in length, in contrast to the females from Happy Isles, which average 75 segments, none legless, and 155.6 mm in length.

Ecology. The habitat of the holotype is not indicated on the vial labels, but individuals at Happy Isles occur under moist decaying logs (Shelley 1994).

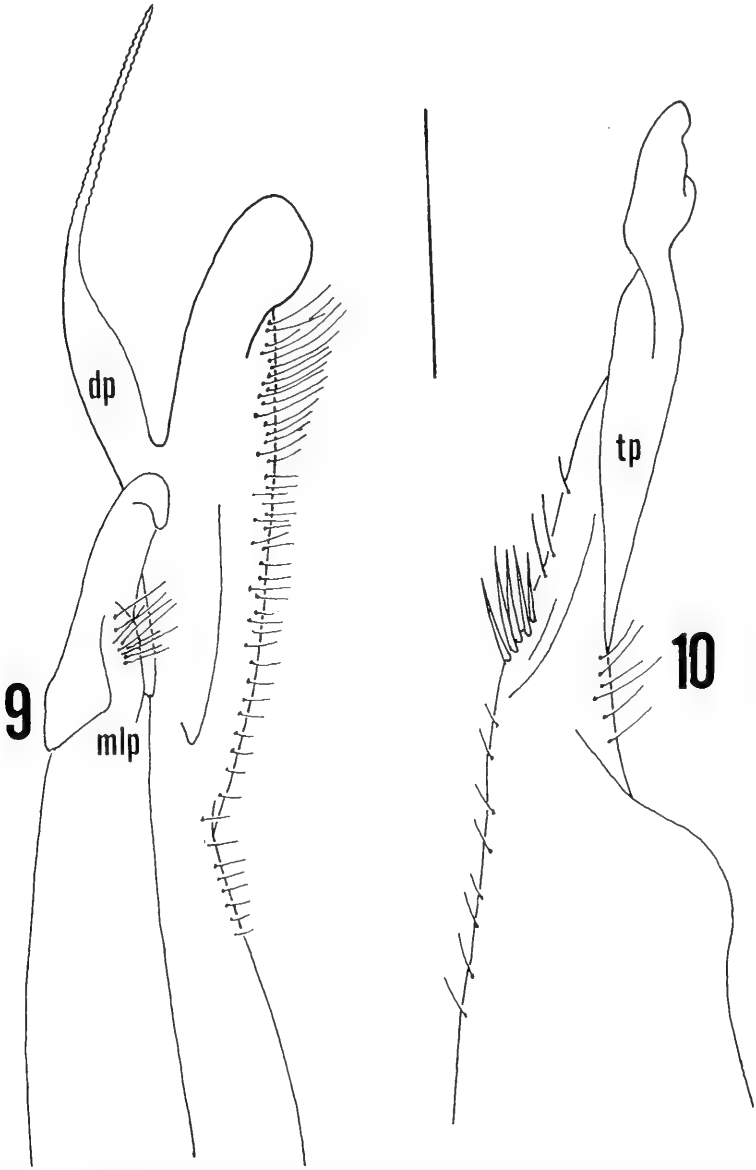
Distribution. The Merced River Valley from above Nevada Falls, Yosemite National Park, to the community of Briceburg, west of the Park along California highway 140, a linear distance of some 18 mi (28.8 km). In addition to the holotype, the following specimens are known; for convenience we repeat the records cited as *Paeromopus* sp. by Shelley (1994) (Fig. 11).

CALIFORNIA: **Mariposa Co.,** Yosemite Nat. Pk., Hidden Meadow (Lost Lake), ca. 1 mi (1.6 km) N Nevada Falls, F, 17 April 1954, J. Gorman (FSCA), Vernal Falls trail, F, 29 May 1953, J. Gorman (FSCA), Happy Isles, F, 2 April 1967, J. R. Helfer (UCD) and 2F, 23 April 1990, R. M. Shelley (NCSM), and Yosemite Valley, F, July 1952, M. Hood (LACMNH).

The following two literature records refer to *P. paniculus:*

Mariposa Co., Vernal Falls, Yosemite Nat. Pk., and Briceburg, along CA hwy. 140, ca. 15 mi (24 km) W Yosemite (Causey 1955, Buckett 1964).

Remarks. We are pleased to confirm Causey's conclusion, based on labels with the Yosemite specimens at the FSCA, which were formerly in her private



Figs. 9-10. *Paeromopus paniculus* holotype. 9, right anterior gonopod, anterior view. 10, left posterior gonopod, caudal view. Abbreviations as in figs. 1-8. Scale line = 1.00 mm for both figs.

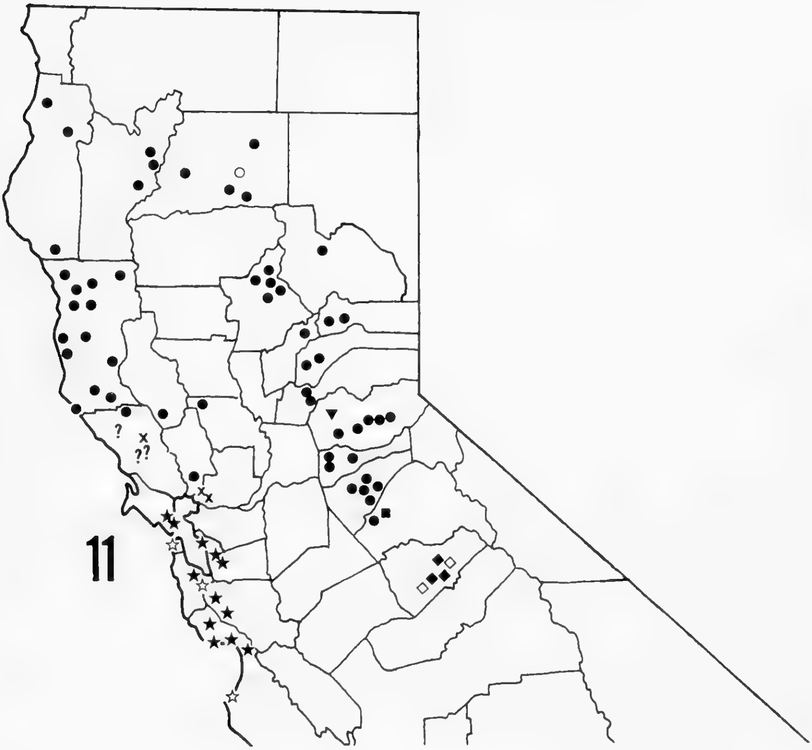


Fig. 11. Distribution of *Paeromopus*. Stars, *P. a. angusticeps;* dots, *P. a. buttensis;* X's, *P. angusticeps* intergrades; question marks, unknown forms of *P. angusticeps*; inverted triangle, *P. eldoradus;* square, *P. cavicolens;* diamonds, *P. paniculus*. Open symbols denote literature records deemed valid.

collection, that this, the southern most population of *Paeromopus* in the Sierras, does represent a new species. Shelley (1994) tentatively concurred because of the darkly banded color pattern, in contrast to the light bands of other forms of *Paeromopus,* but could not propose a name in the absence of males, which still have not been taken within Yosemite National Park. *Paeromopus paniculus* is closely related to *P. eldoradus* and comes off with this species at the second half of couplet 4 in the key to species by Shelley (1994). It is distinguished from *P. eldoradus* by the inconspicuous anterior gonopod tooth, the absence of the caudomedial lamina on the posterior gonopod terminal projection, and the presence of the tuft of spinules at the base of the latter (compare figs. 9-10 with figs. 29-30). The specific name means tuft or bush, and refers to the spinules.

Paeromopus sp.

Additional female samples from Sonoma County cannot be assigned with confidence as either intergrades or a subspecies of *P. angusticeps.* We record them here and show them as question marks in fig. 9.

CALIFORNIA: **Sonoma Co.,** 3 mi (4.8 km) N Kenwood, along Adobe Cyn. Rd., 3F, 20 December 1964, JSB, MRG (UCD); Rio Nido, F, 17 June 1916, W. Gaeggel (CAS); and Occidental, F, 29 October 1964, S. Rattoro (CAS).

Californiulus dorsovittatus Verhoeff

The distribution of *C. dorsovittatus* expands in the north and east with records from eastern Siskiyou County and central Lassen County. Material was examined from the following new localities:

CALIFORNIA: **Lassen Co.,** Silva Lake, F, 16 June 1956, P. S. Bartholomew (CAS). **Shasta Co.,** Moose Camp, exact location unknown, M, 6 July 1993, J. R. Pierson (BYU). **Siskiyou Co.,** Lava Beds Natl. Mon., M, 28 August 1966, R. C. Gardner, S. E. Harrison (UCD); 21 mi (33.6 km) E McCloud, Dead Horse Summit, along CA hwy. 89 nr. Ponderosa, M, F, 7 August 1968, H. B. Leech (CAS) and M, 18 September 1961, W. J. Gertsch, W. Ivie (AMNH); and along Tate Cr., exact location unknown, F, 24 June 1954, H. P. Chandler (CAS). **Tehama Co.,** along Deer Cr., generally E of Tehama but exact location unknown, F, 19 September 1961, W. J. Gertsch, W. Ivie (AMNH).

Californiulus yosemitensis Chamberlin

New records from central Modoc and northeastern Lassen counties expand the area of the Warner Mountains population and connect it with the main area of the genus and family in the southern Cascades, although it is still disjunct from the main area of *C. yosemitensis.* A new record is available from Nevada County, but the continued absence of samples from El Dorado, Amador, and Calaveras counties (Fig. 16) indicates that this area constitutes a lacuna within both the genus and species, but not within the family because *P. a. buttensis* and *P. eldoradus* occur in this gap (Fig. 11). Therefore, the southern area of *C. yosemitensis,* extending from Mariposa and Mono to Kern counties, is disjunct from that from Placer County northward (Fig. 16). Material was examined from the following new localities.

CALIFORNIA: **Fresno Co.,** Kings River Canyon, along Roaring River, M, 4F, July-August, 1910, collector unknown (CAS). **Kern Co.,** 2 mi (3.2 km) N L. Isabella, 2F, May 1971, E. A. Kane (UCD). **Lassen Co.,** Lost L., S. Warner Mts., F, 19 September 1964, A. B.

Gurney (UCD). **Modoc Co.,** 15 mi (24 km) N Alturas, along Joseph Cr., F, 17 June 1954, R. O. Schuster (FSCA); and Crowder Flat & Twin Spgs., ca. 7 mi (11.2 km) S Oregon border & 11-12 mi (17.6-19.2 km) W Goose L., 2F, 25 June 1974, A. K. Johnson (FSCA). **Nevada Co.,** Sagehen Cr., exact location unknown, 2M, 3F, 25 June 16-July 1960, J. J. Jarvis (UCD). **Placer Co.,** Tacoma, exact location unknown, M, 18 August 1964, MRG (UCD). **Plumas Co.,** 8 mi (12.8 km) NW Quincy, M, 21-23 June 1984, P. S. Ward (UCD); Johnsville, F, 20 September 1964, JSB, MRG (UCD) and F, July 1971, H. Pini (UCD); Mt. Ingalls, M, 5F, 11 July 1964, and M, F, 4 September 1967, JSB, MRG (UCD); and Bucks L., M, F, 4 July 1964, and M, 7 September 1964, L. L. Dunning (UCD). **Tulare Co.,** Kings Cyn. Nat. Pk., Redwood Cyn., Redwood Saddle, M, 17 August 1984, V. F. Lee, T. S. Briggs, D. Ubick (CAS); Sequoia Nat. Pk., nr. Crystal Cv., M, 13 July 1961, S. B. Peck (FSCA); Mineral King, M, 2F, date unknown, P. S. Bartholomew (CAS); and Quaking Aspen Cpgd., Sequoia Nat. For., M, 9 September 1959, W. J. Gertsch, V. Roth (AMNH). **Tuolumne Co.,** Pinecrest, M, 14 June 1965, JSB (UCD).

Californiulus euphanus (Chamberlin)

The only new record of *C. euphanus* extends its range in western Washington eastward into the western periphery of the Columbia Plateau (Fig. 16). Sample data are as follows:

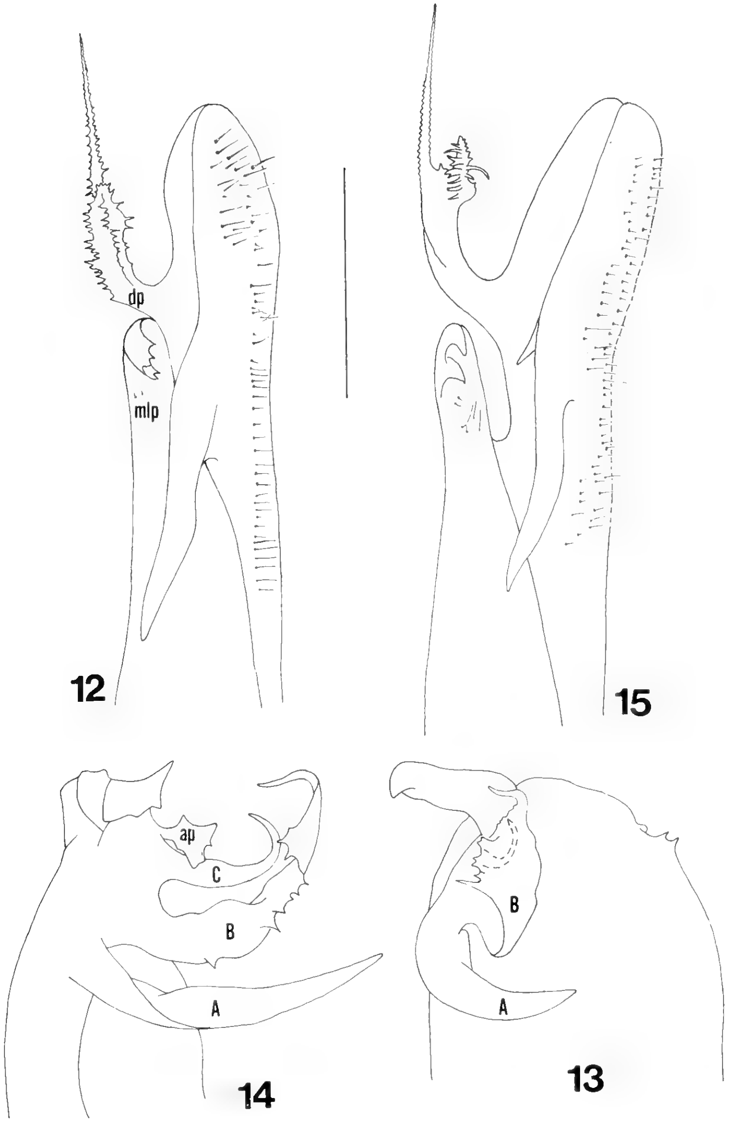
WASHINGTON: **Yakima Co.,** 10 mi (16 km) N Yakima, juv. M, 8 May 1948, E. S. Ross (CAS).

Californiulus blechrostriatus, NEW SPECIES

Figs. 12-15

Type specimens. Male holotype (CAS) collected by B. Banta, 5 April 1959, at an unknown site in Saline Valley, Death Valley National Park, Inyo County, California; one male and two female paratypes (CAS) taken by the same collector, 2 April 1960, along Grapevine Canyon Rd., Saline Valley.

Diagnosis. Color pattern subuniformly dark brown, caudal margins of collum and pleuroterga 2-4 slightly darker but otherwise without trace of transverse banding; pleurotergal striation very faint and shallow, barely noticeable, exoskeleton appearing generally smooth; anterior gonopod ridge curvilinear, tooth moderately long, angling strongly mediad, overhanging groove and nearly overhanging medial margin, distal projection either divided with short, irregular inner branch, or simple and expanded basally, with numerous spiculate projections, margins serrate to jagged, extending to level of distal extremity of gonopod; subterminal projection of posterior gonopod divided into 4 branches, with short, slightly expanded and laminate, accessory process arising ventrad below process 'C'; process 'A' entire, not distally divided, with one termination; process 'B' broad and laminate, moderately expanded mediad, obscuring process 'C' in anterior view, marginally irregular with fine teeth and moderate indentations; process 'C' slightly expanded basally, falcate distad, tip well segregated from that of termination of 'B' (Figs. 12-15).



Figs 12-15. *Californiulus blechrostriatus*, holotype. 12, right anterior gonopod, anterior view. 13, distal extremity of right posterior gonopod, medial view. 14, the same, anterior view. 15, right anterior gonopod of male from Mt. Whitney, anterior view. A, process "A"; ap, accessory process; B, process "B"; C, process "C"; other abbreviations as in figs. 1-8. Scale line = 1.40 mm for figs. 12 and 15, 1.00 mm for figs. 13-14.

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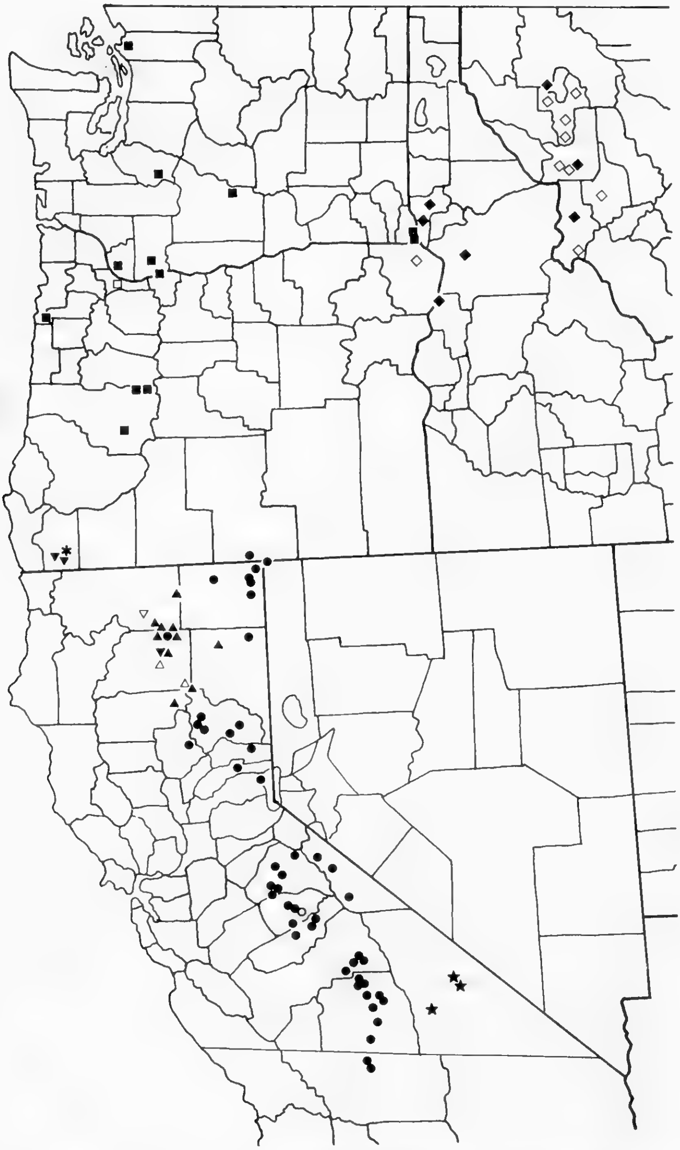

Fig. 16. Distribution of *Californiulus*. Inverted triangles, *C. chamberlini;* upright triangles, *C. dorsovittatus;* dots, *C. yosemitensis;* squares, *C. euphanus;* diamonds, *C. parvior;* stars, *C. blechrostriatus*. Open symbols denote literature records deemed valid, and the dot in Nevada County, California, represents the Sagehen Creek record of *C. yosemitensis*, whose exact location is unknown. The asterisk shows the one locality of *Aprosphylosoma darcenae* Hoffman (Aprosphylosomatidae), the only other species and genus in the superfamily Paeromopodoidea.

Variation. The male paratype agrees closely with the holotype, with only minor differences in the degrees of expansion and marginal spination of process 'B' of the posterior gonopod and of the intricacy of the spiculation of the anterior gonopod distal projection. The specimen from Mt. Whitney agrees with both Saline Valley males except for the anterior gonopod (Fig. 15). The apical process of its midlength projection (mlp) is shorter, narrower, and more obviously uncinate, and the distal projection (dp) is divided into two branches, instead of being expanded basally (Fig. 12), and the inner branch is short, with long, irregular, marginal teeth. Additionally, this male has an accessory spur on the medial surface of the ridge on the right anterior gonopod but not on the left one. Including the epiproct, the holotype has 67 segments, none legless, and measures 83.2 mm in length; a female paratype, the only intact and measurable specimen in this sample has 69 segments, one legless, and measures 74.9 mm in length; and the Mt. Whitney male has 73 segments, one legless, and measures 93.2 mm in length.

Ecology. *Californiulus blechrostriatus* has a marked affinity for arid environments. The only information on the vial labels with the types is the elevation of 4,200 ft. (1,260 m), but this is high desert, in the Basin and Range Physiographic Province, and Saline Valley is the next valley west of Death Valley, the lowest, and the hottest, driest place in North America. The Mt. Whitney male was discovered under a fallen, decaying pine long at 8,000 ft. (2,400 m) on the dry, eastern side of the Sierra Nevada. *Californiulus yosemitensis* can occur in relatively dry biotopes (Shelley 1994), but not to the extreme of those occupied by *C. blechrostriatus,* the easternmost representative of the family in California and the only one occurring in true desert.

Distribution. Known only from Inyo County, California, where it extends eastward from Mt. Whitney to the Saline Valley, a linear distance of approximately 38 mi (60.8 km). In addition to the type specimens, the following sample is known.

CALIFORNIA: **Inyo Co.,** east side of Mt. Whitney, Inyo Nat. For., end of rd. to Whitney Portal, ca. 10.5 mi (16.8 km) WSW Lone Pine, M, 20 May 1970, E. A. Kane (UCD).

Remarks. As they share an undivided process "A" of the posterior gonopod, *C. blechrostriatus* is closely related to *C. yosemitensis*. They differ in the color pattern, as the former shows no trace of the yellow middorsal stripe and medial black line diagnostic of the latter, nor does *C. blechrostriatus* display the transverse banding characteristic of *C. euphanus, C. parvior*, and the species of *Paeromopus*. The accessory, ventral process on the posterior gonopod (Fig. 14, ap) is also unique, but the most striking feature of *C. blechrostriatus* is the extremely faint striation, which contrasts with the condition in every other species and is best seen under oblique light under a stereomicroscope. This trait is the source of the specific name, which derives from the Greek word, "blechros," meaning faint or weak, and "striae," meaning grooves or channels. In the key to species of *Californiulus* (Shelley 1994), *C. blechrostriatus* goes to couplet 4 because it lacks the yellow middorsal stripe, and it is readily distinguished from both *C. euphanus* and *C. parvior* by the faint striae, the accessory process of the posterior gonopod, and the simple, undivided process "A".

ACKNOWLEDGMENTS

We thank the following curators and collection managers for loaning material from the indicated repositories: N. I. Platnick (AMNH); R. W. Baumann (BYU); C. E. Griswold (CAS); G. B. Edwards (FSCA); the late C. L. Hogue (LACMNH); C. B. Barr (UCB); and L. S. Kimsey (UCD). R. G. Kuhler, North Carolina State Museum Scientific Illustrator, assisted in preparation of figures 1-10 and 12-15.

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A NEW SPECIES OF *OXYGONIA* FROM ECUADOR (COLEOPTERA: CICINDELIDAE)[1]

Fabio Cassola[2], Michael G. Kippenhan[3,4]

ABSTRACT: A new species of *Oxygonia, O. onorei,* is described based on two male specimens from Las Pampas and La Otonga, Cotopaxi, Ecuador. Distinguishing characters are depicted.

The genus *Oxygonia* Mannerheim, 1837 (type-species: *O. schoenherri* Mannerheim, 1837), is an interesting Neotropical tiger beetle group which so far includes approximately fifteen species, ranging from Costa Rica and Panama (1 species) to Colombia (3 species), Ecuador (11 species), Peru (5 species) and Bolivia (2 species) (Bates 1881-84, Horn 1926, Wiesner 1992). Most of these species occur in the Andean slopes of Ecuador and this country appears to be the center of the evolution and distribution of the genus *Oxygonia.*

Specimens are uncommon in collections and little is known concerning their ecology and behavior. Buckley collected three species in the River Upano area near Macas in Ecuador over one century ago and found his specimens chiefly on mossy stones in the bed of rapid streams (Bates 1872). Recent observations by Pearson *et al.* (1995) confirm that *Oxygonia* specimens forage on mossy rocks and boulders in the middle of shallow white-water streams. The diurnal species roost at night on leaves of overhanging bushes and trees above the stream surface, while the nocturnal species spend the daytime under rocks and gravel along small to moderate-sized mountain streams and forage on rocks in stream at night.

Most *Oxygonia* species show a remarkable sexual dimorphism in shape and body color, and there is often considerable difficulty identifying both sexes of the various species, especially when associated males and females are not available. However, a systematic review of this genus is presently being made by the second author and there are no described species of which the male is unknown (Kippenhan, in prep.). The purpose of this paper is to describe an interesting new species collected in northwestern Ecuador.

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[1] Received May 14, 1996. Accepted June 8, 1996.

[2] Via F. Tomassucci 12/20, I-00144 Roma, Italy (Studies on Tiger Beetles, LXXXIII).

[3] 15185 Deby Drive, Colorado Springs, Colorado 80921, U.S.A.

[4] Associate, C.P.Gillette Arthropod Biodiversity Museum, Colorado State University, Fort Collins, CO 80523, U.S.A.

ENT. NEWS 108(1) 15-18, January & February, 1997

Oxygonia onorei NEW SPECIES

(Fig. 1 a, b, c)

TYPE MATERIAL. Holotype (male) from Las Pampas, Cotopaxi, Ecuador, May 1988, G.Onore leg., deposited in the collection of the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania. One paratype (male) from La Otonga, 1800m, Cotopaxi, Ecuador, 25 May 1996, A. Paucar leg., in first author's collection.

DIAGNOSIS. The species can be distinguished from all others by its small size (10.5 mm), the testaceous color of the underside and the cleft aedeagal apex.

COLOR. Dorsum metallic brownish bronze, with greenish or blue-violet reflections on head and pronotum. Sides and underside of head and pronotum metallic golden green, with some cupreous reflections; a yellow patch in the middle of pro-and mesosterna. Metasternum, abdominal sterna and elytral epipleura completely testaceous. White elytral markings comprised of a narrow humeral lunule, a short transverse middle band behind front half of elytra and a subapical subtriangular spot. Female unknown.

DESCRIPTION. **Head:** relatively small, metallic dark bronze above with some slight blue-green reflections, golden green below; strong cupreous reflections on genae, clypeus, frons and behind eyes. Surface entirely glabrous, a single sensory seta near middle edge of each eye; vertex very finely striated, some shallow transverse wrinkles on neck. Eyes bulging outward and upward, with a rounded moderate excavation between. Labrum short, transverse, black with an unpigmented subsquare patch on either side of middle; anterior margin excavated in the middle with a fairly substantial central tooth protruding outwards and two small lateral bumps; two pairs of submarginal setae, first one at sides of central tooth, second one inside lateral apical angles of labrum. Mandibles black, rufous on the apical and inner teeth. Labial and maxillary palpi basally testaceous. tinged with metallic brown on last segments. Antennae rather long, reaching nearly the middle of the elytral length; extreme base of scape testaceous, scape and articles 2-4 black with some violaceous reflections, glabrous, antennomeres 5-11 brownish-black, evenly and finely pubescent.

Prothorax: pronotum about as long as wide, rounded at sides, maximum width near the middle, with the front lobe very short in proportion; color metallic dark bronze with violaceous reflections, some golden green or cupreous reflections in front and hind transverse grooves. Surface completely glabrous, very finely transversely striate, the striae shallow, almost effaced on disk; midline fine but distinct, slightly excavated behind. Pro- and mesosternal pieces golden green, glabrous, with some cupreous reflections; a yellow patch in middle of pro- and mesosternum. Metasternum and metepisterna completely testaceous, glabrous, with scattered patches of pearly lustre.

Elytra: purple-brownish shining bronze throughout, completely covered with shallow, evenly-spaced, small round punctures with metallic green or cupreous reflections; some larger foveae near base and front part of suture. Surface uneven, with a strong depression near suture on front third of disk, a second depression on inside part of middle spot, and a third one near apex. Elytral maculation white, consisting of a narrow humeral lunule (only posterior end visible from above), a subrectangular, transverse, middle band behind front half of elytra (extended from near side margins to middle of disk) and a subtriangular hind spot near the subapical margin of elytra (not reaching sutural angle) (Fig. 1a). Elytral apex ended in a strong protruding sutural spine; microserrations present. Epipleura yellow-testaceous.

Abdomen: sterna completely testaceous, glabrous with scattered translucid patches; a single pair of sensory setae near hind edge of 3rd, 4th and 5th visible sterna.

Legs (only pro legs and femur of right meso leg remain in the male holotype): coxae and trochanters yellow, the former with some white pilosity on sides; femora testaceous below. more or less tinged with metallic green above, with a dark black ring at "knees". Tibiae and tarsi of forelegs shining black.

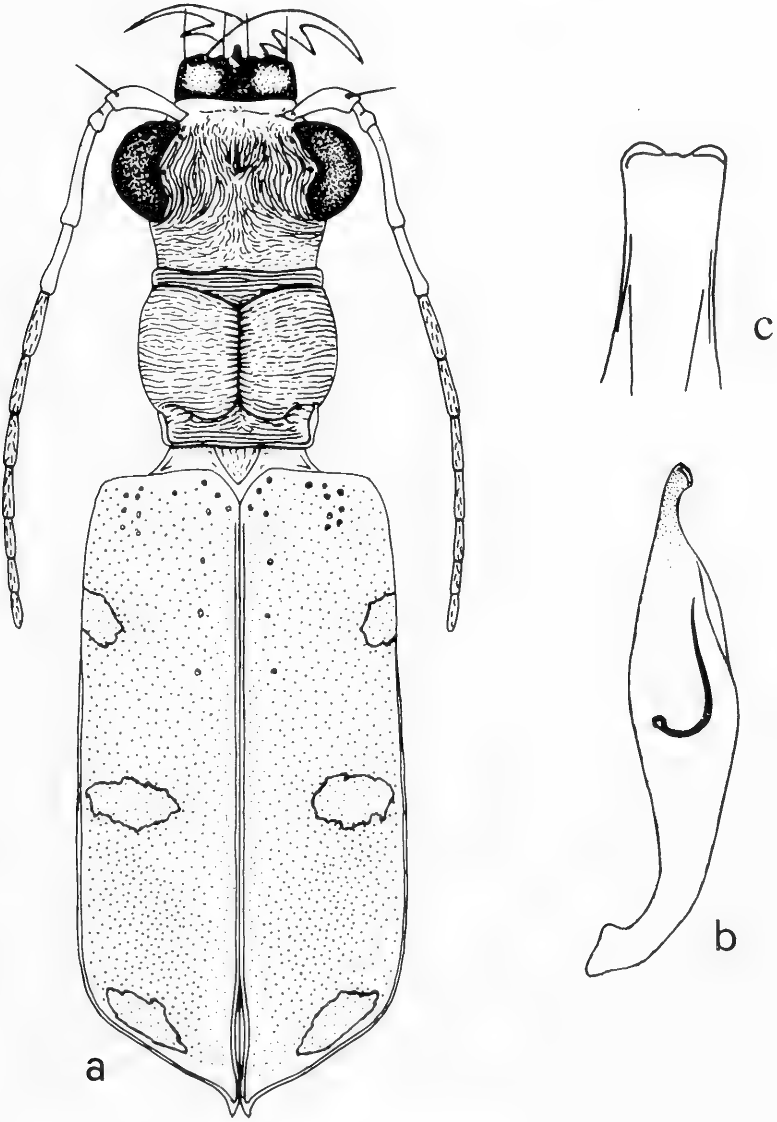

Fig. 1. *Oxygonia onorei* n.sp., male holotype from Las Pampas. Cotopaxi, Ecuador: a. habitus; b. aedeagus (right side); c. apex of aedeagus (dorsal view) .

Genitalia: Male aedeagus rather small, tapering, evenly enlarged in the middle, with a short spatulate apical knob, slightly curved upwards (bi-lobate in dorsal and ventral views) (Fig. 1 b,c).

Length: 10.5 mm (without labrum).

ETYMOLOGY. The species is named after Professor Giovanni Onore, Director of QCAZ (Instituto de Zoologia, Pontificia Universidad Católica, Quito, Ecuador), who collected the single male holotype and kindly submitted it for identification.

DISTRIBUTION. Western Andean slopes of northern Ecuador.

REMARKS. Only two male specimens of *O. onorei* n.sp. are available thus far. However, these specimens are distinctive enough to be described as a new species. The shape of the aedeagus and flagellum is similar to the group of *O. vuillefroyi* Chaudoir (Kippenhan, in prep.), but the cleft apex is unique within the genus. The color of the underside and other features (such as the apically knobbed aedeagus with small "J" shaped flagellum) suggest that this species is most closely related to *O. nigricans* W. Horn and *O. oberthueri* W. Horn (Kippenhan, in prep.) and can be placed between.

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AN UNUSUAL NEW *PACHYCHERNES* FROM PANAMA AND MEXICO (PSEUDOSCORPIONIDA: CHERNETIDAE)[1]

William B. Muchmore[2]

ABSTRACT: A new species, *Pachychernes zehorum,* is described on the basis of material collected in Panama and Mexico (Chiapas). It is unusual in the structure of the first leg of the male, which has modified setae on the tibia and also a unique depression on the dorsum of the tarsus.

The genus *Pachychernes* was established by Beier (1932), based upon *Chelifer* (? *Atemnus) subrobustus* Balzan, from Venezuela. Since then, 7 more species have been assigned to the genus, distributed from Argentina to Florida (Harvey 1991: 611-612; unpublished observations). However, detailed knowledge of the type species is scanty, and the definition of the genus is unsatisfactory; there is good reason to believe that some of the species are improperly assigned. Nevertheless, 3 species are fairly well known and seem to form a coherent group in which males have highly modified setae on the first legs and females have distinctive spermathecae; these are *P. baileyi* Feio (1945), from Brazil (Bahia and Amazonas), *P. shelfordi* Hoff (1946), from Mexico (no further data), and *P. attenuatus* Muchmore (1990), from Mexico (Yucatan and Quintana Roo). A new species, related to these three, has been found in both Panama and Mexico (Chiapas).

Genus *Pachychernes* Beier

Pachychernes Beier, 1932: 114; Beier 1933: 516; Harvey 1991: 611. Type species: *Chelifer* (? *Atemnus) subrobustus* Balzan, 1892. Type locality: Caracas, Venezuela.

Pachychernes zehorum, NEW SPECIES

(Figs. 1-4)

Description: Male and female generally similar, except for the genitalia and the conspicuously modified tibia and tarsus of leg I of the male. Palps dark reddish brown, carapace and other parts lighter brown or tan. Carapace a little longer than broad; surface heavily granulate, with 2 shallow transverse furrows; 2 large eyespots; 60-65 short, finely denticulate setae, usually 4 at anterior and 6 at posterior margin. Coxal area unremarkable. Abdominal tergites 1-10 and sternites 4-10 divided; surfaces of anterior tergites granulate, posterior ones scaly; sternites smooth; pleural membranes granulostriate anteriorly, smoothly striate

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[1] Received June 24, 1996. Accepted August 1, 1996.

[2] Department of Biology, University of Rochester, Rochester, New York 14627.

posteriorly; setae finely denticulate or acuminate. Tergal chaetotaxy of holotype 8:9:10:10: 12:13:13:13:14:12:T3T2T3T:2, others generally similar. Sternal chaetotaxy of holotype ~50:[4-4]:(3)8(3):(1)10(1):20:19:20:22:21:20:T3T7T4T:2, other males similar; sternites 2-4 of allotype with 24:(3)10(3):(1)9(1) setae. Internal genitalia of male typically chernetid in structure, but very large and heavily sclerotized, much like those of *P. baileyi* (see Feio 1945: fig.19). Spermathecae of female (Fig. 1) apparently like those of *P. bailevi*, *P. shelfordi*, and *P. attenuatus* (see Mahnert 1979: fig. 118; Muchmore 1975: fig. 9, 1990: fig. 6), but in the specimens examined here the entire course of the thin tubules could not be seen.

Chelicera 0.33 as long as carapace; hand with 5 setae, *bs* and *sbs* long, denticulate, others long, acuminate; flagellum of 3 setae; galea of male slender, with 5-6 small rami, that of female heavier and with larger rami, 2 at middle and 4 more terminal.

Palp (Fig. 2) rather slender, patella slightly longer than femur. L/B of trochanter 1.65-1.8, femur 2.6-2.9, patella 2.35-2.7, and chela(without pedicel) 2.75-3.1; L/D of hand(without pedicel) 1.7-1.9; movable finger L / hand L 0.8-0.9. Surfaces moderately to lightly granulate, except chelal fingers smooth; most setae slender, finely denticulate. Trichobothria as shown in Fig. 3. Fixed finger with 55-60 and movable finger with 50-55 cusped teeth. Venom apparatus well developed in movable finger, nodus ramosus at, or just proximad of, level of trichobothrium *t*.

Legs rather slender: leg IV with L/D of femur+patella 2.7-3.1, tibia 3.8-4.4, and tarsus 3.8-4.4. Leg I sexually dimorphic: that of female typically chernetid in structure; that of male with tibia somewhat enlarged and unusually setaceous, and tarsus having an extensive, bare depression in the proximal half of the dorsum (Fig. 4). Tarsus of leg IV with a very long tactile seta 0.3 length of segment from proximal end.

Ttritonymph (from Chiapas). Generally similar to adults, but without sexual modifications. Carapace with 2 eyes, 2 faint transverse furrows, and about 50 finely denticulate or acuminate setae. Tergal chaetotaxy 8:8:8:10:11:12:12:12:-. Chelicera with 5 setae on hand and 3 setae in flagellum. Palp with L/B of femur 2.5, patella 2.25, and chela (without pedicel) 2.9; L/D of hand (without pedicel) 1.65; movable finger L / hand L 0.85. Legs as in adults; tarsus with very long tactile seta 0.3 length of segment from proximal end.

Measurements (mm): Male. Figures given first for holotype, followed in parentheses by ranges for 4 paratypes. Body L 3.84 (3.19-3.66). Carapace L 1.25 (1.12-1.23). Chelicera L 0.43 (0.39-0.42). Palp: trochanter 0.67 (0.63-0.69) / 0.385 (0.36-0.385); femur 1.16 (1.04-1.10) / 0.405 (0.36-0.39); patella 1.24 (1.11-1.23) / 0.47 (0.415-0.46); chela (without pedicel) 1.85 (1.76-1.83) / 0.635 (0.56-0.605); hand (without pedicel) 1.07 (0.975-1.07) / 0.62 (0.54-0.60); pedicel L 0.13 (0.13); movable finger L 0.89 (0.865-0.91). Leg I: femur+patella L 0.815 (0.76-0.85); femur 0.39 (0.38-0.435) / 0.26 (0.235-0.265); patella 0.635 (0.585-0.66) / 0.22 (0.21-0.23); tibia 0.59 (0.55-0.62) / 0.18 (0.17-0.18); tarsus 0.615 (0.58-0.64) / 0.13 (0.12-0.125). Leg IV: femur+patella 1.04 (0.96-1.10) / 0.36 (0.36-0.39); tibia 0.88 (0.815-0.88) / 0.20 (0.20-0.21); tarsus 0.59 (0.57-0.605) / 0.14 (0.13-0.14).

Female. Figures given first for allotype, followed in parentheses by ranges for 3 paratypes. Body L 4.11 (3.85-4.87). Carapace L 1.15 (1.21-1.36). Chelicera L 0.39 (0.415-0.43). Palp: trochanter 0.585 (0.64-0.69) / 0.325 (0.355-0.41); femur 0.985 (1.04-1.12) / 0.35 (0.385-0.43); patella 1.03 (1.10-1.19) / 0.39 (0.445-0.51); chela (without pedicel) 1.70 (1.84-1.91) / 0.55 (0.63-0.69); hand (without pedicel) 0.985 (1.06-1.13) / 0.52 (0.615-0.65); pedicel L 0.11 (0.12-0.14); movable finger L 0.815 (0.85-0.89). Leg I: femur+patella L 0.695 (0.75-0.83); femur 0.35 (0.38-0.415) / 0.215 (0.235-0.265); patella 0.54 (0.585-0.62) / 0.19 (0.21-0.235); tibia 0.52 (0.55-0.585) / 0.13 (0.14-0.16); tarsus 0.465 (0.49-0.525) / 0.105 (0.105-0.12). Leg IV: femur+patella 0.96 (1.05-1.16) / 0.31 (0.36-0.415); tibia 0.79 (0.85-0.925) / 0.185 (0.20-0.23); tarsus 0.54 (0.555-0.615) / 0.13 (0.14-0.16).

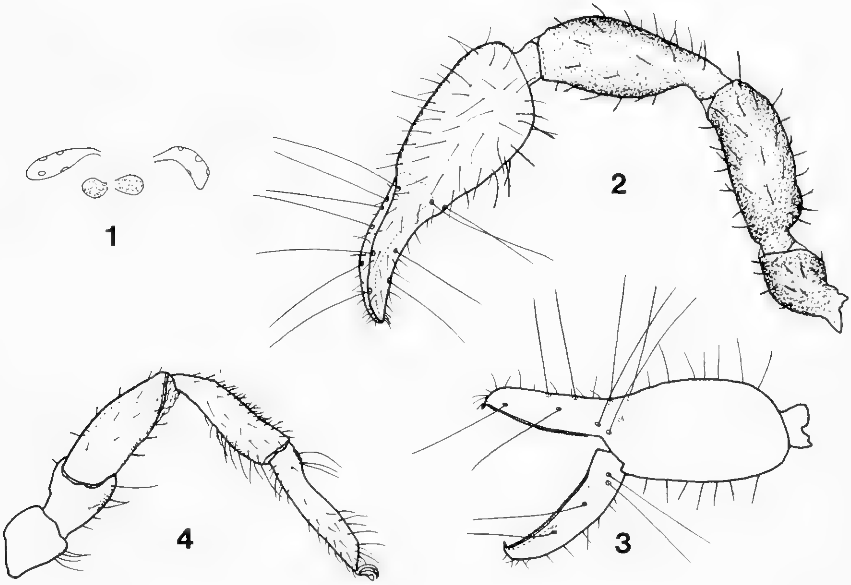
Tritonymph. Body L 3.23. Carapace L 0.93. Chelicera L 0.32. Palp: femur 0.73/0.29; patella 0.74 / 0.325; chela(without pedicel) 1.31 / 0.45; hand(without pedicel) 0.74 / 0.445;

movable finger L 0.63. Leg IV: femur+patella 0.75/0.275; tibia 0.615/0.155; tarsus 0.45/0.11.

Type data: Holotype male (WM7097.01001), allotype female (WM7098.01001), and 8 paratypes (3 males, 4 females, 1 tritonymph) from under bark of live trees along Pipeline Road, Parque Nacional Soberania, PANAMA, 16 January 1988, J. A. Zeh; all but 1 male, 1 female and tritonymph mounted on slides. Three paratypes (2 males, 1 tritonymph) from under bark of trees along trail to ruins, Palenque, Chiapas, MEXICO, 24 January 1976 & 22 January 1985, C. R. Hignutt; mounted on slides. All types deposited in the Florida State Collection of Arthropods, Gainesville, Florida.

Etymology: The species is named in honor of Jeanne A. Zeh and David W. Zeh, who collected and sent me the type specimens from Panama.

Diagnosis: Easily distinguished from all other members of the genus by the first leg of the male, which has both long and short modified setae on the tibia and a unique, distinct depression on the dorsal side of the tarsus.



Figs. 1-4. *Pachychernes zehorum,* new species. 1. Spermathecae of female. 2. Right palp, dorsal view. 3. Left chela, lateral view. 4. Leg I of male.

DISCUSSION

The striking modifications of leg I of the male of *Pachychernes zehorum* are undoubtedly related to courtship and mating. Though no direct evidence exists to support this contention, it seems reasonable, inasmuch as many pseudoscorpions of the family Chernetidae have complex sexual behaviors, during which the male grasps and manipulates the female (see Weygoldt 1969).

Although it is common in pseudoscorpions of the family Cheliferidae, sexual modification of the first legs of males is rare in the Chernetidae. Modified first legs have been found in only 9 species other than *P. zehorum* among the 600+ described species in the Chernetidae — *Pachychernes baileyi* Feio (1945) from Brazil, *P. shelfordi* Hoff (1946) from Mexico, *P. attenuatus* Muchmore (1990) from Mexico, *Bituberochernes mumae* Muchmore (1974) from Florida and Cuba, *B. jonensis* Muchmore (1979) from the Virgin Islands, *Orochernes nepalensis* Beier (1968) from Nepal, *O. sibiricus* Schawaller (1986) from Siberia, and 2 new species of a new genus from California and Arizona (Muchmore, in prep.). The relationships among these species will be interesting to investigate (in progress).

As mentioned above, the spermathecae in the female of *Pachychernes zehorum* are similar to those of some other species in the genus, namely, *P. baileyi, P. shelfordi,* and *P. attenuatus;* no information is available concerning the spermathecae of other species assigned to *Pachychernes* (see Harvey 1991: 611-612). Also, these spermathecae are similar to those of the two known species of *Bituberochernes* Muchmore, namely, *B. mumae* (see Dumitresco & Orghidan 1977: fig. 12B) and *B. jonensis* (Muchmore 1979: fig. 4). It should be noted that the spermathecae of *Chelanops (Neochelanops) peruanus* Mahnert (1984: figs. 28-29) appear like the foregoing, even though the species is not otherwise similar to *Pachychernes* or *Bituberochernes*.

It seems probable, from the similarity of the first pedal tarsi of males and the spermathecae of females, among other characters, that the genera *Pachychernes* and *Bituberochernes* are closely related; a more detailed examination of this situation is in progress.

The occurrence of this species in Panama and Mexico strongly suggests that it is widely distributed through Central America.

All of the specimens of *P. zehorum* were collected from under loose bark of standing trees. Concerning those from Panama, D. W. Zeh comments (in litt.), "We did see clear evidence that this species feeds on ants. Several of the individuals we sent you were collected from under bark in close association with ant corpses." The identity of the ants upon which these pseudoscorpions presumably feed has not yet been ascertained, but they are not the same ants preyed upon by *Paratemnus elongatus* (Banks) (Zeh & Zeh 1990) [Note: the genus of this species is now *Paratemnoides* Harvey 1991: 469].

ACKNOWLEDGMENTS

I am grateful to Charlotte R. Hignutt and David W. Zeh for sending me the specimens upon which this study is based. Also, I am much indebted to Ms. Hignutt for the excellent drawings presented herein, and to Uzi Nur, David W. Zeh, Jeanne A. Zeh, and two anonymous reviewers for constructive comments on the manuscript.

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A NEW SPECIES OF *JANUS* (HYMENOPTERA: CEPHIDAE) FROM INDONESIA[1]

David R. Smith[2]

ABSTRACT: *Janus ecarinatus*, n. sp., is described from western Kalimantan, Indonesia. This is the first record of the family Cephidae for Indonesia, the most southern record in Asia, .and one of the few known from the Southern Hemisphere. The absence of a genal carina and the long cercus are two of the significant characters that separate it from other known species of *Janus.*

The Cephidae, stem or twig borers as larvae, are primarily a northern temperate, holarctic group of about 100 species in 15 genera. Representatives are very rare in tropical regions. The southernmost record in the Western Hemisphere is for *Hartigia mexicana* (Guérin) from the State of Chiapas, Mexico [ca. 17°N] (Smith, 1988). One genus, *Achetocephus* Benson, with two species, is known from Madagascar [ca. 20°S] (Benson, 1946). In Asia, a species of *Janus* Stephens and one of *Urosyrista* Maa have been recorded from as far south as Burma [ca. 22°N] (Benson, 1946).

The species described below as *Janus ecarinatus* from western Kalimantan, Indonesia, now represents the most southern record of Cephidae in Asia, the second genus and third species from the Southern Hemisphere, and the first record of the family from Indonesia.

About ten species of *Janus* are known from Eurasia and North America. Larvae are twig borers, and recorded hosts are species of *Malus, Populus, Pyrus, Ribes, Quercus, Salix,* and *Viburnum.* Adults are distinguished from other cephid genera by the tarsal claw with the inner tooth longer and stouter than outer tooth and with an acute basal lobe; antenna not thickened apically but gradually thickened after the second flagellar segment and the third antennal segment longer than the fourth; left mandible lacking a central tooth, outer tooth simple and inner tooth simple with a basal shoulder on lower inner surface; apical maxillary palpal segment originating near the base of the penultimate segment; forewing with vein 2A adjacent to the posterior margin of the wing and vannal fold, not separated from them by more than twice the width of the vein; and one or two preapical spines on the hindtibia.

Several characters typical for *Janus,* however, are different in *J. ecarinatus.* All previously known species of *Janus* have a genal carina, cercus one third or less the length of the sawsheath, the hindbasitarsus shorter than the following tarsal segments combined, and serrulae of the lancet truncate at their apices. In *J. ecarinatus,* the genal carina is absent, the cercus is nearly as long as the

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[1] Received March 8, 1996, Accepted April 3, 1996.

[2] Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, MRC-168, Washington, D.C. 20560.

ENT. NEWS 108(1) 24-28, January & February, 1997

sheath (Figs. 2, 4), the hindbasitarsus is longer than the following tarsal segments combined, and the serrulae of the lancet are pointed at their apices (Fig. 5). I regard these differences as more significant for species separation than for generic distinction, and I believe *J. ecarinatus* belongs in the same lineage as other *Janus* species because it shares many derived character states with them. The absence of a genal carina also occurs elsewhere in Cephidae: in *Achetocephus* and in one species of *Pachycephus* Stein (Benson, 1946), a genus of about five species found in the Mediterranean area and Eurasian steppes.

Janus ecarinatus Smith, NEW SPECIES

(Figs. 1-5)

Female.– Length, 13 mm. Antenna with scape and pedicel yellow, flagellum black. Head yellow with dorsum between eyes black and with black extension through ocellar area anteriorly to antennae; broad black band on occiput surrounding occipital foremen; narrow anterior margin of clypeus, apex of mandible, and apical maxillary palpal segment black. Thorax yellow with anterior half of pronotum, anterior margin of mesopleuron, line separating mesopleuron and mesepimeron, spot on lower angle of mesepimeron, and anterior half of mesonotum (prescutum, anterior halves of lateral lobes, and anterior corner of scutellum) black. Abdomen yellow with brown bands on apical half to two thirds of terga 2-7, narrower on 8; cercus and sheath black. Legs yellow with hindfemur (more yellow at base), extreme apex of hindtibia lightly, and apical two tarsal segments black. Wings slightly uniformly yellowish; veins and stigma light brown.

Antenna 23- to 24-segmented, with scape slightly longer than pedicel and third segment about 1.6X longer than fourth segment. Anterior clypeal margin rounded. Distance between antennae subequal to distance from antenna to tentorial pit, 0.5X distance from antenna to anterior margin of clypeus, and 1.6X distance between antenna and inner margin of eye. Malar space less than diameter of anterior ocellus; genal carina absent; apical maxillary palpal segment originating from base of penultimate segment; distance between posterior ocelli and posterior margin of head 2.3X distance between anterior ocellus and antennae and 3.3X distance between posterior ocellus and eye; fine shallow punctures on head with shiny interspaces. Thorax shining with very fine scattered punctures, mesonotum more punctate with fine surface sculpture; abdomen shining without surface sculpture or punctures. Hindbasitarus 1.4X longer than length of remaining tarsal segments combined; midtibia with one preapical spine; hindtibia with 2 preapical spines; foretibia with one long, simple apical spine, 0.4 X length of forebasitarsus. Vein lr of forewing reaches stigma. Cercus nearly reaching to apex of sawsheath; sawsheath about 0.6X length of basal plate. Serrulae of lancet pointed at apices, each with several small anterior subbasal teeth.

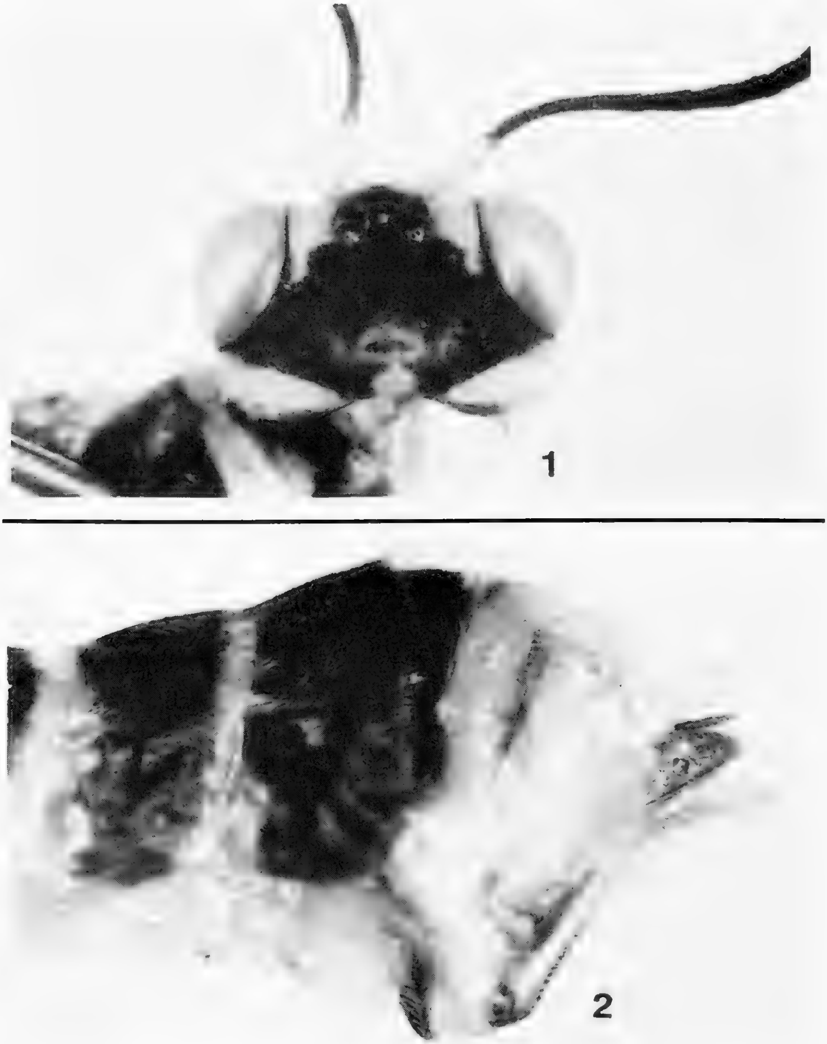
Male.– Unknown.

Holotype.– Female, labeled "Indonesia: W. Kalimantan, Gunung Palung Nat. Pk., June 15 - August 15, 1991, Darling, Rosichon, Sutrisno, 11S 910116," "Cabang Panti Res. Sta. 1°15'S, 110° 5'E, 1° rainforest, Malaise trap head, Sandstone - light gap." Deposited in the Museum Zoologu Bogor, Bogor, Indonesia.

Etymology. The species name is from Latin, referring to the lack of a genal carina.

Discussion.– This species differs from all other species of *Janus* by the absence of a genal carina, long hindbasitarsus, long cercus, and pointed serrulae of the lancet, as discussed above. The predominantly yellow coloration with black primarily on top of the head, anterior half of the mesonotum, and bands on the abdomen are also distinctive.

Benson (1946) described a species of *Janus* from Burma, Maa (1949, 1950) described two species and gave keys to the species of China, and Muche (1981) gave a key to the world species. The differences cited above, however, preclude *J. ecarinatus* as a previously described species.



Figs. 1-2. *Janus ecarinatus*. 1, Head, dorsal view. 2, Apical 6 or 7 abdominal segments, sheath, and ovipositor, lateral view.

Fig. 3-5. *Janus ecarinatus*. 3, Lateroventral view. 4, Cercus and sheath, lateral view. 5, Central serrulae of lancet.

ACKNOWLEDGMENTS

I thank D. Christopher Darling, Royal Ontario Museum, Toronto, Ontario, for bringing this specimen to my attention. Thanks also to the following for review of this manuscript: H. Goulet, Agriculture Canada, Ottawa; N.M. Schiff, Bee Research Laboratory, USDA, Beltsville, Maryland; and F.C. Thompson and R.W. Hodges, Systematic Entomology Laboratory, USDA, Washington, D.C.

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NOTES ON MATING BEHAVIOR OF *RHIPIPHORUS LUTEIPENNIS* (COLEOPTERA: RHIPIPHORIDAE)[1]

A. G. Wheeler, Jr. [2]

ABSTRACT: The generally ephemeral adults of rhipiphorid beetles (subfamily Rhipiphorinae) offer few chances to observe their courtship and mating behavior. A large population of *Rhipiphorus luteipennis* in a sand plain in Oneida County, New York, during mid-August 1992 provided an opportunity to observe several aspects of its sexual behavior, including precopulatory swarming by males.

The Rhipiphoridae, often called wedge-shaped beetles, are interesting biologically: larvae are hypermetamorphic and exhibit both an endoparasitic (endophagous) and an ectoparasitic (ectophagous) phase. Hosts have been reported only for about 15% of an estimated 300 species worldwide (Clausen 1940, Linsley *et al.* 1952, Selander 1991). Known rhipiphorid hosts are bees and wasps (Rhipiphorinae), cockroaches (Rhipidiinae), and wood-boring beetles (Hemirhipidiinae and Pelecotominae) (Svacha 1994).

Adults are infrequently seen, especially males, although most of the approximately 44-54 North American species (Arnett 1985, Z. H. Falin pers. comm.) are not actually rare. Many rhipiphorid beetles are poorly represented in collections chiefly because of their short lifespan. Males of rhipiphorines typically live no longer than a day; females may be similarly short-lived but tend to emerge over a longer period than do males (Clausen 1940, Linsley and MacSwain 1951, Linsley *et al.* 1952).

Rhipiphorus, the largest rhipiphorid genus in North America, contains about 36, mostly western, species. Of the nine or ten species whose hosts are known (Linsley *et al.* 1952, Hurd 1979), all parasitize the immature stages of anthophorid or halictid bees. Habits of *Rhipiphorus* adults are little known except for their attraction to plants visited by host bees. Females often oviposit on flower buds, where the phoretic triungulin first instar eventually attaches to a flower-visiting adult bee and is carried to its provisioned nesting cell. After feeding internally, the rhipiphorid larva exits the host larva and begins to feed externally. The host larva remains alive until feeding by the parasitoid is nearly completed. After a pupation period of about two weeks, the free-living, ephemeral adults emerge from nesting sites of their hosts (Clausen 1940, Linsley *et al.* 1952).

Opportunities to observe sexual activity in rhipiphorines are undoubtedly rare. Courting and mating pairs of *R. dammersi* Barber have been observed in

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[1] Received April 12, 1996, Accepted May 31, 1996.

[2] Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, PA 17110. Present address: Department of Entomology, Clemson University, Clemson, SC 29634.

California (Barber 1939), but premating and mating behavior of North American species have been described only for *R. smithi* Linsley & MacSwain in California (Linsley *et al.* 1952). Here, I give notes on mating behavior of *R. luteipennis* (LeConte), including precopulatory male swarms observed in New York.

Described from New York by LeConte (1865), *R. luteipennis* is also known from Maine, New Jersey, and Alabama in the eastern United States (Rivnay 1929) and ranges west to Idaho, Montana, California, and New Mexico (Hatch 1965, Linsley and MacSwain 1950, Arnett 1983). Despite its wide distribution, *R. luteipennis* is uncommon in collections, and its hosts and other biological information remain unknown (Linsley *et al.* 1952, Staines 1983).

STUDY SITES AND METHODS

Observations were made in the sand plains east of Holland Patent (Oneida Co.), N.Y. The study site is a hanging delta of glacial origin; the loose, sandy soil is characterized as Merrimac fine sand (Maxon *et al.* 1915). Scattered colonies of a panic grass, *Panicum lanuginosum* var. *lindheimeri* (Nash) Fern., and poverty oatgrass, *Danthonia spicata* (L.) F. Beauv., occur in large open patches of sand. Red pine, *Pinus resinosa* Ait., and Scotch pine, *P. sylvestris* L., have been planted within the sand plain. Small trees growing at the edge of the mainly open sandy area (c. 0.5 hectare) include American beech, *Fagus grandifolia* Ehrh.; gray birch, *Betula populifolia* Marsh.; and red maple, *Acer rubrum* L.

Observations were made on 15 August 1992 between 1515 and 1645 hours. During this period it was about 22°C and partly cloudy, with a light breeze. The rhipiphorid population was encountered by chance during fieldwork on other insects; only a notebook was available for recording behavioral observations. Voucher specimens (28) of *R. luteipennis* are deposited in the Cornell University Insect Collection, Ithaca, N.Y.

OBSERVATIONS

Accustomed only to encountering single or a few *Rhipiphorus* or *Macrosiagon* adults on flower buds and flowers of various composites and other plants, I was struck by the number of *R. luteipennis* adults – probably several hundred – in the Oneida Co. sand plain. Adults were common on low vegetation (0.5-1.0 m), including a panic grass plant with 21 individuals on stems and inflorescences: 9 unpaired adults (sex not determined) and 6 pairs with male atop female. Whether the paired individuals were actually *in copula* or were exhibiting some postinsemination association (Alcock 1994) is unknown. Other adults, mostly females, were observed on stems of poverty grass or on foliage of American beech saplings or a low *Rubus* sp. (c. 1m high). Occasionally only a single male or female was found on a plant. Adults were never observed on larger plants at the periphery of the open sand. Two dead adults were on panic grass stems, and several others were in spider webs near ground level.

Other adults were in flight. Two males hovered over a sapling red maple (c.0.5 m high), whereas groups of 5-10 males swarmed a few centimeters above bare sand. Swarms consisted of males and a female that apparently entered or became part of the swarm. A swarming male hit the sand, struggled to right itself, and took 10-15 seconds before resuming flight. Males could be caught by hand, but, when disturbed, they were capable of darting away like a bee or syrphid fly.

I observed four or five unsuccessful attempts at copulation. One pair flew from a swarm to a grass stem where the male mounted the female; they dropped to the sand and grappled for several seconds before separating. Other unsuccessful pairings were observed, the males and females falling to the sand, grappling 5-10 seconds and separating without flying to vegetation. I watched another pair crawl over the sand with male atop female, ascend a grass stem, and separate without mating. Several of the brief struggles on the sand appeared to involve males.

One apparently successful mating included nearly four minutes of grappling on the sand, followed by copulation that lasted about 1.5 minutes before the pair abruptly separated. Another grappling pair was observed *in copula* on the sand, but in both cases, behavior that preceded copulation was not observed. Twice I observed a male on top of a mating pair.

I returned to the sand plain on 22 August, but there was no sign of the species. Not even a dead individual could be found in litter at the base of panic grass colonies or under other plants.

DISCUSSION

The foregoing observations on *R. luteipennis,* although fragmentary, invite comparison with those on *R. smithi,* the only North American rhipiphorid whose sexual behavior has been detailed. Linsley *et al.* (1952) reported intense activity in males of *R. smithi*: swarming 0.3-0.6 meters above the ground in search of females emerging from nests of their bee hosts. Mating typically occurred upon females' emergence. Two or more males usually attended a female, the other males flying away when copulation was effected. Males moved upwind toward females, and a caged female attracted numerous males within 15 minutes. These observations, coupled with that of the female's raising her abdomen intermittently, suggest the presence of a female sex pheromone. The male's feathery, fan-shaped (biflabellate) antennae tend to support this hypothesis (Linsley *et al.* 1952, White 1983).

My observations on *R. luteipennis*, though less extensive than those of Linsley *et al.* (1952) on *R. smithi*, are somewhat similar. Males of both species swarm near the ground and occasionally attempt to copulate with one another. I did not observe males moving upwind toward an emerged female, but this may merely have reflected my inability to identify emergence of female *R. luteipennis* from nests of a presumed hymenopteran host.

Not only is the host of *R. luteipennis* undiscovered and its seasonal history unknown, but numerous other biological data are also lacking, especially details of the reproductive behavior. Assuming a female sex pheromone is present, does it operate at relatively long range, or does it serve as a contact pheromone within male swarms? Is copulation necessarily preceded by swarming, or can a female, calling from a plant, attract a male and mate? Do males and females mate only once or multiple times? Does mate guarding occur in this species?

Given the ephemeral adult life of rhipiphorines, information on their reproductive behavior most likely will continue to accumulate slowly. It is hoped that the adaptive significance of various components of their mating behavior can eventually be elucidated and that enough comparative data will become available to allow reproductive behavior in *Rhipiphorus*, and in this poorly known family, to be placed in a phylogenetic context.

ACKNOWLEDGMENTS

I am grateful to E. R. Hoebeke (Cornell University, Ithaca, N.Y.) for identifying *R. luteipennis*, Z. H. Falin (University of Kansas, Lawrence) for confirming the identification and providing helpful comments on the manuscript, P. H. Adler (Clemson University, Clemson, S.C.) for his valuable review of the manuscript, C. L. Staines (Maryland Department of Agriculture, Annapolis) for sending copies of several relevant papers, and R. Dirig (Cornell) for information on the study site.

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AQUATIC COLEOPTERA AND HEMIPTERA OF ORGAN PIPE CACTUS NATIONAL MONUMENT, ARIZONA[1]

Eric Larsen[2], Carl Olson[3]

ABSTRACT Aquatic Coleoptera and Hemiptera were collected in Organ Pipe Cactus National Monument (ORPI), Arizona, from March, 1980 through 1995. The Monument, a Man in the Biosphere Preserve, is located in the Sonoran Desert on the border with Sonora, Mexico. Most aquatic habitats in ORPI are tinajas, scoured out basins in the bedrock of ephemeral streams in the Ajo and Bates Mountains. Quitobaquito Springs, its associated pond, several concrete stock troughs, and Armenta Tank are the aquatic habitats of the valley floor Prior to 1980 there had been no systematic collection of aquatic insects. The collection consisted of five species; three beetles and two bugs By 1983 the recorded fauna consisted of 61 species of aquatic Coleoptera and Hemiptera To date, 42 species of aquatic Coleoptera from 5 families, and 21 species of aquatic Hemiptera from 8 families have been collected

Aquatic insect communities are not as well known as their terrestrial counterparts and aquatic environments in desert regions are even less well known than those in more temperate regions. Even so, the invertebrate faunas of streams have a rich history of study, due in part to an early interest by anglers in the invertebrate prey of fish. In recent years the fauna of ephemeral pools have received some attention in community studies (e.g., Larson 1985, Nilsson 1984, 1986, Ranta 1982, 1985), and as model systems in the study of competition (e.g., Juliano and Lawton 1991, Larson 1985, Pajunen 1977,1979a, 1979b, 1982, Vepsalainen 1978).

This report on the aquatic Coleoptera and Hemiptera of Organ Pipe Cactus National Monument (ORPI) in southwestern Arizona contains information on species collected within the Monument over the past 15 years. The Monument, a Man in the Biosphere Preserve, is well within the boundaries of the Sonoran Desert (Fig. 1) and receives about 6" of rainfall per year during a winter and summer "rainy" season. The winter rains are generated by storms from the Pacific Ocean that have enough energy to continue past the Sierras of California to deposit small amounts of moisture in the Sonoran Desert. This precipitation tends to come from broad based weather patterns and results in gentle rain fall. Conversely, moisture for the summer rains (monsoons) comes from the Gulf of Mexico. This rain is produced by local, intense, short lived convection storms, usually within individual valley systems. These storms may deposit

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[1] Received November 21, 1995, Accepted January 7, 1996

[2] Biology Department, Villanova University, Villanova, PA 19085-1699

[3] Department of Entomology, University of Arizona, Tucson, AZ 85721

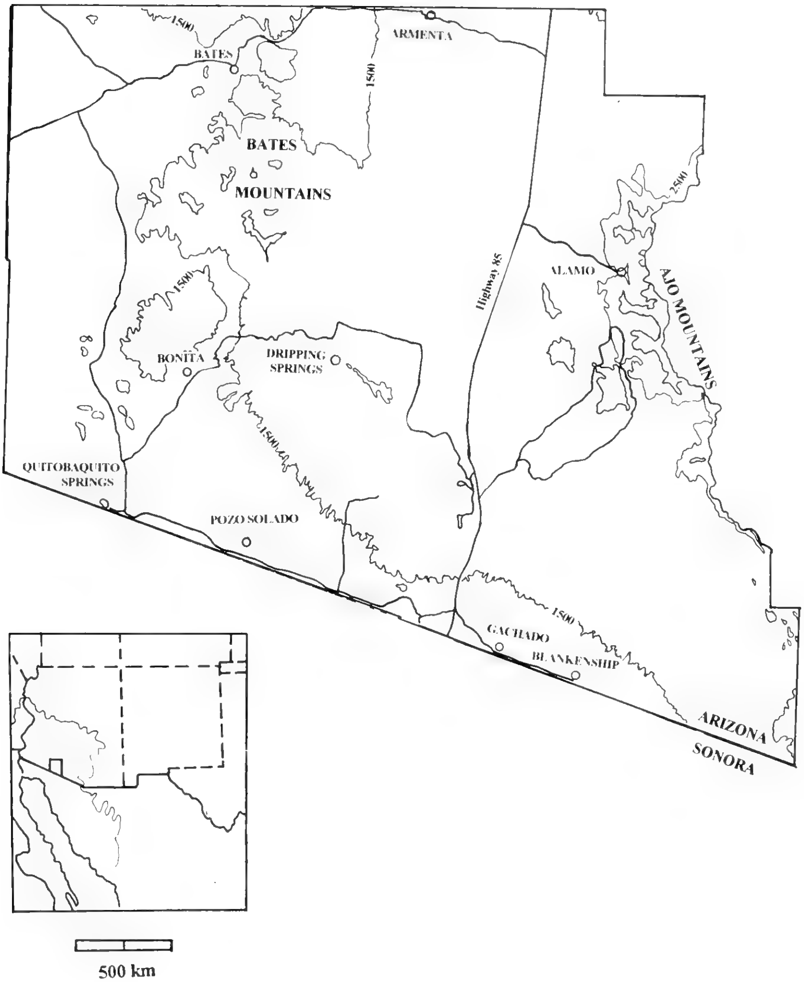

Figure 1. Organ Pipe Cactus National Monument and its location in Arizona with respect to the boundaries of the Sonoran Desert (inset). The concrete troughs (open circles), associated with wells in some cases, are no longer reliable sources of water within the Monument. Dripping Springs is the only semi-permanent spring within the Monument. Perennial aquatic habitats are found in the major drainages of the Ajo Mountains and Quitobaquito Springs. Topographic lines (feet) coarsely outline the major features of the Monument.

over two centimeters of precipitation in less than 30 minutes. It is perhaps this type of storm that scoured out the basins in the bedrock of ephemeral streams and produced the tinajas in the arid mountains of the Southwest (Bryan, 1920). These aquatic habitats are ephemeral by definition. The larger, more protected tinajas may persist for many years, drying up in only the most severe droughts.

METHODS

This report is the result of extensive surveys for aquatic beetles (Coleoptera) and bugs (Hemiptera) that were conducted from 1980 through 1988, with occasional surveys through 1995. There were 105 days of collecting from 1980 to 1988, but 85 were within the first two years of the survey. Additional records were obtained from the ORPI insect collection and the insect collection at the University of Arizona.

The water column, sides of tinajas and stock troughs, and the bottom of water sources were sampled. Most species were collected in the water column or on the gravel/muck substrate. Several of the smaller beetle species were collected by sifting through the substratum of the tinajas. Sweep samples were made with hand nets. Collections were preserved in 70% ethanol and transported to the laboratory for identification.

Of the aquatic habitats in the Monument, tinajas in Alamo Canyon and Bull Pasture of the Ajo Mountains and concrete stock troughs on the valley floor were censused most frequently. Aquatic insects were collected at Dripping Springs and the pond at Quitobaquito Springs on only a few occasions. At the time surveys for aquatic insects were initiated, Monument personnel maintained water in seven concrete stock troughs (Bates Well, Bonito Well, Gachado Well, Armenta Well, Pozo Solado, Alamo Canyon, and Blankenship Well). That practice was abandoned in the mid 1980's and these habitats hold water only following rain.

RESULTS

The current aquatic beetle and bug fauna of Organ Pipe Cactus National Monument comprises 63 species: 42 beetle species (1 Dryopidae, 24 Dytiscidae, 1 Gyrinidae, 1 Hydraenidae, 15 Hydrophilidae), and 21 bug species (2 Belostomatidae, 5 Corixidae, 1 Gerridae, 1 Mesoveliidae, 3 Naucoridae, 1 Nepidae, 7 Notonectidae, 1 Veliidae,) (Table 1).

Only five aquatic insects were in the ORP1 collection prior to a survey of aquatic insects conducted by a graduate class from the University of Arizona in 1980. Twenty-seven species were added from that survey. Since that time, an additional 31 species have been found within ORP1 over a 3 year period. As there have been no new species collected in ORP1 in the last decade of intermittent sampling, it is reasonable to assume that at least the common or regular residents of the Monument have been documented. Indeed, of the 63 species collected so far, only 11 are represented by a single specimen (E. Larsen, unpublished data).

Of the current aquatic habitats represented in the Monument, more species of beetles have been collected in the tinajas of the Ajo Mountains than in the other habitats (Table 2). Species collected in the other habitats are, for the most part, a subset of those found in the Ajo Mountains, with 7 exceptions: 4 species of dytiscids and 3 species of hydrophilids. In all cases, these species were rare in the Monument (E. Larsen, unpublished data). Obviously, the absence of some species in collections from the pond at Quitobaquito Springs may be due to a lesser sampling effort than expended in the Ajo Mountains, but the absence of some dytiscid species (e.g., *Hydreana circulate,* some species of *Laccophilus,* and *Copelatus* spp.) is probably due to a preference for gravel substrate not present in the pond.

Virtually all of the specimens of beetles from Dripping Springs were collected in the outflow, a muddy trickle several meters long that appears when outflow exceeds evaporation. As this occurrence is relatively rare and the majority of the basin that collects water is nearly completely hidden from above by overhanging rock, few aquatic insects were ever found here on any particular collecting trip.

Heteropteran species do not show the same nested pattern of occurrence exhibited by the coleopteran species. Species found in the pond at Quitobaquito Springs are not a subset of species found in the tinajas (Table 3). Twelve of 18 species were found in either the pond or the tinajas, but not both. Of the species found in both habitats, 3 skate or walk across the surface of the water in pursuit of prey (the gerrid, the mesoveliid, and the veliid) and perhaps are less restricted by the nature of the habitat substratum than the fully aquatic insects.

DISCUSSION

The aquatic insect fauna of ORPI is a mixture of temperate and tropical insects with a few Southwest endemics. This is illustrated by two genera of Dytiscidae. Of the six species of *Laccophilus, L. pictus, L. vaecensis,* and *L. mexicanus* are largely tropical, *L. fasciatus* is widespread, and *L. sonorensis* is endemic to the Southwest (Zimmerman 1970). Five species of *Deronectes* have been collected in ORPI; *D. striatellus* is widespread, *D. roffi* and *D. coelamboides* are Southwest endemics, and *D. aequinoctialis* is tropical, reaching the northern extent of its range in Arizona (Zimmerman and Smith 1975). Among the bugs, the Notonectidae exhibit a similar pattern. Seven species of backswimmers have been collected within the Monument. *Notonecta indica, N. kirbyi, B. margaritacea,* and *B. scimitra* have temperate distributions, *N. lobata* and *B.*

arida are endemic to the Southwest, and *B. albida* and *B. arizonis* are tropical (Truxal 1953, Hungerford 1933). Both of the tropical species reach the northern-most portions of their ranges in Arizona. Among the naucorids, *Pelocoris biimpressus biimpressus,* has been recorded from Guatemala, Mexico, and several States in the Southwest (LaRivers, 1956, Polhemus and Sites 1995). *Ambrysus occidentalis* is endemic to the Southwest and *A. pulchellus* reaches the most northern extent of its range in southern Arizona, southern New Mexico, and southwest Texas (La Rivers, 1951).

Little evidence for habitat selection between the pond and the tinajas was observed in the beetle assemblages (Table 2). The species collected only at the pond were rare, represented by only one or two specimens over the past 15 years (E. Larsen, unpublished data). In contrast, of the species unique to the Ajo Mountains (i.e., *Agabus lugens*, *Copelatus* spp., *Deronectes aequinoctialis*, *Desmopachria portmani*, *Dineutus sublineatus*, and *Enochrus carinatus*), only *Dineutus sublineatus* is represented by a single observation (E. Larsen unpublished data).

All families of bugs represented by more than one species in ORPI exhibit nearly mutually exclusive distribution patterns between the tinaja and pond habitats (Table 3). The nature of the habitat preferences is unknown, but may reflect habitat choice at the moment of colonization (e.g., some species will not colonize a small habitat such as that represented by a tinaja relative to a pond) or physiological tolerances (e.g., the tinajas would have greater temperature fluctuations than the pond due to their smaller size).

New Records

All species recorded in this report are new site records for Arizona. The following three species are new Arizona records. The dytiscid, *Copelatus distinctus,* has few records in the U.S., but is known to occur throughout Mexico (Young, 1963). It was abundant in the gravel bottoms of tinajas in the Ajo Mountains during the time course of these surveys. The closest published records for the mesoveliid, *Mesovelia mulsanti* White, are from California and Texas (Smith 1988). The notonectid, *Buenoa albida,* has been reported from Texas and Mexico (Truxal 1953). In addition to this record, *B. albida* has been collected just outside of ORPI in Armenta Tank, as well as other locales in Pima and Yuma Counties (Larsen, 1986 and C. Olson, unpublished data).

The environment of Organ Pipe Cactus National Monument is harsh. For aquatic insects to gain a foot-hold in this rugged environment they must be able to find the isolated tinajas, survive the often elevated temperatures in tinajas unshaded by canyon walls, and successfully reproduce. The number of aquatic species reported here demonstrates that finding the tinajas is not a problem. The presence of beetle larvae and bug nymphs in the peak of the Sonoran Desert summer (E. Larsen, personal observation) is strong evidence that the physical environment is not beyond the physiological capabilities of these insects.

Table 1. Aquatic Coleoptera and Hemiptera collected within the boundaries of Organ Pipe Cactus National Monument. Arizona.

COLEOPTERA

Dryopidae
Helichus immsi Hinton

Dytiscidae
Agabus lugens (LeConte)
Copelatus chevrolati renovatus Guignot
C. distinctus Aube
Cybister ellipticus LeConte
Deronectes aequinoctialis (Clark)
D. coelamboides Fall
D. decemsignatus (Clark)
D. roffi (Clark)
D. striatellus (LeConte)
Desmopachria portmani Clark
Eretes sticticus (Linnaeus)
Hydroporus vilis LeConte
Hygrotus fraternus LeConte
H. medialis (LeConte)
Laccophilus fasciatus terminalis Sharp
L. maculosus shermani Leech
L. mexicanus mexicanus Aube
L. pictus coccinelloides Regimbart
L. sonorensis Zimmerman
L. vaecensis Young
Rhantus atricolor (Aube)
R. gutticollis Say
Thermonectus nigrofasciatus (Aube)
Uvarus sp.

Gyrinidae
Dineutus sublineatus Cheverolat

Hydraenidae
Hydreana circulate Perkins

Hydrophilidae
Berosus infuscatus LeConte
B. miles LeConte
B. punctatissimus LeConte
B. rugulosus Horn
B. salvini Sharp
B. stylifer Horn
Chaetarthria pallida (LeConte)
Enochrus carinatus fuscatus (Horn)
E. cristatus (LeConte)
E. pygmaeus pectoralis (LeConte)
Helochares normatus (LeConte)
Helophorus brevipalpus Bedel
Hydrophilus triangularis (Say)
Tropisternus ellipticus (LeConte)
T. lateralis LeConte

HEMIPTERA

Belostomatidae
Belostoma flumineum Say
Lethocerus medius (Guerin-Meneville)

Corixidae
Corisella edulis (Champion)
Graptocorixa abdominalis (Say)
G. serrulata (Uhler)
Hesperocorixa laevigata (Uhler)
Trichocorixa sp.

Gerridae
Aquarius remigis (Say)

Mesoveliidae
Mesovelia mulsanti White

Naucoridae
Ambrysus occidentalis LaRivers
A. pulchellus Montandon
Pelocoris biimpressus biimpressus Montandon

Nepidae
Ranatra quadridentata Stål

Notonectidae
Buenoa albida (Champion)
B. arizonis Bare
B. margaritacea Torre-Bueno
B. scimitra (Bare)
Notonecta indica Linnaeus
N. kirbyi Hungerford
N. lobata Hungerford

Veliidae
Microvelia beameri McKinstry

Table 2. Habitats for aquatic Coleoptera collected in Organ Pipe Cactus National Monument, Arizona.

	Ajo Mountains	Quitobaquito Springs	Dripping Springs	Concrete Troughs
Dryopidae				
Helichus immsi	X			X
Dytiscidae				
Agabus lugens	X			
Copelatus c. renovatus	X			
C. distinctus	X			
Cybister ellipticus		X		
Deronectes aequinoctialis	X			
D. coelamboides		X		X
D. decemsignatus		X		X
D. roffi	X	X		X
D. striatellus	X			X
Desmopachria portmani	X			
Eretes sticticus	X	X		X
Hydoporus vilis	X		X	X
Hygrotus fraternus	X			X
H. medialis	X	X		X
Laccophilus f. terminalis	X			X
L. m. shermani	X	X		
L. mexicanus	X	X		X
L. p. coccinelloides	X			X
L. sonorensis	X			X
L. vaecensis	X			X
Rhantus atricolor	X			X
R. gutticollis	X			X
Thermonectus nigrofasciatus		X		X
Uvarus sp	X			X
Gyrinidae				
Dineutes sublineatus	X			
Hydreanidae				
Hydreana circulata	X			X
Hydrophilidae				
Berosus infuscatus		X		X
B. miles	X	X		X
B. punctatissimus	X			X
B. rugulosus	X			X
B. salvini	X			X
B. stylifer				X
Chaetarthria pallida		X		
Enochrus c. *fuscatus*	X			
E. cristatus	X		X	
E. p. pectoralis	X			X
Helochares normatus				X
Helophorus brevipalpus	X	X		
Tropisternus ellipticus	X			X
T. lateralis	X			X

Table 3. Habitats for aquatic Heteroptera collected in Organ Pipe Cactus National Monument, Arizona.

	Ajo Mountains	Quitobaquito Springs	Dripping Springs	Concrete Troughs
Belostomatidae				
Belostoma flumineum		X		
Lethocerus medius	X			X
Corixidae				
Corisella edulis	X			X
Graptocorixa abdominalis	X			X
G. serrulata	X			X
Hesperocorixa laevigata		X		X
Trichocorixa sp.		X		X
Gerridae				
Aquarius remigis	X	X		X
Mesoveliidae				
Mesovelia mulsanti	X	X		
Naucoridae				
Ambrysus occidentalis		X		
A. pulchellus		X		
Pelocoris b. biimpressus		X		
Nepidae				
Ranatra quadridentata	X	X		X
Notonectidae				
Buenoa albida		X		
B. arizonis	X	X	X	X
B. margaritacea	?	X		X
B. scimitra		X		
Notonecta indica		X		X
N. kirbyi	X			X
N. lobata	X			X
Veliidae				
Microvelia beameri	X	X	X	X

ACKNOWLEDGMENTS

This work was carried out with the cooperation and assistance of the staff of Organ Pipe Cactus National Monument. Terry Peters, the former Natural Resources Specialist, and Caroline Wilson, Chief Naturalist, deserve special thanks for logistic support. Voucher specimens have been deposited in the University of Arizona Entomology collection and the collection of Organ Pipe Cactus National Monument. We thank Gene Hall, David Madison, J.T. Polhemus, Dan Polhemus, and an anonymous reviewer for many useful comments on the manuscript.

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REPORT OF A MORPHOLOGICALLY HERMAPHRODITIC FLEA (SIPHONAPTERA) AND OTHER FLEA ANOMALIES FROM MOROCCO[1]

Michael W. Hastriter[2]

ABSTRACT: A case of morphological hermaphrodism in *Nosopsyllus henleyi henleyi* and anomalous conditions in specimens of *Xenopsylla ramesis*, *Leptopsylla segnis*, and *Stenoponia tripectinata megaera* from Morocco are described and illustrated.

Numerous authors have reported a variety of anomalies among Siphonaptera. Bartkowska (1968), Beaucournu *et al.* (1988), Goncharov (1972a), Haas (1965; 1983b), Holland (1943), Jordan (1921), Lopes *et al.* (1992), Mead-Briggs (1964), Sharma and Joshi (1961), Smit (1949a; 1949b), and Worms (1973) discussed cases of double spermathecae. Triple spermathecal conditions are reported by Beaucournu *et al.* (1988), Benton (1967), and Stark (1953). Various anomalous conditions to include castration of male and/or female fleas were reported by Bartkowska (1966; 1968), Beaucournu (1969), Benton (1967), Brinck-Lindroth and Smit (1973), Claassens (1967), Goncharov (1972b), Haas (1972; 1983a), Ioff and Tiflov (1940), Li and Wang (1973), Smit (1952; 1953), and Wagner (1931). Holland (1959) and Jordan (1921) suggested possible evolutionary significance of reoccurring anomalous conditions. Deformities of flea appendages were reported by Sanjeans and Travis (1955), Schwan and Dobkin (1981), and Smit (1981). Akofyan (1961), Brink-Lindroth and Smit (1973), Goncharov (1972b), and Haas (1983a) each reported descriptive cases of intersexuality defined by Brink-Lindroth and Smit as "dominantly male..., but also the structures of secondary sexual characters, such as head, antennae, antesensilial setae, and postsensilial region, which are then more or less intermediate between those of male and female". Beaucournu and Launay (1987) described and illustrated a case of morphological hermaphrodism in *Nosopsyllus henleyi* and distinguished it from cases of intersexuality as, "co-existence of male genitalia (segment IX and phallosome) and female genitalia (vagina, duct and spermatheca)". The author does not consider Brink-Lindroth and Smit's definition of intersexuality to be the same as hermaphrodism. Based on the definition of Beaucournu and Launay (1987), a second hermaphrodite, noted in Hastriter and Tipton (1975), is herein described with significant biological similarities to their report.

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[1] Received March 12, 1996. Accepted June 19, 1996.

[2] Monte L. Bean Life Science Museum, Brigham Young University, 290 MLBM, P.O. Box 20200, Provo, Utah 84602-0200.

MATERIALS AND METHODS

During 1969-70, 9,936 fleas were collected from small mammals in Morocco (Hastriter and Tipton, 1975). Among these fleas were five anomalies. All specimens were processed using KOH, dehydrated in serial alcohols, cleared in oil-of wintergreen, and mounted in Canada balsam. Terminologies follow those of Rothschild and Traub (1971).

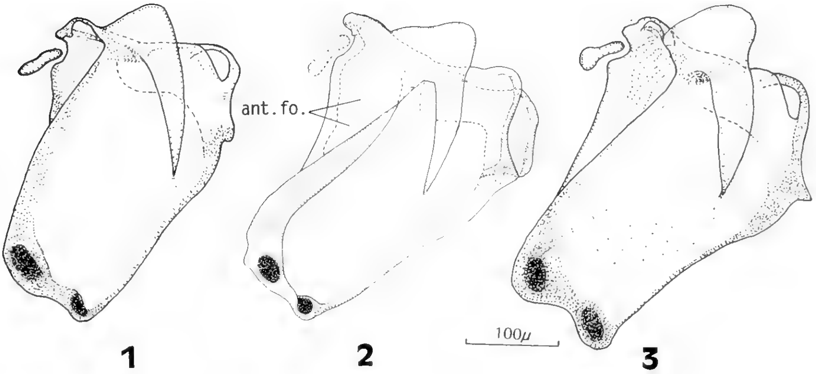
OBSERVATIONS AND DISCUSSION

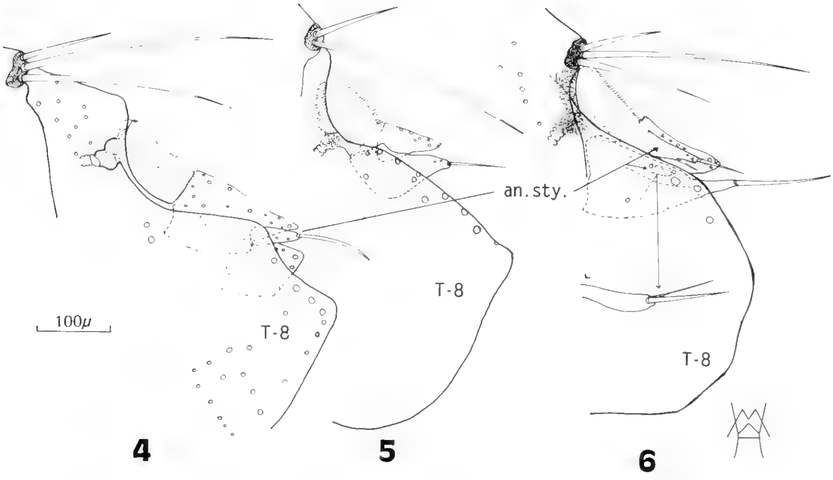
A single specimen identified as *Nosopsyllus henleyi henleyi* (Rothschild, 1904) collected 15 kilometers southwest of Missour, Fes Province, Morocco, from female *Meriones libycus*, 28 Jun 1970 by L.W. Robbins had primary and secondary male and female sexual characteristics commensurate with a true morphological hermaphrodite.

Head: Setation of the head is similar in males and females, although males possess a single stout seta that females do not have, located ventral to the antennal fossa and anterior to the ocular row. This seta is not present in the hermaphrodite. The specimen has a normal male occipital groove, but it does not extend forward as deeply toward the interantennal suture (falx). The dorsal antennal fossae do not completely merge forming a definite interantennal suture or falx as in normal males; however, the separation is not as great as in females. The antennae bear important secondary sexual characteristics of both sexes. Bilaterally, the scape is typically male, the second segment bears long setae characteristic only of females, and the clubs are male. The left antenna has two missing terminal segments leaving seven, and does not extend onto the thoracic depression (antennal fossa) of the proepisternum.

Thorax: The thorax of *Nosopsyllus henleyi henleyi* does not significantly differ in males and females except for the proepisternal region. In males, the heavy ridge separating the dorsal and ventral pleural region (hereafter termed the propleural strut) is strongly arched ventrad, extending the cephalic portion of the antennal fossa to accommodate the longer male club. In females, this propleural strut bows slightly upwards as the antennal fossa does not extend onto the proepisternum below the cervical link plate (Figs. 1-3). The antennal fossa of the proepisternum is less developed than normal males and the last two segments of the male right antenna are abnormally bent to conform to this poorly developed groove. This anomalous condition may have attributed to the loss of the two terminal segments on the left side, as no protection was provided. The pronotal combs of male and female *N. h. h.* do not exhibit sexual dimorphism as in some species.

Legs and Abdomen: Apparent secondary sexual features are not associated with the legs, or first six segments of the abdominal tergites and sternites.





Figs. 1-3. *Nosopsyllus h. henleyi* prosternosomes. Fig. 1. Normal female. Fig. 2. Normal male. Fig. 3. Hermaphrodite.

Figs. 4-6. *N.h.h.* antepygidial bristles, eighth tergite (T-8), and dorsal/ventral anal lobes. Fig. 4. Normal female. Fig 5. Normal male. Fig. 6. Hermaphrodite – rudimentary anal stylet (an.sty.) shown enlarged.

Tergum VII - Normal males and females possess two and three antepygidial bristles, respectively, arranged as in Figures 4-5. This specimen has the same number and arrangement as typical females with exception of the ventral bristle, which is slightly shorter (Fig. 6).

Tergum VIII - The shape of T-8 of the anomaly is characteristically male, but differs slightly in contour from either sex and has the setal pattern of neither (Figs. 4-6).

Tergum IX - The 7th abdominal spiracle is situated within the sensilial plate as in normal males. Female spiracles are not elongate in lateral view as are males. The spiracle is slightly deformed and situated anteriorly more than normal males (Figs. 4-6). The P1 and movable process of the clasper, apodeme of T-9, and manubrium are slightly deformed, but well developed (Fig. 7).

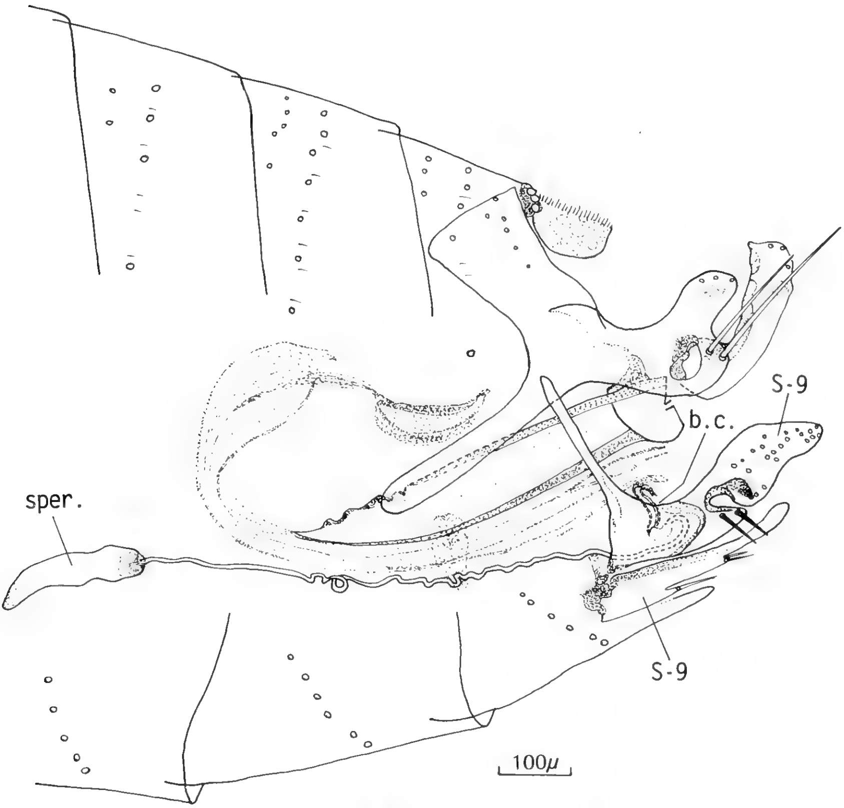
Dorsal and Ventral Anal Segments - These terminal segments are malformed and sexually intermediate. The dorsal anal segment of the hermaphrodite resembles the normal female as it bears an almost normal anal stylet (Fig. 6). It also bears a reduced, but clear rudiment of a female anal stylet bilaterally on the ventral anal lobe, which usually has no such appendages. It is of interest to note that Goncharov (1972b) illustrates cases of rudimentary anal stylets in numerous specimens of *Nosopsyllus laeviceps* (Wagner, 1909) arising from what he terms the eleventh segment. The author does not wish to discuss the numerical interpretation of terminal segments, but points out that the rudimentary anal stylets illustrated by Goncharov occupy the same position on the ventral anal segment as the hermaphrodite herein described. These two closely related flea species evidently display similar and possibly atavistic expression of "anomalous" traits when exposed to teratogenic agents.

Sternum VII - The S-7 is typical of normal males. The S-8, although very reduced in normal specimens of *N. h. h.*, is completely nondiscernable in this specimen.

Sternum IX - The S-9 appears in duplicate, although the more posterior ventral of the two pairs are grossly deformed. The anterior dorsal pair are essentially normal except for malformations of the proximal arms and apodemal rods (Fig. 7).

Aedeagus - The aedeagus does not significantly differ from normal males, although the crochets are bluntly deformed and the penis rods are vastly shorter than normal males whose penis rods coil three times like a watch spring. The penis rods do not exceed a half coil (Fig. 7). The paired Wagner's gland was clearly visible. Testicular tissues were not visible as preparation procedures had undoubtedly destroyed them.

Female Genital Features - The primary sexual characteristics that define this specimen as a true hermaphrodite morphologically include a small and deformed spermatheca, complete with strigillae, a cribriform area surrounding the bulge orifice, and a duct leading from the spermatheca that broadens into a



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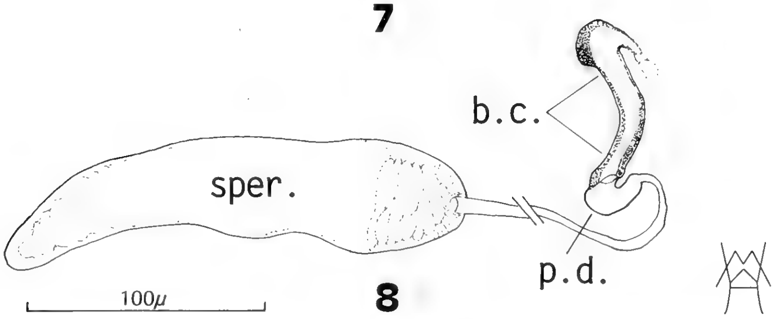

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Figs 7-8. *Nosopsyllus h. henleyi* hermaphrodite. Fig. 7. Male clasper, anterior aedeagus (terminal aedeagus not illustrated, dual ninth sternite (S-9), bursa copulatrix, spermatheca and duct. Fig. 8. Enlargement of spermatheca (sper.), bursa copulatrix (b.c.), and pars dilatata (p.d.).

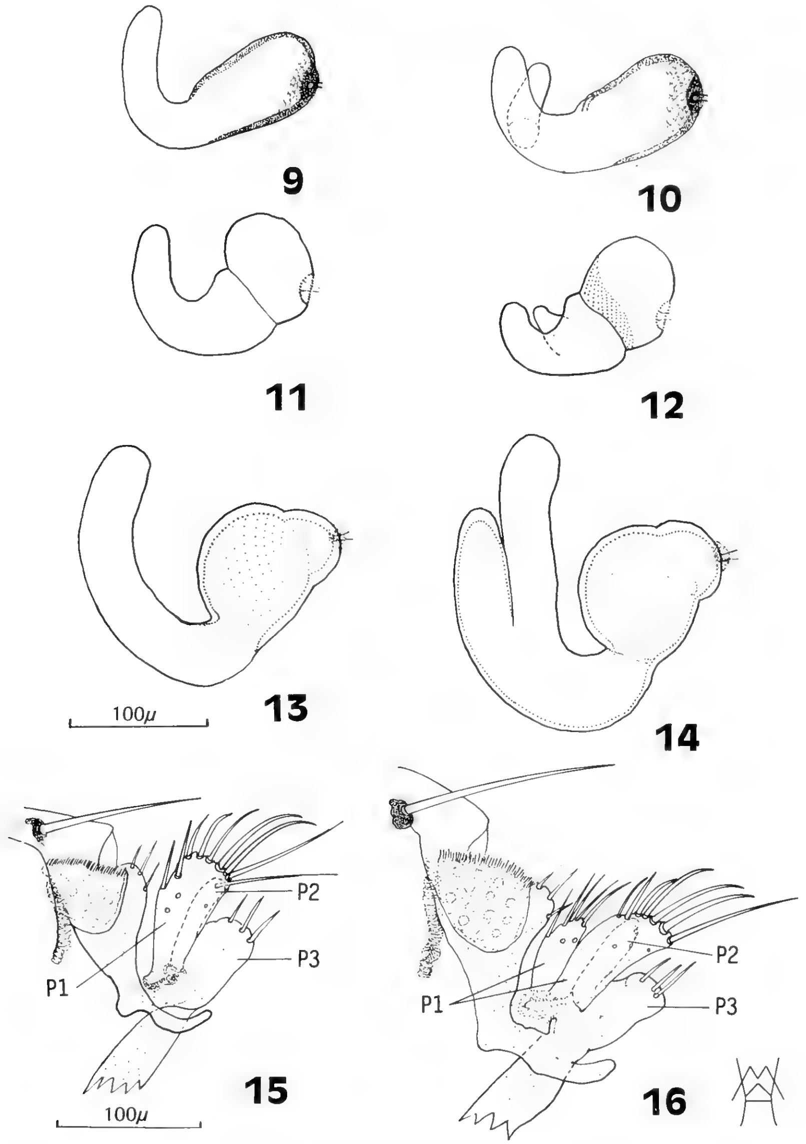
nearly non-discernible pars dilatata at the juncture of the bursa copulatrix (Fig 8). The pars dilatata extends from a grossly deformed and anatomically inverted sclerotized duct of the bursa copulatrix (Fig. 7). The position of the bursa copulatrix may have been anatomically altered during processing. A vaginal canal is not visible with the imposition of heavily chitinized male structures.

The hermaphrodite, *N. h. henleyi,* described by Beaucournu and Launey (1987) is remarkably like this specimen not only morphologically, but biologically. Their specimen was collected in Laghouat, Algeria approximately 375 miles east of Missour, Fes Province, Morocco from the same host species, *Meriones libycus*. The nominate subspecies of *Nosopsyllus henleyi* occurs on *M. libycus* and *M. caudatus* (some consider the latter to be a subspecies of *M. libycus)* in arid lowland areas of Morocco east of the Middle Atlas Mountains. The common ecological attributes shared by the only two reported hermaphroditic Siphonaptera removed from the same host species with similar geographical habitats can likely be attributed to an entomophagous Mermethid nematode identified coincidentally in *N. h. h.* by Deunff (1984). It should be noted that there is wide, uniform geographical distribution for these mammalian host species and their parasites (nematodes and Siphonaptera) from Morocco to Laghouat, Algeria and across North Africa.

Miscellaneous Anomalies: Three specimens had single anomalous spermathecae with dual hillae. They include: *Leptopsylla segnis* (Schönherr, 1811) (3 kilometers north of Settat, Settat Province, Ex: female *Rattus norvegicus*, 23 Apr 1970 by L.W. Robbins) (Figs. 9-10); *Xenopsylla ramesis* (Roths., 1904) (8 kilometers south of Tiznit, Agadir Province, Ex: male *G. campestris*, 18 Dec 1969 by L.W. Robbins) (Figs. 11-12); and *Stenoponia tripectinata megaera* Jordan, 1958 (16 kilometers west of Aoulouz, Agadir Province, Ex: female *Gerbillus campestris*, 14 Mar 1970 by R.E. Vaden) (Figs. 13-14).

A single male specimen of *X. ramesis* (9 kilometers southeast of Al Hoceima, Al Hoceima Province, Ex: male *G. campestris,* 31 May 1970 by M.G. Hearst) bears an extra P1 of the clasper only on the left side. It is distinct, but smaller than the anatomically normal adjacent P1 (Figs. 15-16).

It is interesting to note that of the 9,936 fleas removed from 38 mammal species (Hastriter and Tipton, 1975), three of the four miscellaneous anomalies were all taken from *G. campestris*. The inferred teratogenic etiology of a common entomophagous nematode parasite among the *G. campestris* population is probable. Studies of nematode parasites infesting murine rodents and their fleas in the region warrant further investigation similar to those of Brink-Lindroth and Smit (1973) in northern Scandinavia. In addition, numerous authors have observed and reported entomophagous nematode parasites in the coelomic cavity of adult fleas, but the infestation of pupal and prepupal stages have not been reported. Surely the occurrences of dual anatomical structures and coexisting



Figs 9-16. Respectively, normal and dual tailed spermathecae of: *Leptopsylla segnis* (Figs. 9-10), *Xenopsylla ramesis* (Figs. 11 12), and *Stenoponia tripectinata maqaera* (Figs. 13-14). Figs. 15-16. Processes of clasper of *X. ramesis*. Fig. 15. Normal P1, P2 and P3 of clasper. Fig. 16. Duel P1, normal P2 and P3 of clasper.

male/female organs are likely to be produced by parasitic trauma (physical and/or chemical) during earlier developmental stages. The methods of parasite invasion, timeliness of infection, and effects of parasitosis all deserve additional inquiry.

ACKNOWLEDGMENTS

The author expresses his appreciation to Richard W. Baumann, Curator of Insects, Monte L. Bean Museum, Brigham Young University for kindly providing space and equipment. Also, special thanks to Glenn E. Hass and Harold E. Stark for reviewing the manuscript and providing helpful suggestions.

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SISTER RELATIONSHIP OF THE NEOEPHEMERIDAE AND CAENIDAE (EPHEMEROPTERA: PANNOTA)[1,2]

T.-Q. Wang[3], W. P. McCafferty[3], Y. J. Bae[4]

ABSTRACT: A consistent structural characteristic has been found to be unique to the mayfly families Neoephemeridae and Caenidae. It is termed a sutural ommation and is present on the adult mesonotum. The structure is described and illustrated. Its unique presence supports the hypothesis of a sister relationship of Neoephemeridae and Caenidae among the pannote mayflies, a cladistic arrangement that has been somewhat debatable in the past. The Baetiscidae and Prosopistomatidae, which previously have been hypothesized to be closely related to either Neoephemeridae or Caenidae by various authors, are considered to constitute an aberrant clade of mayflies with still dubious relationships within the Ephemeroptera.

Neoephemerid mayflies, the "large squaregills" (McCafferty 1981), were considered among the burrowing mayflies in the first half of this century. For example, Traver (1935) considered them as one of the subfamilies of Ephemeridae (= families of Ephemeroidea), and Ulmer (1939) considered them in the family Potamanthidae. This association was based on the common possession of basally arched MP_2 and CuA veins in the forewings. Edmunds and Traver (1954) placed the neoephemerids with the Caenidae, the "small squaregills" (McCafferty 1981), in a separate superfamily Caenoidea. This association was based on larval morphology, in particular the similar gill structure. Since that time, all workers, with the exception of Demoulin (1958), have grouped Neoephemeridae with Caenidae rather than Ephemeroidea. McCafferty and Edmunds (1979) placed the Caenoidea among other mayflies that possess the apomorphic characteristic of more or less fused developing wingpads and are known as the pannote mayflies.

Given the general relationships of large groupings of mayfly families (e.g., see McCafferty 1991), it appears that adult similarities (wing venation) of neoophemerids and burrowing mayflies (Ephemeroidea) were present in their immediate common ancestor, and of the pannote mayflies, only retained in the neoephemerids. On the other hand, the larval similarities of neoephemerids and other pannotes, including caenids, (e.g., fused wingpads) appear to be derived in these groups. Edmunds (1965), McCafferty (1972), and McCafferty and Edmunds (1976) have discussed how differential rates of evolution in the larval and adult stages can lead to such disparate stage characterization in certain

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[1] Received May 6, 1996. Accepted August 9, 1996.

[2] Purdue Agriculture Research Program Journal Number 15040.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

[4] Department of Biology, Seoul Woman's University, 126 Kongung 2-dong, Nowon-gu, Seoul 139-744, Korea.

Ephemeroptera taxa (i.e., with relatively ancestral characterization in one stage and relatively derived characterization in another stage).

Among the pannote mayflies, three major historical schemes of familial relationships are noteworthy. McCafferty and Edmunds (1979) recognized Neoephemeridae as a phyletic sister group of Caenidae. Landa and Soldán (1985) recognized Neoephemeridae as a sister group of Baetiscidae, with the two derived with another lineage consisting of Caenidae and Prosopistomatidae. McCafferty (1991) followed Landa and Soldán (1985) in recognizing Neoephemeridae as a sister group of Baetiscidae, but derived this lineage from near the base of the Pannota. He also included Prosopistomatidae and Caenidae as sister groups (see also Tshernova 1970). None of the previous arguments supporting these various schemes have been compelling.

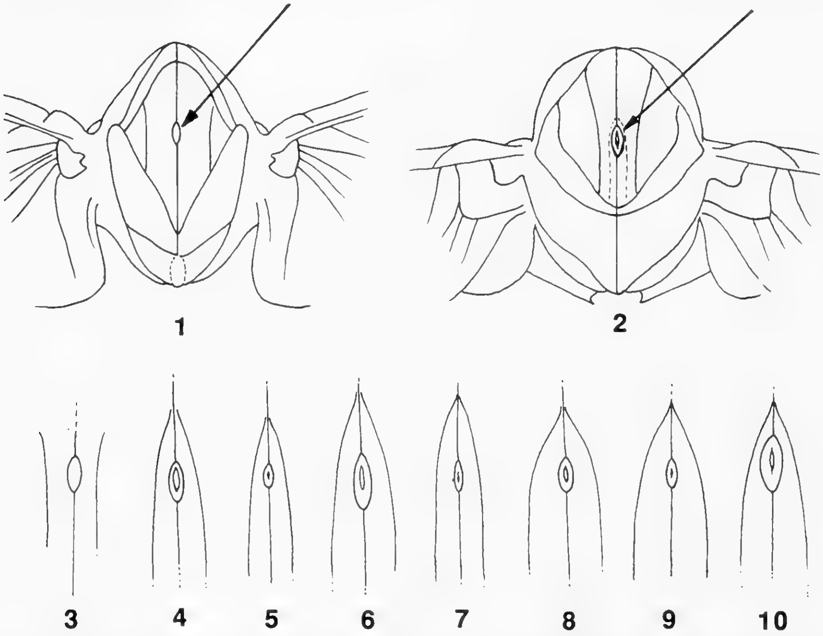
The Landa and Soldán (1985) scheme was based on data from internal anatomy, especially the ureterlike (their term) characteristics of Malpighian tubules in the case of Neoephemeridae and Baetiscidae, and the arrangement of the alimentary canal in the case of Prosopistomatidae and Caenidae. Although these internal anatomical data provided valuable descriptions for certain pannote mayflies, any interpretation of them as synapomorphic is suspect because of not only the very small number of representatives sampled from families (Landa 1969) but also the current inability to substantiate cladistic polarity with respect to them.

McCafferty (1991) suggested that the operculate gills of abdominal segment 2 in Neoephemeridae and Caenidae were fundamentally different. However, based on our recent comprehensive morphological studies, these gills are indeed essentially the same with respect to shape, ridge development and armature. McCafferty (1991) also stated that the carapacelike development of the larval thorax was not similar in Baetiscidae and Prosopistomatidae. Nonetheless, among Ephemeroptera, the carapace is found only in the Baetiscidae and Prosopistomatidae. We have additional data (Wang and McCafferty unpublished) showing that underlying gill morphology and certain mouthpart structures are similar and unique in these two families. These data strongly suggest that the carapace was commonly derived in the Baetiscidae and Prosopistomatidae. Kluge *et al.* (1995), without stating any reason, removed these latter two families from the Pannota and considered them sister families in a separate suborder of Ephemeroptera.

Although we have not been able to find any larval characteristics common to both Neoephemeridae and Caenidae that are, without a doubt, apomorphic and unique (not subject to homoplasy), we have recently discovered a stable adult characteristic that strongly supports the hypothesis of a sister relationship of the two families. We present this characterization herein.

NEW CHARACTERIZATION AND DISCUSSION

A small, elongate eye-shaped membrane located medially on the mesonotum of adult caenids was noted and illustrated by Provonsha (1990). This appears as a short, primordial split along the medial suture, comprised of a clear membrane (Figs. 1, 3). We have found that this structure also occurs in adults throughout the Neoephemeridae (Figs. 2, 4-10), but in no other mayflies (obviously all possible outgroups) that we know of. It differs somewhat in the Neoephemeridae in terms of how membranous the structure is; sometimes it is not membranous. We call this structure the sutural *ommation* because of its eye shape. We hypothesize that it evolved in the immediate common ancestor of the Neoephemeridae and Caenidae: its uniqueness among all mayflies is strongly suggestive of a sister relationship of the two families. Since we cannot surmise a likely function of this ommation, it is highly possible that it is non-adaptive. If that is the case, it may be an excellent stable character for not only defining the Neoephemeridae + Caenidae clade but diagnosing the Edmunds and Traver (1954) and McCafferty and Edmunds (1979) concept of the superfamily



Figs. 1-10. Sutural ommation of the adult mesonotum. 1. *Caennis latipennis*. 2. *Neoephemera youngi*. 3. *Brachycercus nasutus*. 4-5. *Potamanthellus amabilis*. 6-7. *P. chinensis*. 8-9. *N. purpurea*. 10. *P. compressa*.

Caenoidea in the adult stage.

The relative phylogenetic position of the hypothesized Neoephemeridae + Caenidae clade among the Pannota is still not clear. None of the previously published proposals are convincing because of the use of characteristics with unsubstantiated polarity. In any case, we are now convinced that the two families form a distinct clade within the Pannota.

Baetiscidae and Prosopistomatidae, which have been variously associated with Neoephemeridae or Caenidae previously, appear to be sister lineages that form a separate clade based on the carapace and certain mouthpart and gill characteristics as mentioned above (Wang and McCafferty ms). The clade is aberrant, and its relationship to the Pannota is unclear at this time. For example, if the shared trait of the A_1 vein of the forewings ending in the outer margin (see Fontaine 1958) is plesiomorphic in Prosopistomatidae + Baetiscidae, then all other mayflies constitute a separate grouping because they would share the apomorphic modified forewings with a reduced anal area and shortened A_1. This would also indicate that the carapace of Prosopistomatidae + Baetiscidae is not derived in common with the fused wingpads of the Pannota, including the Ephemerellidae, Leptohyphidae, Tricorythidae, Neoephemeridae, and Caenidae. Obviously, more cladistic research is needed before these further questions can be completely resolved.

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ANNOUNCEMENT

The Humboldt (formerly Eagle Hill) Field Research Institute is again offering a wide variety of natural history seminars and workshops, June-September, 1997. Three topics of particular interest to entomologists are: Aquatic Entomology, Aug. 10-16; Intro. to Forest Insect Biodiversity, Aug. 10-16; and Intro. to Biology of Spiders, Aug. 17-23. Further information and a detailed brochure is available from the Humboldt Field Research Inst., PO Box 9, Steuben, ME 04680-0009; 207-546-2821; FAX 3042; Email humboldt@nemaine.com
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A SOUTH DAKOTA RECORD FOR *CHAULIODES RASTRICORNIS* (MEGALOPTERA: CORYDALIDAE)[1]

P.J. Johnson, K.D. Roush, X. Lin[2]

ABSTRACT: *Chauliodes rastricornis* is reported from Bennett County, South Dakota. This is the first confirmation of this species in the state. The collection locality is the most westward locality in the northern Great Plains region and for the species. This species may be introduced to the region.

Corydalidae, or fishflies and dobsonflies, have not been well surveyed in the northern Great Plains region. Parfin (1956) provided a checklist and some ecological notes for the species of Minnesota. Tarter *et al.* (1976) presented a distributional synopsis of selected megalopterans, including *Chauliodes* species in the region. Apparently, the only published South Dakota record was provided by Tarter *et al.* (1976) who reported *C. rastricornis* Rambur from the state, without further information. These authors also presented records for Nebraska, from Cherry and Antelope counties, in the northcentral and northeastern portions of the state. Smith (1925) reported this species from Douglas County, Kansas, but this record is in the east-central portion of the state and appears continuous in distribution through neighboring states to the east, and eastern Oklahoma and Texas (Hazard 1960; Tarter *et al.* 1976).

The larvae of *Chauliodes* spp. can readily be distinguished from those of other genera of megalopterans by the presence of elongate respiratory tubules on abdominal segment 8, these extending beyond the anal prolegs (Cuyler 1958). Larvae of the two species in this genus, *C. rastricornis* and *C. pectinicornis* (Linnaeus), can be differentiated by the color of the ecdysial cleavage line on the abdomen. *Chauliodes rastricornis* has a black cleavage line and *C. pectinicornis* has a yellow cleavage line (Cuyler 1958; Hazard 1960).

We collected four *C. rastricornis* larvae from the outflow area of an anthropogenic sportfishing pond in southwestern South Dakota, approximately 8 air miles south-southeast of Martin. Specifically, these larvae are labelled as follows: South Dakota, Bennett County, Lacreek National Wildlife Refuge, trout pond #2 outflow, T36N R37W sec. 25 NW1/4, 24.ix.1995, ca. Long. 10138W, Lat. 4304N, P.J. Johnson, X. Lin & K.D. Roush collrs. The recovery of these specimens confirms the presence of *C. rastricornis* in South Dakota and provides the first specific record of occurrence in the state.

Available distributional information for *C. rastricornis* from Parfin (1952), Hazard (1960), Tarter *et al.* (1976), and A. Contras-Ramos, University of Min-

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[1] Received April 10, 1996. Accepted May 4, 1996.

[2] Address for all authors: Insect Research Collection, Box 2207A, South Dakota State University, Brookings, SD 57007, U.S.A.

nesota (pers. comm., 1995) indicates that the previous confirmed westernmost records of this species in the northern Great Plains region were from Cherry and Antelope counties in the northcentral and northeastern portions of Nebraska. Otherwise, the nearest recorded sites are in Winona County, Minnesota, in the southeastern corner of the state, and Story County in central Iowa. Thus, the discovery of this species from southwestern South Dakota provides a further westward range extension.

All specimens reported herein were collected by sweeping the waters, sediments and vegetation at shoreline and near-shore areas < 0.3 m in water depth with a triangular dipnet. The pond is incompletely shaded by only scattered sapling peachleaf willow (*Salix amygdaloides*). Cattail (*Typha angustifolia*) and waterweed (*Elodea canadensis)* dominated the aquatic flora and vegetation, with only a few arrowhead (*Sagittaria latifolia*), sedge (*Carex comosa*) and burreed (*Sparganium eurycarpum)*; plant names follow Larson (1993). The sample site was 2-4 m from the entrance to a 0.5 m diameter outflow culvert but possessed a slow flow rate due to a dense cattail stand before the culvert. Surficial bottom sediments included a deep layer of unconsolidated fine organic particulates overlain with macrophyte leaves and stems in various stages of decay. No larvae were recovered in flowing water immediately below the culvert. This site agrees with generalized habitats for *C. rastricornis* (Neunzig and Baker, 1991).

Records of *C. rastricornis* from Nebraska, as cited by Tarter *et al.* (1976) and noted above, are from counties included in the Nebraska Sandhills physiographic region. The new South Dakota site is literally at the northern margin of the Sandhills. Together, these records may suggest a natural distribution through the Sandhills and that this distribution is part of the greater range of the species through adjacent states to the east and south. The disjunct pattern of occurrence could reflect land and water use changes, or local extinction of populations during the last century and prior to adequate faunal sampling. *Chauliodes rastricornis* is typically a species of lentic waters (Neunzig and Baker, 1991), though slow stream waters are also acceptable (Parfin 1952). Appropriate lentic habitats in most of South Dakota and Nebraska were few prior to extensive impoundment and pond building since the late 1800's. This suggests that a natural distribution of this species to the Lacreek Refuge through southern South Dakota would require this species to have occupied portions of rivers that drain the refuge and vicinity, including the Missouri River, White River, and Little White River. Similarly, distribution through the Nebraska Sandhills would have included the Niobrara, Elkhorn, and Loup river systems. Available distribution and collection information does not include any of these rivers as habitats for *C. rastricornis.*

Anthropogenic environmental changes may be implicated in the apparent range expansion of *C. rastricornis.* The pond from which the South Dakota specimens were collected is regularly stocked with rainbow trout (*Oncorhynchus mykiss* (Walbaum) derived from a state fish hatchery located near Rapid City, South Dakota; but no *Chauliodes* species is known from Rapid City or the Black Hills and vicinity.

Pond building and stocking since the late 1800's for support of livestock, wildlife, food fish, and sportfishing brought the introduction of non-native fishes and attendant food resource organisms. From 1899 through 1901 many species of food and game fish were rail transported in bulk and introduced into lentic and lotic waters throughout the northern Great Plains (R. Smith, U.S. Fish & Wildlife Service, Spearfish, *pers. comm.* 1996). Many of these game fishes derived from source areas in more eastern portions of the United States and within the natural range of *C. rastricornis.* Additionally, intentional and unintentional introductions of both fish and aquatic insects continue to occur in the region. For example, in October 1995, two larvae of *Corydalus cornutus* (Linnaeus) were received for identification from a pet store in Sioux Falls, South Dakota. These specimens were included with tropical fish reared and shipped from Florida, an apparently frequent event in the hobbyist fish trade.

Competing hypotheses suggesting either nativeness or introduction of *C. rastricornis* cannot be fully reconciled at this time. However, a cursory examination of the history of fisheries development in the northern Great Plains suggests that introduction of *C. rastricornis* is a strong possibility.

Specimens reported herein are deposited in the Insect Research Collection, South Dakota State University. This is report #2915 of the South Dakota Agricultural Experiment Station.

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TWO NOTEWORTHY COLLECTIONS OF TICKS (ACARI: IXODIDA: IXODIDAE) FROM ENDANGERED CARNIVORES IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC[1]

Richard G. Robbins[2], William B. Karesh[3], Susan Rosenberg[3],
Nancy Schonwalter[4], Chanthaviphone Inthavong[5]

ABSTRACT: Adults of the ixodid ticks *Haemaphysalis asiatica* and *Rhipicephalus haemaphysaloides* and nymphs of an undetermined species of *Amblyomma* are reported from a Laotian specimen of the Asian golden cat, *Catopuma temminckii*, and an adult of *Ixodes ovatus* is reported from a Laotian specimen of Owston's palm civet, *Chrotogale owstoni*. These are the first published records of any ticks from either carnivore and the first record of *I. ovatus* from the Lao People's Democratic Republic.

The escalating human assault on the world's biomes will, in the near future, obscure or obliterate host-parasite relationships that have taken eons to evolve (Windsor 1990, Rózsa 1992, Durden and Keirans 1996). In acarology, major patterns of tick-host coevolution are now relatively clear (Hoogstraal and Aeschlimann 1982, Hoogstraal and Kim 1985), but a remarkable number of terrestrial vertebrates have seldom or never been examined for these interesting and biomedically important arthropods. In January 1996, one of us (WBK) was summoned to the village of Lak Sao (18.10N, 104.55E), Khammouane Province, on the eastern border of the Lao People's Democratic Republic, to provide care for recently captured specimens of two endangered carnivores: a young adult female Asian golden cat, *Catopuma temminckii* (Vigors and Horsfield, 1827) (Felidae), and an adult male Owston's palm civet, *Chrotogale owstoni* Thomas, 1912 (Viverridae). Both animals were also examined for ticks, and complete collections from each were immediately shipped to the senior author for identification and evaluation.

The tick collection from *Ca. temminckii* comprises the following: *Haemaphysalis asiatica* (Supino, 1897), 10 males; *Rhipicephalus haemaphysaloides* (Supino, 1897), 1 female; and *Amblyomma* sp., 3 nymphs; all collected 22 Janu-

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[1] Received July 8, 1996. Accepted September 12, 1996.

[2] Armed Forces Pest Management Board, Walter Reed Army Medical Center, Washington, DC 20307-5001.

[3] Field Veterinary Program, Wildlife Health Center, Wildlife Conservation Society, 185th Street and Southern Boulevard, Bronx, NY 10460-1099.

[4] Carnivore Preservation Trust. 1940 Hanks Chapel Road, Pittsboro, NC 27312.

[5] Director, Center for Protected Areas and Watershed Management, Ministry of Agro-forestry, Vientiane, Lao P.D.R.

ENT. NEWS 108(1) 60-62, January & February, 1997

ary 1996. *Haemaphysalis asiatica* is a morphologically striking species that cannot be confused with any other member of its genus in Southeast Asia. Hoogstraal and Trapido (1966) redescribed all stages of this tick and summarized the literature on hosts (chiefly viverrids and felids) and distribution. *Rhipicephalus haemaphysaloides* occurs throughout the Oriental zoogeographic region, where it parasitizes a wide range of indigenous and introduced mammals, wild and domestic, as well as various birds (Anastos 1950, Tanskul *et al.* 1983). Of the world's approximately 103 species of *Amblyomma*, 16 occur in the Oriental zoogeographic region and at least 11 are found in continental Southeast Asia (Toumanoff 1944, Tanskul *et al.* 1983, Keirans 1992, Petney and Keirans 1995). However, immatures of many species remain poorly known and are generally "identified" by association with adults. We have been unable to locate published records of these or any other ticks from *Ca. temminckii,* a cat that is declining over much of its range, is classified as endangered by the U.S. Department of the Interior, and is on appendix 1 (species threatened with extinction that are or may be affected by trade) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Nowak 1991). This tick collection constitutes accession AGC1, MEDARKS (Medical Archives) 96-0406, Field Veterinary Program, Wildlife Conservation Society, on long-term loan to RGR.

The tick collection from *Ch. owstoni* consists of a single partly engorged female of *Ixodes ovatus* Neumann, 1899, collected 22 January 1996. *Ixodes ovatus* is the type of the monotypic subgenus *Partipalpiger* of *Ixodes* (Hoogstraal *et al.* 1973) and is both common and widespread in Asia, ranging from Japan to northeastern India and Nepal. In continental Southeast Asia, *I. ovatus* is known from Vietnam, Thailand, and Myanmar (formerly Burma) (Petney and Keirans 1994). Adults of this distinctive species usually parasitize larger mammals, including humans, but there appear to be no published records from the Lao P.D.R. and, again, no records of this or other tick species from *Ch. owstoni,* an exceedingly rare civet that is under considerable pressure from hunters (Schreiber *et al.* 1989, Nowak 1991). Indeed, the Lak Sao civet was being sold as food in the village market and is the only known living representative of its species. This tick collection constitutes accession OPC1, MEDARKS 96-0407, Field Veterinary Program, Wildlife Conservation Society, also on long-term loan to RGR.

The Wildlife Conservation Society, founded in 1895 as the New York Zoological Society, is arguably the world's premier conservation research institution, with more than 270 on-the-ground projects in 51 nations (Conway 1994). Since 1992, the senior author has been privileged to identify and provide ecological information for over 3,000 tick specimens shipped from Society research stations in Asia, Africa, and Latin America (e.g., Calle *et al.* 1994). We anticipate publishing additional host and distribution records for exotic ticks as specimens come to hand.

ACKNOWLEDGMENTS

For their constructive comments on an earlier version of this work, we thank our colleagues at the Armed Forces Pest Management Board: Colonel Phillip G. Lawyer, U. S. Army, and Captain Craig H. Forcum, U. S. Air Force. The opinions and assertions advanced herein are those of the authors and are not to be construed as official or reflecting the views of the U. S. Departments of the Army or Defense.

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NEW HOST RECORD FOR *OOENCYRTUS KUVANAE* (HYMENOPTERA: ENCYRTIDAE)[1]

Richard W. Hofstetter, Kenneth F. Raffa[2]

ABSTRACT:. Eggs of the pine tussock moth, *Dasychira pinicola* (Lepidoptera: Lymantriidae), were successfully parasitized in the laboratory by the gypsy moth egg parasitoid *Ooencyrtus kuvanae* (Hymenoptera: Encyrtidae). This is the first report of *O. kuvanae* parasitizing this species. The pine tussock moth is a pest species in Wisconsin and may be considered as an alternate host for *O. kuvanae*.

Ooencyrtus kuvanae Howard (Hymenoptera: Encyrtidae) was introduced into New England from Japan for biological control of the gypsy moth, *Lymantria dispar* (L.) (Lepidoptera.: Lymantriidae) (Crossman 1917). It successfully established, and has since spread west with the expanding gypsy moth population, including Wisconsin. *O. kuvanae* has relatively few known hosts around the world outside of the gypsy moth. It has been reared from field collected *Dendrolimus spectabilis* Butler (Lepidoptera: Lasiocampidae), *Eriogyna pyretorum* Westwood (Lepidoptera: Saturniidae), *Euproctis chrysorrhoea* L. (Lepidoptera: Lymantriidae) eggs and two gypsy moth parasitoids, *Cotesia melanoscela* Ratzeburg (Hymenoptera: Braconidae) and *Anastatus disparis* Ruschka (Hymenoptera: Eupelmidae), and has been reared in the laboratory on 8 other species of Lepidoptera: 3 Lymantriidae, 3 Saturniidae, 2 Lasiocampidae (Brown 1984, Crossman 1925, Ni *et al.* 1994, Tadić & Binčev 1959). *O. kuvanae* is multivoltine and may utilize alternative hosts throughout the year.

The pine tussock moth, *Dasychira pinicola* Dyar (Lepidoptera: Lymantriidae), is one of the most damaging defoliators of jack pine, *Pinus banksiana* Lamb, in northern Wisconsin (Sreenivasam *et al.* 1972). *D. pinicola* can also feed on red pine, eastern white pine, spruce, and fir. *D. pinicola* overwinter as early instar larvae, resume feeding in the spring, pupate in mid summer and emerge as adults in late July and August. Eggs are present throughout August.

The objective of this study was to determine whether *O. kuvanae* could successfully parasitize pine tussock moth eggs.

MATERIALS AND METHODS

The laboratory culture of *Ooencyrtus kuvanae* originated as a field collec-

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[1] Received May 28,1996. Accepted June 29, 1996.

[2] University of Wisconsin-Madison, Department of Entomology, Madison WI 53706.

tion on gypsy moth (*Lymantria dispar* L.) egg masses from Virginia. Parasitoids were collected by S. Barth and R. Cameron, Beneficial Insects Introduction Research Lab, USDA ARS, Newark, DE, in the spring of 1993. It has been cultured since that time in the laboratory on L. *dispar* egg masses provided by USDA APHIS, Otis Air National Guard Base, Cape Cod, Massachusetts. Rearing conditions were 22"C, 60% - 70% RH, and 14L:1OD. Experiments began in August of 1994 after 12 to 14 generations on gypsy moth egg masses in the laboratory.

Voucher specimens of *O. kuvanae* have been deposited in the University of Wisconsin, Madison Insect Research Collection.

Egg masses of the pine tussock moth, *Dasychira pinicola* were field collected in Douglas Co., WI in late July (1994) by Shane Weber, Wisconsin Department of Natural Resources. Individual females were placed on single 2 week old intact egg clusters, and allowed to oviposit for four days. The number and sex of emerging offspring were recorded. Also the number of emergence holes were recorded for each egg mass. Newly emerged offspring were mated and placed on *L. dispar* egg masses and allowed to oviposit.

RESULTS AND DISCUSSION

Female *O. kuvanne* successfully parasitized pine tussock moth egg masses (Table 1). The mean number of *O. kuvanae* offspring was 7.0 (4.8 std) per egg mass and 10.7 (0.58 std) per female. In comparison, parasitoids placed on gypsy moth egg masses under these conditions produce an average of 30 (14 std) offspring per egg mass and per female (Hofstetter & Raffa 1996). *O. kuvanae* progeny emerged from three of the four *D. pinicola* egg masses tested. In two egg masses, there were more offspring than number of holes, suggesting that several parasitoids emerged from one or more individual eggs. Of the egg masses that were parasitized, 35.2% (12.0 std) of the eggs per mass were successfully parasitized.

Female offspring successfully mated and parasitized gypsy moth egg masses. Progeny were observed to emerge from the gypsy moth egg masses.

The pine tussock moth is in the same family as the gypsy moth, so it is not surprising that *O. kuvanae* can successfully parasitize these eggs. The eggs are spherical, whitish, and approximately 1mm in diameter. They are deposited in loose clusters, one to two layers thick, mostly on pine needles near midcrown but also on the trunk, dead twigs, and similar vegetation.

The pine tussock moth could potentially serve as an alternate host for *O. kuvanae* when primary hosts are scarce. In addition, *O. kuvanae* could potentially add to the biological control of *D. pinicola.*

Table 1. Number of *Ooencyrtus kuvanae* progeny and percent male offspring when placed on *Dasychira pinicola* egg masses.

Mass #	No. of eggs per egg mass	No. emergence holes	Parasitoid offspring	% Male Offspring
1	47	11	11	36.4
2	19	9	11	36.4
3	21	0	0	—
4	23	8	10	30.0

ACKNOWLEDGMENTS

We thank personnel of the USDA ARS, Beneficial Insects Introduction Laboratory, particularly R. Fuester, S. Barth, and R. Cameron, for collecting and shipping *O. kuvanae,* and Shane Weber, Wisconsin DNR, for collecting and shipping pine tussock moth egg masses. Funding was provided by the Wisconsin Department of Natural Resources, The UW-Madison Graduate School, McIntire Stennis, and UW-Madison College of Agricultural and Life Sciences.

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SCIENTIFIC NOTE

FIRST HOST RECORD FOR THE GENUS *LARISSIMUS* (HYMENOPTERA: BRACONIDAE)[1]

Angélica Maria Penteado-Dias[2]

Larissimus cassander was originally described based on material collected by Fritz Plaumann in Seara (Nova Teutonia), Santa Catarina, Brazil.

The only described species in the genus, it is one of the larger Microgastrinae, with strong coloration similar to some Braconinae (Nixon, 1965) (e.g. yellow or orange and black with banded wings). At the time of its description, the species was classified in the tribe Microgastrini. Mason (1981) proposed a reclassification to Microgastrinae and considered *Larissimus* to belong to the Cotesiini.Besides the detailed description of the female, Mason (1981) provided a figure of its hind wing. At that time hosts and larvae were unknown.

In August, 1989, one female was reared from larvae of *Bertholdia sp.* (Lepidoptera: Arctiidae) collected in a forested area of the Canchim farm (Embrapa, São Carlos, SP, Brazil) on *Croton floribundus* Spreng (Euphorbiaceae). This specimen has been deposited in the taxonomic collection of the Departamento de Ecologia e Biologia Evolutiva da Universidade Federal de São Carlos (DCBU) . *Croton floribundus* is a very common plant in the secondary forest areas in Rio de Janeiro, Minas Gerais, São Paulo and Paraná states and several other species of Lepidoptera larvae are found on it.

ACKNOWLEDGMENTS

I gratefully acknowledge the help of Manoel Martins Dias Filho (UFSCar) by providing the name of the lepidopteran host. This work was supported by Conselho Nacional de Desenvolvimento Cientifico e Tecnológico (CNPq) from Brazil.

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[1] Received June 15, 1996. Accepted July 5, 1996.

[2] Departamento de Ecologia e Biologia Evolutiva, Universidade Federal de São Carlos. CP 676. CEP 13 565-905. São Carlos, SP, Brasil.

BARK BEETLE (COLEOPTERA: SCOLYTIDAE) OUTBREAK IN PINE FORESTS OF THE SIERRA DE LAS MINAS BIOSPHERE RESERVE, GUATEMALA[1]

Robert A. Haack[2], Gerardo Paiz-Schwartz[3]

ABSTRACT: From 1992 to 1995 an outbreak of pine-infesting bark beetles occurred in eastern Guatemala, primarily along the southern slopes of the Sierra de las Minas Mountains, between 500 and 2100 m elevation, in the Departments of El Progreso and Zacapa. Based on examination of bark beetle-killed pine *(Pinus)* trees at several sites, *Dendroctonus frontalis* was the principal mortality agent and *Pinus oocarpa* was the most affected tree species. Egg galleries similar to those of *D. frontalis* were also found on dead *Pinus maximinoi* and *Pinus tecunumanii* trees. Infested pine stands were typically unmanaged, overstocked, and located on steep slopes. In addition, most outbreak areas had experienced frequent ground fires and overgrazing. The ultimate stressing agent that apparently triggered this outbreak was a severe regional drought in 1992. Besides *D. frontalis,* other scolytids collected along the lower trunk of *P. oocarpa* trees were *Dendroctonus parallelocollis, Ips calligraphus, Ips grandicollis, Pityophthorus confusus,* and *Xyleborus intrusus.* At lower elevations, *Ips calligraphus* was the only scolytid collected from the lower trunk of infested *Pinus caribaea* trees.

Bark beetle (Coleoptera: Scolytidae) outbreaks in the pine *(Pinus* spp.) forests of Guatemala have been recorded since the late 1800s, with outbreaks this century occurring during the 1930s, 1950s, 1970s, and 1980s (Alvarado 1939, Schwerdtfeger 1955, Haack 1995). Most of these outbreaks occurred in the western highlands of Guatemala, primarily in the Departments of Huehuetenango and Totonicapan, but during the outbreaks of the 1970s and 1980s, pines in several other western departments were affected. Although several species of bark beetles in the genera *Dendroctonus* and *Ips* were encountered during these past outbreaks, *Dendroctonus adjunctus* Blandford was recognized as the principal mortality agent (Becker 1955, Schedl 1955, Schwerdtfeger 1955, 1956, 1959, 1961). During these outbreaks, *Pinus rudis* Endlicher was the most severely affected pine species, but also attacked were *Pinus maximinoi* H.E. Moore (= *Pinus tenuifolia* Bentham), *Pinus montezumae* Lambert, *Pinus oocarpa* Schiede, and *Pinus pseudostrobus* Lindley. In this paper, we use the pine nomenclature given in Perry (1991). Few outbreaks have been reported in pine forests of eastern Guatemala, which consists largely of *P. oocarpa* and *Pinus caribaea* Morelet. However, several major outbreaks have occurred this cen-

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[1] Received March 28, 1996. Accepted April 28, 1996.

[2] USDA Forest Service, North Central Forest Experiment Station, 1407 South Harrison Road, East Lansing, Michigan 48823, USA.

[3] Fundación Defensores de la Naturaleza, Avenida Las Americas 20-21, Zone 14, Guatemala City, Guatemala.

tury in the *P. oocarpa* forests of neighboring Honduras; the most severe outbreak took place during the 1960s, when about 20% of the pines in Honduras were killed, primarily by *Dendroctonus frontalis* Zimrnermann (Beal *et al.* 1964, Ketcham and Bennett 1964, FAO 1968, Wilkinson and Haack 1987). In both

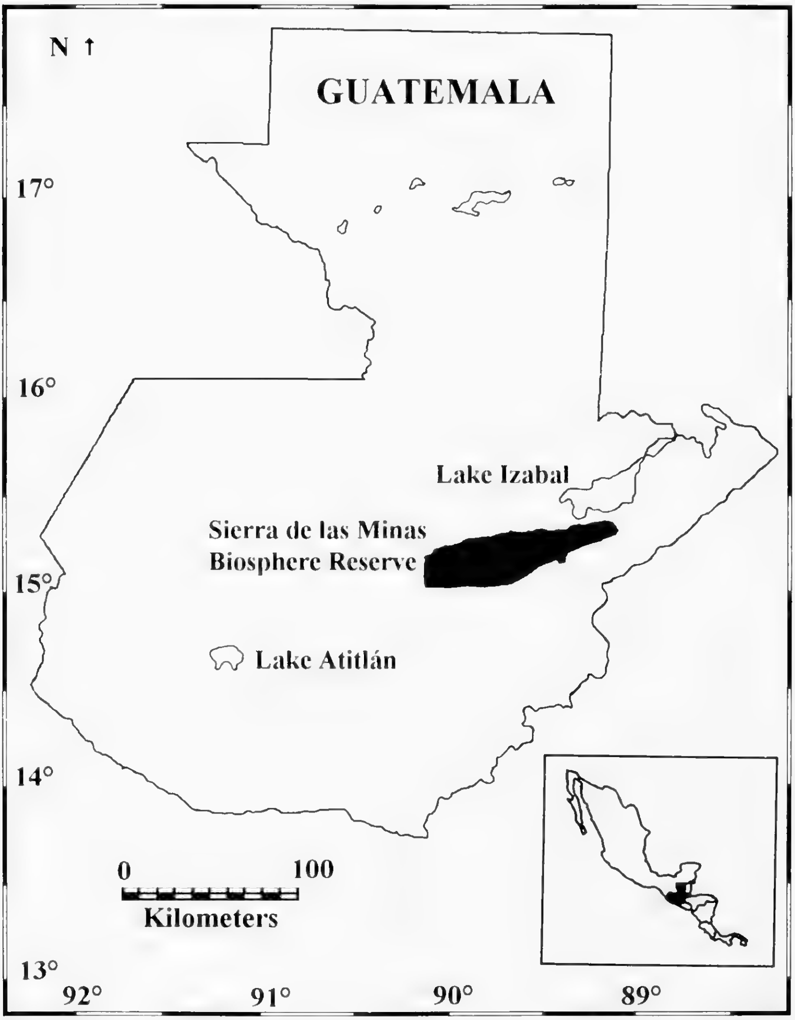

Fig. 1. Outline map of Guatemala, showing location of the Sierra de las Minas Biosphere Reserve (shaded area). Insert map shows outline of Mexico and Central American countries, with Guatemala shaded.

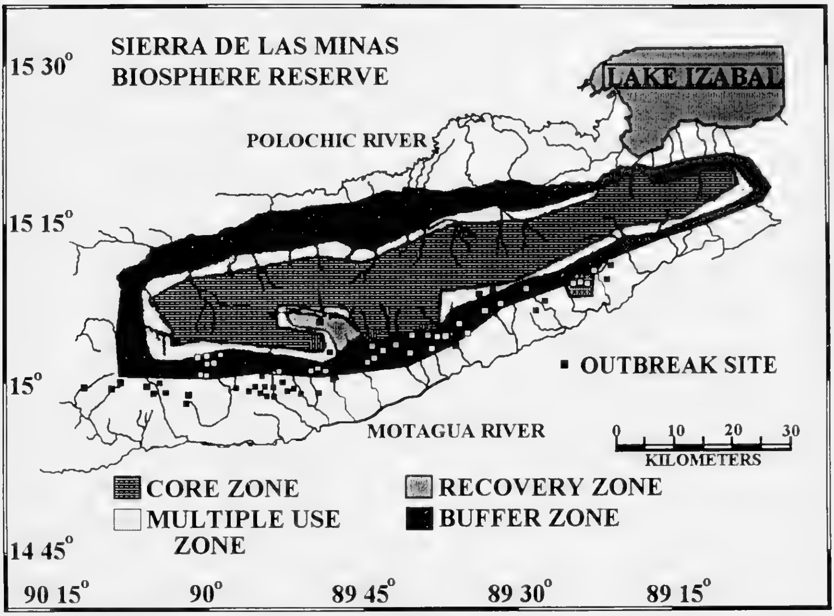

Fig. 2. Outline map of the Sierra de las Minas Biosphere Reserve, indicating the location of the four management zones and the major bark beetle outbreak sites (squares, either black or white).

Guatemala and Honduras, it appears that poor forest management, overmature stands, frequent fires, overgrazing, and drought were the major contributing factors in these outbreaks (Beal *et al.* 1964, Ketcham and Bennett 1964, Schwerdtfeger 1955, Wilkinson and Haack 1987).

This paper deals with a bark beetle outbreak that occurred during 1992-1995 in the Sierra de las Minas Biosphere Reserve in eastern Guatemala (Figs. 1-2). This site, recognized by UNESCO as a Biosphere Reserve in 1993, is administered by Fundación Defensores de la Naturaleza, a non-governmental organization located in Guatemala. The senior author visited the outbreak area in August 1995 to help evaluate the situation and recommend management options (Haack 1995).

The Sierra de las Minas is a chain of mountains in eastern Guatemala that runs mostly east to west (Figs. 1 -2). This mountain range is about 150 km long, 10-30 km wide, and varies in elevation between 150 m and 3015 m (Dix 1996). There are 63 rivers that drain the Sierra de las Minas, feeding into the Polochic River to the north and the Motagua River to the south (Fig. 2). Mean annual rainfall varies from 0.5 to 4.0 m. The area's vegetation is diverse, including seven Holdridge life zones that range from dry forests to cloud forests (Holdridge *et al.* 1971, Dix 1996). There are 13 species of conifers in the Sierra de las Minas, representing 6 genera: *Abies, Cupressus, Juniperus, Pinus, Podocarpus,* and *Taxus* (Dix 1996). Of these 13 species, there are 6 *Pinus* species; *P. oocarpa* is found at elevations between 500 and 2750 m, *P. maximinoi* between 1100 and 2400 m, *P. tecunumanii* Schw. above 1500 m, *P. caribaea* below 800 m, *P. pseudostrobus* above 1600 m, and *P. ayacahuite* Ehrenb. above 2000 m.

The Sierra de las Minas Biosphere Reserve, 130 km long and 15-30 km wide, covers much of the Sierra de las Minas Mountains. The Reserve is 236,300 ha in size and is divided into four management zones, i.e., the core zone (105,700 ha), recovery zone (4200 ha), multiple use zone (34,600 ha), and buffer zone (91,800 ha; Fig. 2). In the core zone of the Sierra de las Minas Biosphere Reserve, no economical activities are allowed and the natural resources are protected. In the recovery zone, restoration activities are conducted. In the multiple use zone, sustainable resource use is allowed, including the extraction of wood products. In the buffer zone, communities are established and agriculture is allowed. Typically, the buffer zone of a Biosphere Reserve supports forestry, low-intensity agriculture, recreation, and scattered small settlements (Gregg 1991).

METHODS

Several outbreak areas were visited in late 1994 and early 1995 by the junior author and various cooperators. During these visits, data were taken on elevation, presence or absence of bark beetles, size of the affected area, and pine species affected. During August 1995, both authors visited nine outbreak sites throughout the affected area and recorded information on elevation, pine species affected, and the current status of the outbreak. When we encountered bark-beetle killed pines that had been cut or had fallen, we noted the within-tree distribution of the various groups of bark beetles along the trunk and branches. This determination was based on the distinctive egg galleries that are created by *Dendroctonus, Ips,* and other bark beetles (Wood 1982, Kirkendall 1983, Cibrian *et al.* 1995). Occasionally, we found dead adults in the egg galleries of attacked trees; such adults were used to make positive associations between a particular bark beetle species and its egg gallery pattern. For several pines that were currently under attack, the bark was removed from the lower trunk and several scolytid specimens were collected. A few currently infested pines were felled and inspected for bark beetles. Scolytid specimens were identified by Stephen L. Wood. In the present paper, we use the scolytid names as given in Wood (1982) and Wood and Bright (1992). All required permits for this study were obtained from CONAP (Cosejo Nacional de Areas Protegidas = Guatemalan National Council for Protected Areas). Voucher specimens were deposited in the museum of the Universidad del Valle, Biology Department, Guatemala City, Guatemala.

RESULTS AND DISCUSSION

Host Trees and Associated Scolytids. Bark beetle outbreak sites were located along the southern slopes of the Sierra de las Minas Mountains in the Departments of El Progreso and Zacapa (Fig. 2). Most outbreak sites occurred within the buffer zone of the Biosphere Reserve or just outside of it (Fig. 2). The outbreak sites occurred at elevations between 500 and 2100 m, primarily in lower montane moist forests dominated by *P. oocarpa.* For 43 individual outbreak sites from separate watersheds that were visited in late 1994 and early 1995, the average outbreak area was 16 ha (range 1-95 ha) and the average elevation was 1200 m (range 500-2100 m). By August 1995, more than 50 outbreak sites had been recorded in the Sierra de las Minas Mountains, covering more than 900 ha.

The vast majority of the bark beetle-killed pines in the Sierra de las Minas were *P. oocarpa.* The diameter at breast height (1.4 m) of most bark beetle-killed *P. oocarpa* trees ranged from 10 to 40 cm. The second most affected pine species was *P. maximinoi,* and the third most often attacked was *P. tecunumanii.*

Specimens of six scolytid species were collected from the lower trunk of currently infested *P. oocarpa* trees in August 1995, including *Dendroctonus frontalis, Dendroctonus parallelocollis* Chapuis, *Ips calligraphus* (Germar), *Ips grandicollis* (Eichhoff), *Pityophthorus confusus* Blandford, and *Xyleborus intrusus* Blandford. Species of *Dendroctonus, Ips,* and *Pityophthorus* are phloem feeding bark beetles, while *X. intrusus* is a xylem-infesting ambrosia beetle.

In dead *P. maximinoi* and *P. tecunumanii* trees, from which the bark beetles had already exited, egg galleries similar to those of *D. frontalis* dominated along the entire trunk. It is possible that other species of *Dendroctonus,* such as *D. mexicanus* Hopkins or *D. vitei* Wood, could have made some of the galleries, especially at higher elevations within the outbreak area. Adult size and egg gallery pattern are similar among *D. frontalis, D. mexicanus,* and *D. vitei* (Vite *et al.* 1974, Renwick *et al.* 1975, Wood 1982, Lanier *et al.* 1988), and thus identification by egg galleries alone is difficult. In areas of Mexico where both *D. frontalis* and *D. mexicanus* occur, *D. frontalis* is found at elevations below 2000 m, while *D. mexicanus* is found between 1800 and 2500 m (Lanier *et al.* 1988). In Honduras, *D. frontalis* was collected from *P. oocarpa* trees between 1400 and 1700m (Wilkinson and Haack 1987). *Dendroctonus vitei* was first recognized in 1974 (Wood 1974) and is so far known from Guatemala and southern Mexico (Wood and Bright 1992); it has been collected between 2000 and 2500 m in Guatemala (Vite *et al.* 1974, 1975). *Dendroctonus mexicanus* has been reported from *P. oocarpa,* but *D. vitei* has not (Wood and Bright 1992).

At the eastern edge of the Sierra de las Minas near Lake Izabal (Fig. 2), a few bark beetle-killed *P. caribaea* trees were found at elevations below 800 m. These trees were not part of the main outbreak area. *Ips calligraphus* was the only scolytid that we found on the lower trunk of currently infested *P. caribaea* trees.

There are few reports of *D. frontalis* in Guatemala (Moser *et al.* 1974, Lanier *et al.* 1988, Wood and Bright 1992). According to Wood and Bright (1992), *D. frontalis* occurs from the southeastern United States to Honduras. Adults, 2.0 to 3.2 mm long, attack several species of pine, including *P. maximinoi, P. oocarpa,* and *P. tecunumanii* in Mexico and Central America (Wood 1982, Cibrian *et al.* 1995). In the genus *Dendroctonus,* females initiate attack, produce an aggregation pheromone, and are monogynous (i.e., joined by a single male). In Honduras, it is estimated that *D. frontalis* may complete as many as nine generations per year (Beal *et al.* 1964). When reading the earlier *Dendroctonus* literature it is important to note that Wood (1963) synonymized *D. mexicanus* under *D. frontalis,* but later he (Wood 1974) recognized them again as two distinct species.

Dendroctonus parallelocollis ranges from Mexico to Honduras (Wood and Bright 1992, Cibrian *et al.* 1995). Adults, 4.9 to 6.3 mm long, have been recorded from four species of pine, including *P. oocarpa* (Becker 1955, Schedl 1955, Wood 1982, Cibrian *et al* 1995). Attack by this beetle occurs along the lower trunk and major roots of pine trees and is usually associated with *D. frontalis* and *D. mexicanus* (Wood 1982, Cibrian *et al.* 1995). Care must be used when reading the literature since Wood and Bright (1992) state that references to *D. parallelocollis* from 1909 to 1969 actually refer to *Dendroctonus approximatus* Dietz.

Ips calligraphus occurs in eastern North America, the southern and southwestern United States, Mexico south to Nicaragua, and the Caribbean islands of the Dominican Republic, Bahamas, and Jamaica (Lanier 1972, Yates 1972, Garraway 1986, Haack *et al.* 1989, Bunce and McLean 1990, Wood and Bright 1992). Adults are 3.8 to 5.9 mm long and have six spines along their elytral declivity. *Ips calligraphus* attacks several species of pine, including *P. caribaea, P. maximinoi,* and *P. oocarpa* (Schedl 1955, Wood 1982, Cibrian *et al.* 1995). In the genus *Ips,* males initiate attack, produce an aggregation pheromone, and are polygynous (i.e., joined by two or more females). In Florida and the Dominican Republic, *I. calligraphus* can complete 8 to 12 generations per year (Haack 1985, Haack *et al.* 1989). It is important to note that *Ips interstitialis* (Eichhoff) was synonymized under the name *I. calligraphus* by Wood (1982), and that most early papers on Guatemalan six-spined *Ips* mention only *I. interstitialis* (Becker 1955, Schedl 1955, Schwerdtfeger 1956).

Ips grandicollis occurs in eastern North America; Mexico south to Nicaragua; and various Caribbean islands (Wood and Bright 1992). Adults are usually 2.9 to 4.6 mm long and have five spines along their elytral declivity. They attack several species of pine, including *P. caribaea* and *P. oocarpa* (Wood 1982, Cibrian *et al.* 1995), and their biology is very similar to that of *I. calligraphus.* Readers should note that early papers on Guatemalan five-spined *Ips* usually mention only *I. cribricollis* (Eichhoff) (Becker 1955, Schedl 1955, Schwerdtfeger 1956); however, *I. cribricollis* was placed in synonymy with *I. grandicollis* by Wood (1977). Although Lanier (1987) stated that these two *Ips* species were distinct and that both occur in Central America, Wood and Bright (1992) continue to regard *I. cribricollis* as a synonym of *I. grandicollis.*

Pityophthorus confusus occurs from the southern United States to Nicaragua (Wood and Bright 1992). Adults, 1.9 to 2.9 mm long, have been recorded on several species of pine, including *P. oocarpa* (Becker 1955, Schedl 1955, Bright 1981, Wood 1982, Wilkinson and Haack 1987). Like *Dendroctonus* and *Ips* bark beetles, *P. confusus* breeds in the phloem (inner bark). Males initiate attack and are polygynous, usually with 2 to 5 females joining each male. Galleries may extend in any direction. *Pityophthorus confusus* usually infests the trunk and branches of pine trees that are already under attack by species of *Dendroctonus* or *Ips* (Bright 1981, Wilkinson and Haack 1987).

Xyleborus intrusus has a geographic range that extends from Canada to Honduras, including certain Caribbean islands (Bunce and McLean 1990, Wood and Bright 1992). Adults, 2.2 to 2.7 mm long, have been recorded from several species of pine, but no specific host records were given for Guatemala (Wood 1982, Wood and Bright 1992). The occurrence of *X. intrusus* on *P. oocarpa* is apparently a new host record. Little is known about the biology of *X. intrusus.* In general, beetles in the genus *Xyleborus* construct their many branched galleries in the sapwood of the host tree. An ambrosial fungus is cultivated on the gallery walls, and the larvae feed on this fungus. Males are rare in the genus *Xyleborus,* and when they do occur, they are flightless. *Xyleborus* females typically mate with their brothers before leaving the host tree. Wood (1982) reports that *X. intrusus* usually attacks the base of recently killed, standing pine trees.

Bark Beetle Attack Sequence and Within-Tree Distribution. Based on our inspection of the egg and larval galleries in dozens of already dead *P. oocarpa* trees, *D. frontalis* was the first bark beetle to attack, and was found from groundline into the lower crown branches. *Ips* and *Pityophthorus* galleries were found along the lower trunks of these same trees, but they were most common along the upper trunk and main branches. Galleries of *D. parallelocollis* were found only along the lower 2-3 meters of the trunk. These observations on within-tree distribution are similar to those made for bark beetles on *P. oocarpa* in Honduras (Wilkinson and Haack 1987).

Possible Contributing Factors and Current Conditions. Pine forests in the Sierra de las Minas are subjected to many environmental stresses. Most outbreak areas consisted of mature, overstocked stands, on steep slopes with shallow soils. In addition, most affected stands had a history of frequent ground fires and overgrazing. Such conditions have been listed as contributing factors to pine bark beetle outbreaks in Guatemala, Honduras, and the Dominican Republic (Schwerdtfeger 1955, Beal *et al.* 1964, Ketcham and Bennett 1964, FAO 1968, Wilkinson and Haack 1987, Haack *et al.* 1989). Another factor that likely favored the current bark beetle outbreak in Guatemala was a severe drought throughout the Motagua River Valley in 1992. Outbreaks of pine bark beetles have often been reported during or soon after periods of severe drought (Mattson and Haack 1987), although the link between drought and outbreaks of *D. frontalis* in the United States is not clearcut (Turchin *et al.* 1991).

In August 1995, very few pines were currently under attack and the outbreak appeared to be collapsing. The vast majority of the bark beetle-killed pine trees had died during 1993, 1994, and the first half of 1995. The 1995 rainy season was among the wettest on record in the Motagua River Valley, and this likely improved tree resistance (Mattson and Haack 1987). In addition, in August 1995, natural enemies of bark beetle were very common under the bark of currently infested *P. oocarpa* trees, including larvae of predatory beetles (Cleridae, Histeridae, Tenebrionidae, Trogositidae), larvae of predatory flies (Dolichopodidae), and signs of parasitism by various Hymenoptera (exit holes and cocoons in larval bark beetle galleries). Pressure from these natural enemies likely aided in the collapse of the current *D. frontalis* outbreak, as has been suggested for *D. frontalis* outbreaks in the United States (Turchin *et al.* 1991, Reeves *et al.* 1995). Lists of predators, parasitoids, and other associated arthropods of pine bark beetles have been previously reported for Guatemala (Becker 1955, Schedl 1955, Moser *et al.* 1974) and Honduras (Clark 1974).

ACKNOWLEDGMENTS

We thank the USDA Forest Service and Fundación Defensores de la Naturaleza for financial and logistical support; the US AID office in Guatemala for logistical support; Stephen Wood, Brigham Young University, for identifying the bark beetles; and Peter Lorio, USDA Forest Service, and Kenneth Raffa, University of Wisconsin, for reviewing an earlier version of this paper.

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SOCIETY MEETING OF OCTOBER 23, 1996

ECOLOGICAL WANDERINGS IN THE ORIENT

Paul W. Schaefer
Beneficial Insects Introduction Research Laboratory, USDA, Newark, DE

Through years (beginning in 1975) of having foreign exploration experiences in Japan, Korea, People's Republic of China, Hong Kong and Taiwan, Dr. Schaefer presented a brief summary of the various projects that he has worked on in the Orient. These include principally the gypsy moth, *Lymantria dispar* and its close relatives, *Lymantria* spp. (Lepidoptera: Lymantriidae), but other explorations involved the Mexican bean beetle, *Epilachna varivestis* (Coleoptera: Coccinellidae), Japanese beetle, *Popillia japonica* (Coleoptera: Scarabaeidae), Larch casebearer, *Coleophora laricella* (Lepidoptera: Coleophoridae), beneficial coccinellids, including *Harmonia axyridis* (Coleoptera: Coccinellidae) and the chestnut gall wasp, *Dryocosmus kuriphilus* (Hymenoptera: Cynipidae). Inasmuch as many of these projects have involved the recovery of very small, nondescript, generally uninteresting insect species to most people, Dr. Schaefer focused his camera lens on some *other* insects encountered incidental to his main research projects. This was often done through opportunities to observe his host Japanese, Chinese and Taiwanese scientists conducting their individual research projects, including such activities as black lighting and pheromone trapping for moths, sampling various insect populations, and frass and/or biomass collections. A series of color illustrations of insects was shown as a means of illustrating a small part of the diversity of Asian insect life. The magnificent diversity of Oriental species as well as the great variation in form, color and function was the underlying theme for the evening.

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8 MARCH & APRIL, 1997 US ISSN 0013-872X
NO. 2

ENTOMOLOGICAL NEWS

THE AMERICAN ENTOMOLOGICAL SOCIETY

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THE STATUS OF SOME SPECIES OF *ENALLAGMA* (ODONATA: ZYGOPTERA: COENAGRIONIDAE)[1]

Michael L. May[2]

ABSTRACT: I have investigated the identity and generic placement of five little known species of coenagrionid damselflies usually assigned to *Enallagma.* Of these, *E. camerunense* is shown not to belong to *Enallagma* but probably to be an aberrant *Pseudagrion. Enallagma kauderni,* commonly regarded as a subspecies of *E. nigridorsum,* appears to be as well-differentiated from the latter as either is from *E. vansomereni,* so I consider *E. kauderni* to be a full species. Examination of the type of *Enallagma melanotum* demonstrated it to be identical with *Agrion* (now *Cercion*) *sexlineatum. Enallagma psuedalongatum* has been incorrectly placed as a synonym of *E. elongatum* in recent catalogs, probably owing to misinterpretation of Fraser's (1947) comparison of these distinct species. Finally, *E. strouhali* is apparently identical with the earlier described *E. risi;* I also discuss the possible relations of these taxa to *E. cyathigerum* and *E. boreale.*

The genus *Enallagma,* as currently understood, has been characterized largely by default, i.e., on the basis of plesiomorphic characters shared with numerous other coenagrionid genera (e.g., anal vein separating from the wing margin before Ac, R_3 separating from R_2 near the 5th and 4th postnodal crossveins in the fore- and hindwings respectively, pterostigmata similar in all wings of both sexes, a rounded frons, postocular spots present, and females with a vulvar spine on the sternum of abdominal segment 8 [Selys, 1876; Munz., 1919; Kennedy, 1920b]) and by the absence of the derived characters that distinguish presumably related genera (i.e., the dorsoapical prominence of abdominal segment 10 of male *Ischnura*). Appropriate synapomorphies have not been recognized that serve to diagnose *Enallagma* unambiguously.

As a consequence, *Enallagma* is a large and unusually diverse genus with strong, disjunct centers of diversity in eastern North America and subsaharan Africa, and a scattering of species in the Palearctic and Oriental regions (Haritonov & Belyshev, 1980). This strong concentration of species in two areas that have been geologically separated for at least 90 MY (and perhaps up to 170 MY; Windley, 1984) suggests the independent radiation of two clades, isolated either by vicariance or, more probably, by dispersal in these regions. No generally acceptable characters have been proposed to distinguish them, however. Kennedy (1920a) separated the African species into three genera, *Africallagma* (type species, *Agrion glaucum* Burmeister), *Ischnallagma* (type, *Ischnura elongata* Martin), and *Proischnura* (type, *Enallagma subfurcatum*

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[1] Received July 5, 1996. Accepted August 20, 1996.

[2] Department of Entomology, New Jersey Agricultural Experiment Station, Cook College, Rutgers University, New Brunswick, NJ 08903, U. S. A.

Selys), but these also were ill-defined and have not been widely accepted (e.g., Longfield, 1936; Bridges, 1994).

It is hardly surprising, then, that of the 70 extant species of *Enallagma* listed by Bridges (1994) at least a dozen are of uncertain identity, mostly because their descriptions are not decisive as to generic placement or possible synonymy with other species and because the species have not been clearly identified or redescribed subsequently. In this paper I attempt to clarify the status of five of these.

MATERIALS AND METHODS

Visual observations and drawings were made with a Wild™ stereomicroscope equipped with a camera lucida. When possible, structural details, especially of the penes, were examined using an Hitachi™ S510 electron microscope after coating with gold-palladium. Descriptive terminology for venation is that of Tillyard and Fraser (1938) and for the male caudal appendages that of Snodgrass (1954). Collections from which material was obtained are designated by the following acronyms: CM – Carnegie Museum of Natural History (Pittsburgh); CU – Cornell University Collection; IRSN – Institut Royal des Sciences Naturelles (Brussels); MLM – collection of M.L. May; MNB – Museum für Naturkunde der Humboldt Universität, Berlin; NMNH – National Museum of Natural History (Smithsonian Institution, Washington); NHMV – Naturhistorisches Museum, Vienna; RU – Rutgers University Collection.

Synonymies are not exhaustive but include selected works bearing directly on the taxonomic status of the species. Recent general catalogs (Bridges, 1994; Davies & Tobin, 1985; Tsuda, 1991) are omitted because all three of these include all the listed names.

RESULTS AND DISCUSSION

Enallagma camerunense Karsch

Enallagma camerunense: Karsch 1899, p. 8 (male descr.); Pinhey 1962, p. 29 (taxon. and distrib. note).

Besides the type series, comprising two males from Cameroon, this species has apparently been reported only by Pinhey (1962), who examined a specimen from Ghana. He considered it "not a true *Enallagma*", but gave no reason for this opinion. I obtained the types, both now lacking abdominal segments 5-10, from the MNB. Their colors are very well preserved, and virtually identical, but one has the mesepisternum broken as though by a pinhole, and from this specimen (date label "15/5 96") I dissected the penis; I here take the opportunity to designate the other, more intact specimen as the lectotype and have added a label with this designation (white, orange bordered, printed with "E. camerunense, LECTOTYPE, M. May 1996"; above this are the following labels: blue, printed "N. Kamerun, Johann Albrechtshöhe, 18 VIII-30 IX 96, L. Conradt S."; red, printed "Type" with "Syn-" handwritten in front; pale yellow, printed, "Zool. Museum, Berlin").

The color pattern was described in some detail by Karsch (1899), but only verbally, and minor discrepancies exist between description and specimens, so the head, thorax, and two basal abdominal segments are illustrated in Fig. 1. Most of the pale areas are orange or yellowish, but the postocular spots are blue green, the dorsal abdominal pale areas bright blue (these become yellowish laterally), and an indistinct metepisternal stripe pale bluish; these areas were described by Karsch as "gelb". Otherwise, however, the color pattern, hindwing measurements, and dates agree exactly with the description, so I believe these are correctly identified as the types, although they bear no determination label.

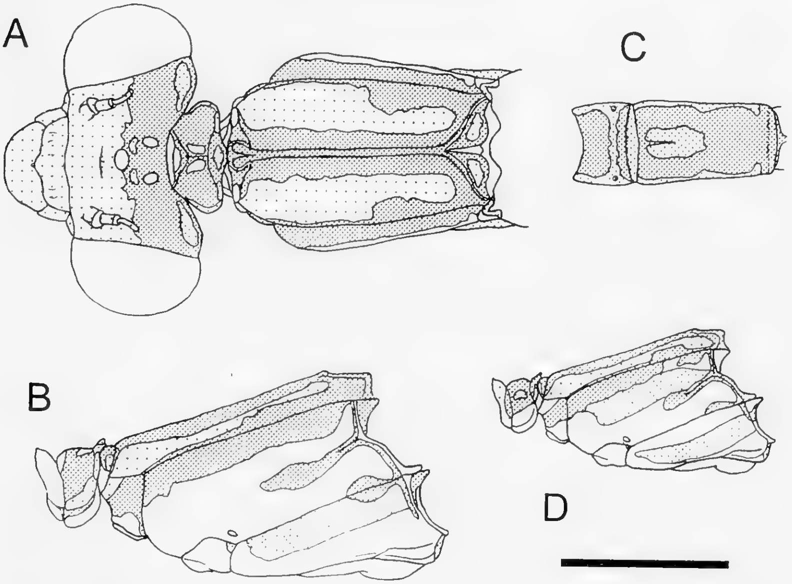
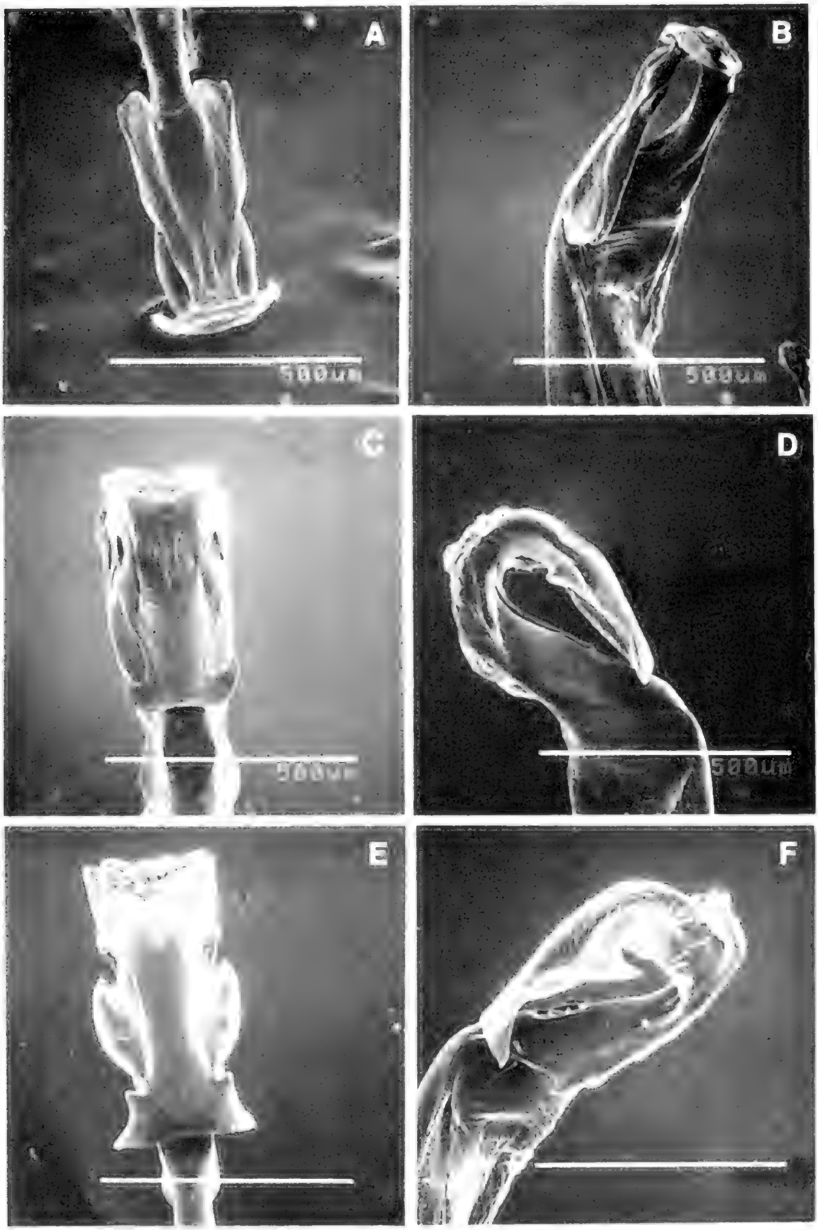


Figure 1: Color pattern of *Enallagma camerunense* Karsch, lectotype (A-C) and *Pseudagrion sublacteum* (Karsch), Kenya, L. Victoria, NMNH, ident as *P. pseudomassaicum rusingae* by Pinhey (D).- A: head and thorax, dorsal view; - B, D: thorax, lateral view: - C: first and second abdominal segments, dorsal view. Heavy stippling - black; intermediate - blue (note that mes- and metepimeral blue stripes are much paler than other blue areas and merge gradually with surrounding cream to yellow-green areas); light - bright orange; none - pale orange to cream. Scale bar = 2.0 mm for A-C, 3.0 mm for D.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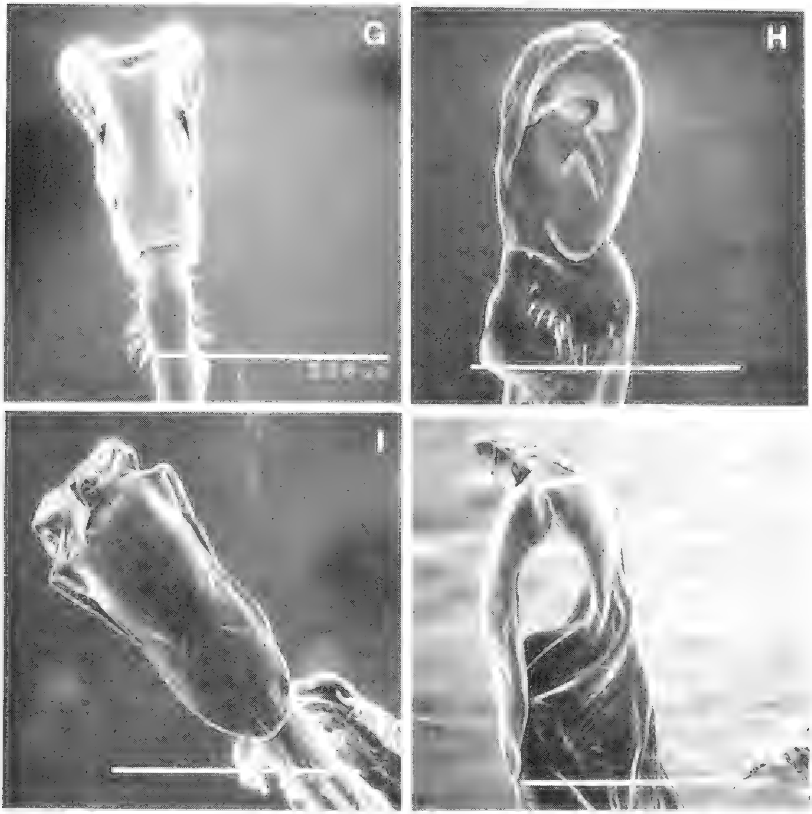

Figure 2: Penes of: *Enallagma camerunense* Karsch, paratype (A, B); *Enallagma cyathigerum* Charpentier), Canada, B.C., nr Haney, RU (C, D); *Enallagma antennatum* (Say), U.S.A., Nebraska, Dodge Co., RU (E, F); *Enallagma glaucum* (Burmeister), South Africa, Bloemfontein, CM (G, H); *Pseudagrion sudanicum* LeRoi, Zimbabwe, Masuma R., NMNH, ident. as *P. rubroviridis* by Pinhey. - A, C, E, G, I: ventral views (note that in A only, the apex points upward); - B, D, F, H, J: lateral views. Scale is equal for all figures (scale bar = 0.5 mm).

In particular, the narrowing of the orange antehumeral stipes is distinctive and not found in other *Enallagma.* This is a result of marked inward expansion of the black humeral stripes in the vicinity of the shallow depression (the mesopleural fossa) at the upper end of each mesopleural suture, a feature of coloration present but much less strongly developed in many other coenagrionids.

In the absence of the caudal appendages, the penis seems to offer the best opportunity to determine the affinities of the specimens. This is shown in Fig. 2, where it is compared to those of the North American *Enallagma cyathigerum* (Charpentier) and *E. antennatum* Say and the African *E. glaucum* (Burmeister). It is dissimilar to all of these (e.g., in lacking an internal fold and well-developed laterodistal lobes) and to other African species (Fig. 3) but somewhat resembles that of, e.g., *Pseudagrion sudanicum* LeRoi (Fig. 21, J). In addition. the thoracic color pattern is reminiscent of that of *P. sudanicum* and even more so of *P. sublacteum* (Karsch) (Fig. 1 D), especially in the combination of dorsal orange and lateral bluish coloring and the encroachment of the humeral on the antehumeral stripe near the mesopleural fossa. The latter is not present in all *Pseudagrion* but occurs in several other species I examined at the NMNH (and see Pinhey, 1973, his Fig. 3). The venation of both *camerunense* specimens is like that of *Enallagma* in that the anal vein diverges from the wing margin well before Ac. However, although in *Pseudagrion* the separation of the anal vein generally occurs at or barely before Ac, Pinhey (1964) noted that this separation can be as far before Ac as in *Enallagma.* Based on penile morphology, coupled with its unusual color pattern, *camerunense* clearly appears not to be an *Enallagma* and is most likely to belong in *Pseudagrion.* It is not identical to any *Pseudagrion* species that I have examined or that Pinhey (1964, 1973) keyed or illustrated, although the penis is also somewhat similar to *P. sjöstedti,* a species showing great variability in coloration; the color pattern is rather like *P. serrulatum* but the penis of that species is quite different. For now I suggest it stand as *Pseudagrion camerunense* (Karsch), especially since that name would have priority over any likely synonyms.

Enallagma kauderni (Sjöstedt)

Ischnura kauderni Sjöstedt 1917, p. 4 (female descr.; figs.).
Enallagma nigridorsum forma b: Ris 1921, p. 323 (male, female descr.; figs.).
Enallagma nigridorsum kauderni: Schmidt 1951. p. 207 (male, female descr.; figs.).
Enallagma kauderni: Lieftinck 1965, p. 253 (listed without comment).

Although described by Sjöstedt (1917) in *Ischnura, E. kauderni* was recognized by Ris (1921) as being closely related to *Enallagma nigridorsum* Selys and has been placed as a subspecies of the latter by most recent authorities (Davies & Tobin, 1985; Tsuda, 1991; Bridges 1994) except Lieftinck (1965). It is difficult to resolve the true relationship of these species, since *kauderni* apparently is confined to Madagascar and the Comoros Islands and hence is nowhere sympatric with *nigridorsum.* Nevertheless, I believe *E. kauderni* should be recognized as a full species. *Enallagma nigridorsum, E. vansomereni* Pinhey, and *E. kauderni* form a compact species group (May, unpublished data; *E. somalicum* Longfield is also close). Figs. 3 and 4 compare the caudal appendages and penes of these three species. The cerci of all three have a smooth

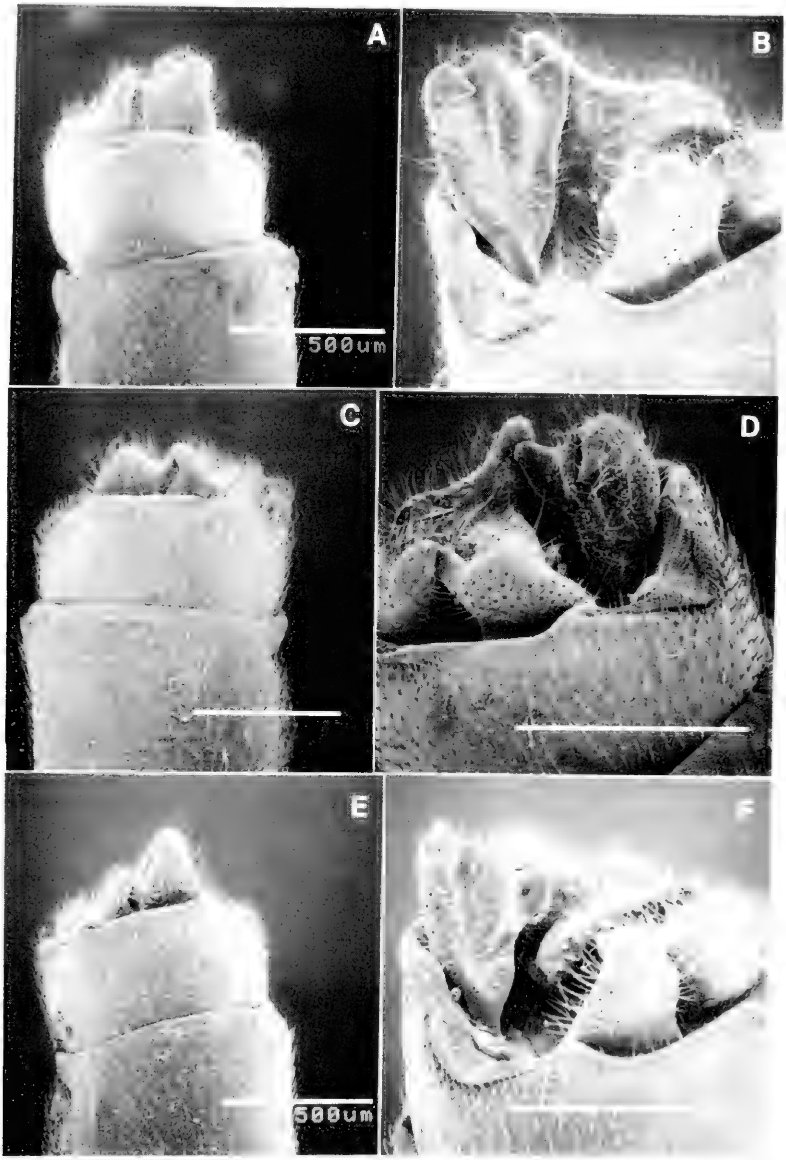

Figure 3: Caudal appendages of *Enallagma kauderni* (Sjöstedt), Madagascar, NMNH (A, B); *E. nigridorsum* Selys, Tanzania, Arusha, NMNH (C, D); and *E. vansomereni* Pinhey, Uganda, Paimol, Aicholi, NMNH (E, F). - A, C, E: tenth abdominal segment and caudal appendages, lateral view (note that the dorsum is to the right in A, E, to the left in C); - B, D, F: caudal appendages, oblique dorsolateral view (from left in B, F, from right in D). Scale bars = 0.5 mm.

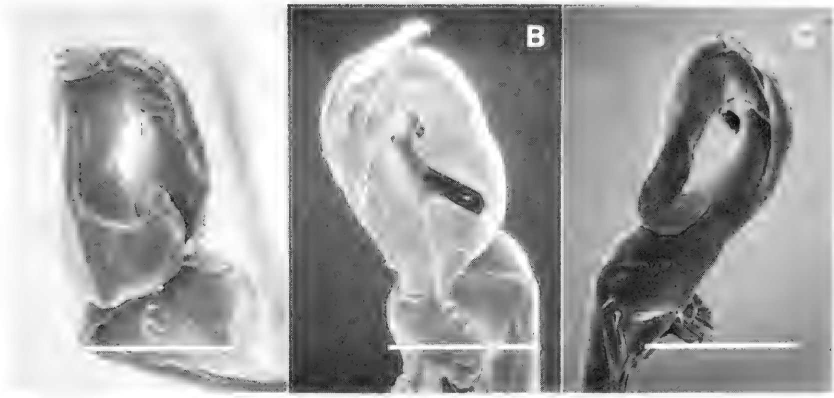

Figure 4: Penes of *Enallagma kauderni* (A), *E. nigridorsum* (B), and *E. vansomereni* (C), lateral view; specimens same as in Fig. 3. Scale bars = 0.2 mm.

dorsal hook with its edge more or less dorsoventrally elongated, a somewhat flattened ventral lobe, and between these a central swelling. As the figure shows, in profile the cerci are all distinctive in shape, while the dorsal arm of each paraproct of *E. kauderni* is relatively longer and more slender than in the other two species. The dorsal cercal hook of *E. kauderni* is different in shape and the ventral lobe less abrupt, while the central swelling protrudes much more prominently backward than in *E. nigridorsum* or *E. vansomereni*. Finally, the penis, especially, the shape of the terminal lobes, is much closer in *E. kauderni* to *E. vansomereni* than to *E. nigridorsum*. In general it appears that the taxa are all about equally well differentiated and thus should all be regarded as distinct species.

Enallagma melanotum Selys

Enallagma melanotum: Selys 1876. p. 538 (male descr.); Kirby 1890. p. 147 (catalog); Needham 1930, p. 266 (key); St. Quentin 1962, p. 16: Haritonov & Belyshev 1980, p. 81 (distrib.). *Agrion sexlineatum*: Selys 1883, p. 135 (female descr.).

Coenagrion sexlineatum: Kirby 1890, p. 150 (catalog); Ris 1916, p. 35; Needham 1930, p. 275 (male, female descr.; figs.; key).

Cercion sexlineatum: Asahina 1950, p. 140 (figs.).

Two males from China were doubtfully placed in *Enallagma* by Selys (1876) in his original description of *melanotum*. As far as I can determine, no specimens have subsequently been referred to this species, although the name was noted by Needham (1930), St. Quentin (1962), and Haritonov & Belyshev (1980) at least. In the syntypes, loaned by IRSN, the head and thoracic patterns are essentially identical, but the entire abdomen is missing from one of the two specimens. That of the other has been broken and repaired, but twisted about 90 degrees; nevertheless, the abdomen seems correctly associated with the thorax and head. This specimen is designated herewith as the lectotype (it bears the following labels: small, yellow, hand written "Chine, Hou." [?]: white, handwritten except "det." printed "det. de Selys, Enallagma ?, melanotum"; white, handwritten except "det." printed "Agrion, sexlineatum ?, det. Asahina 1953").

As indicated by both color pattern and morphology of the caudal appendages (Fig. 5), this specimen proved apparently to be identical to *Cercion sexlineatum* (Selys). *Cercion,* although not very clearly defined, is distinguished from *Enallagma* by the absence of a vulvar spine in females and by the form of the male caudal appendages; *sexlineatum* is the only *Cercion* with the dorsolateral lobes of the cerci so short and the ventromedial arms closely appressed for most of their length to the caudal surface of segment 10 (Asahina, 1950, 1961). The only unusual feature in the type of *E. melanotum* is the presence of tiny dorsal denticles on the cerci. The penis of the *E. melanotum* type could not be extruded but was largely visible within the genital fossa. The slight difference in shape from *C. sexlineatum* (Fig. 5) is evidently due to postmortem changes resulting from compression within the fossa. Dr. Asahina suggested (personal communication, 1993) that *E. melanotum* might actually be synonymous with *C. v-nigrum* (Needham). I studied the type of the latter at CU, however, and found that the cerci protrude markedly backward and each have two easily visible, nearly coplanar branches, while the paraprocts each have large, white, setose medial lobes, just as illustrated by Needham (1930) and quite unlike *E. melanotum.* I have not examined the type of *C. sexlineatum,* but it is a widespread and distinctive species in Japan and China that has been illustrated repeatedly. I therefore feel confident in concluding that *E. melanotum* is identical to *sexlineatum.* Although the name *melanotum* has rarely been applied in taxonomic practice, it clearly has priority over *sexlineatum,* and Needham (1930) and St. Quentin (1962) gave comparisons, albeit very brief ones, to other species. Therefore, *Enallagma melanotum* should be transferred to *Cercion* and *C. sexlineatum* must fall as a junior subjective synonym of *melanotum.*

Enallagma pseudelongatum Longfield

Enallagma elongatum: Ris 1921, p. 324 (male descr.).
Enallagma pseudelongatum: Longfield 1936. p. 474 (male, female descr.; figs); Fraser 1947, p. 143 (synonymy; figs.).

This species has been erroneously treated as a synonym of *E. elongatum* (Martin) (Davies & Tobin, 1985; Tsuda, 1991; Bridges, 1994), probably because of the misleading title of Fraser's 1947 paper (see Literature Cited). Fraser certainly regarded the two species as distinct, however, and illustrated the differences in the male caudal appendages quite clearly. Based on my

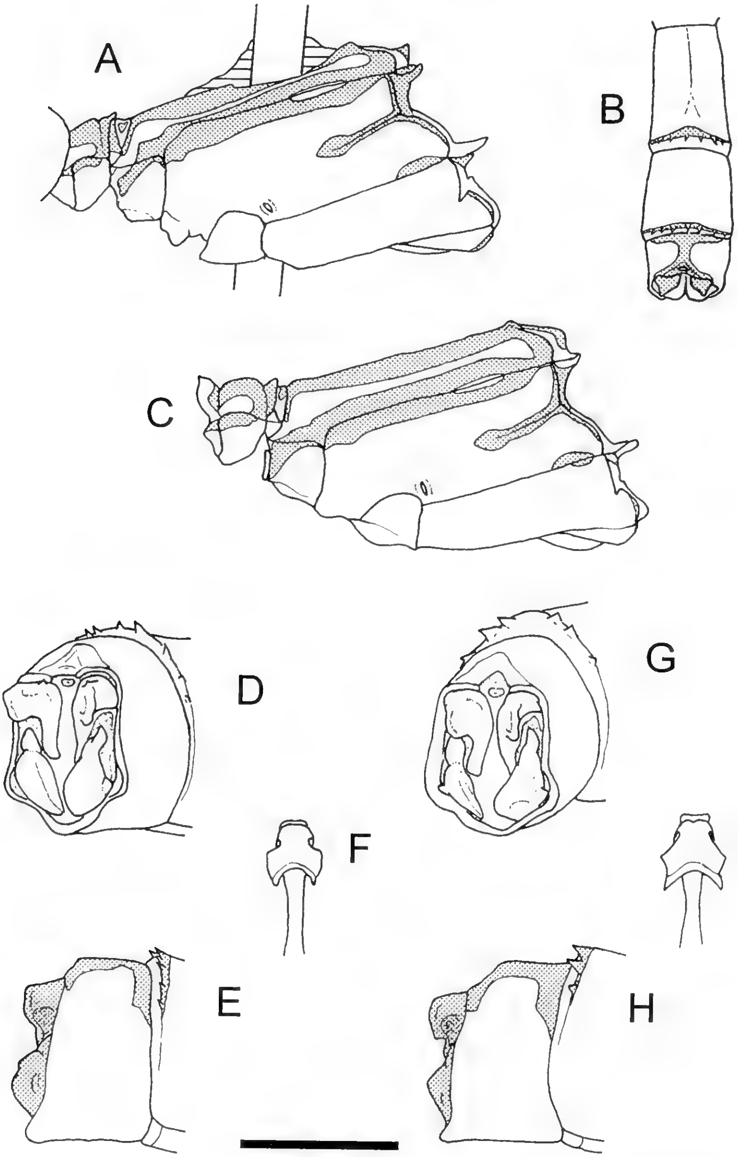

Figure 5: Color patterns and reproductive structures of male *Enallagma melanotum* Selys, lectotype (A, B, D-F) and *Cercion sexlineatum* (Selys), Japan, det. Asahina, FSCA (C, G-I). – A, C: thorax, lateral view, horizontal hatching is internal surface of cuticle exposed by break around pin; -B: distal abdominal segments, dorsal view. – D, G: caudal appendages and tenth abdominal segment, posterolateral view; – E. H: caudal appendages and tenth abdominal segment, lateral view: – F, I: distal portion of penis, ventral view. Scale bar = 2.0 mm, except 1.0 mm in F, I.

examination of specimens at NMNH identified by E. Pinhey and compared by me to Fraser's drawings, I concur fully with his opinion. The "synonymy" of his title refers not to the fact that the two names are synonyms but merely indicates that he included the synonymic history of each.

Enallagma risi Schmidt

Enallagma risi: Schmidt 1961, p. 409 (male, female descr.; figs.); Dumont 1975, p. 244 (male, female descr.; figs.); Haritonov 1975, p. 11 (distrib.); Asahina 1978, p. 116 (larva); Haritonov & Belyshev 1980 (distrib.).

Enallagma strouhali: St. Quentin 1962, p. 16 (male, female descr.; figs.); Haritonov 1975, pp. 11, 19 (distrib.; key); Haritonov & Belyshev 1980, p. 81 (distrib.).

Among the most difficult and confusing species groups within *Enallagma* is that including the type, *E. cyathigerum.* Bridges (1994) listed seven species that I include here: *belyshevi* Haritonov, *boreale* (Selys) (with 2 subspecies and 1 synonym listed), *cyathigerum* (2 subspecies, 9 synonyms), *deserti* (Selys) (1 subspecies), *nigrolineata* Belyshev & Haritonov, *risi*, and *strouhali* St. Quentin. The actual status of several of the supposed synonyms and subspecies is open to question. For example, Donnelly (1989) placed *E. vernale* Gloyd as a subspecies of *E. cyathigerum* because apparently intermediate specimens exist, but the relationship cannot be that of subspecies in the usual sense because the two forms co-occur over a wide geographic area. Jurzitza (1975) regarded *E. boreale* as a synonym or subspecies of *E. deserti* on the basis of the essentially identical morphology of the caudal appendages, but this was provisionally rejected by Garrison (1984) and Westfall & May (1996) pending a thorough study of related forms. Variation in color pattern apparently is quite extensive among North American populations of *E. boreale* and *E. cyathigerum* (Walker, 1953), yet many of the named infraspecific forms differ mainly in peculiarities of coloration as, indeed, do the supposed species, *E. belyshevi* and *E. nigrolineata,* for example.

Unravelling this tangle will require close study of abundant material over an enormous geographic span. Here I attempt only to straighten a few threads. The greatest proliferation of recognized taxa is in a great arc, from southwestern to central Asia, through southern Siberia, and on to the Kuriles and northern Japan, where these are the only species of *Enallagma* (Haritonov, 1975; Haritonov & Belyshev, 1980; Belyshev and Haritonov, 1982). Schmidt (1961) described *E. risi* based on types from Afghanistan. He compared these to *E. deserti,* but emphasized both verbally and in his illustrations the presence of a medially directed terminal point of the dorsal arm of the cerci; except for this, the illustrations are, unfortunately, not very detailed. Schmidt also noted and illustrated the caudal appendages of males from central Mongolia that he considered to be the same species, although he did not include them in the type series. A year later St. Quentin (1962) described *E. strouhali* from Manchuria. This he considered closest to *E. calverti* Morse, normally regarded as a synonym of *E. boreale.* He compared it also to *E. cyathigerum, E. deserti, and E. risi,* but from these he thought the caudal appendages "completely different" ("durchaus verschieden"), although he noted that the male from Mongolia illustrated by Schmidt could be the same species. I directly compared the holotype male of *E. strouhali* (NMHV) to a series of supposed *E. risi* from Mongolia (MNB), including the three identified and listed by Schmidt, and found them to be essentially identical (Fig. 6). I have not located the type of *E. risi,* but Dumont's (1975) illustrations of specimens from Afghanistan also appear identical, and Prof. Dumont has confirmed (personal communication, 1996) that my illustrations are not distinguishable from his specimens. This includes that of the female mesostigmal plates, which are distinctive by virtue of the anterior margin of each being raised into a prominent, erect ridge (Fig.

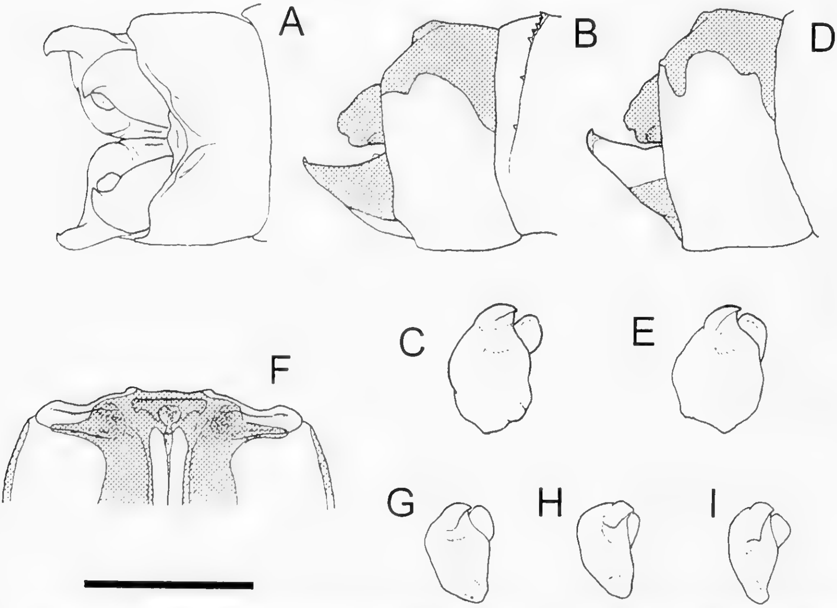

Figure 6: Caudal appendages and tenth abdominal segment of *Enallagma strouhali* St. Quentin, holotype (A-C) and *E. risi* Schmidt, Zentral-Mongolai, Ugai-nor, 27-IV-1954, det. E. Schmidt, MNB (D, E); mesostigmal plates of *E. risi,* Mongolia, Chara-us-nur, 28 June 1964, MNB (F); and cerci of *Enallagma* sp. nr. *belyshevi,* China, Chahar Prov. [now Inner Mongolian Autonomous Region], Yang-Kia-ping, NMNH (G), *E. boreale circulatum.* Japan, Hokkaido, Kushiro Marsh, MLM (H), and *E. b. boreale,* U.S.A., VT, Windsor Co., MLM (I). – A: dorsal view; – B, D: lateral views; – F: dorsal view; – C, E, G-I: right cercus, dorsomedial view. Scale bar = 1.0 mm except for C and E, for which bar = 0.7 mm.

6F). Thus I think there can be little doubt that the two species are the same and that *E. risi* thus extends at least from Afghanistan to Manchuria (Prof. Dumont also has specimens in his collection from northern Pakistan and Tajikistan). *Enallagma cyathigerum mongolicum* Benedek (Dumont, 1975), *E. deserti continentale* Belyshev, and *E. beleyshevi* might also be synonyms of *E. risi,* but this remains to be confirmed.

Beyond this, the similarity of the caudal appendages of *E. risi* to *E. b. boreale* and *E. b. circulatum* Selys. and thus also to *E. deserti,* is quite close (Fig. 6C, E, H, I). The apical hook is more obviously expanded in an anterodorsal to posteroventral direction, and it is more strongly recurved (thus less projecting in lateral view) in *E. boreale* than in *E. risi.* However, cerci from a specimen from northern China (Fig. 6G) appear more or less intermediate. This is from an area where *belyshevi* or *circulatum* as well as *risi* could occur; the specimen shows no sign of the lateral black abdominal markings that characterize typical *circulatum* but is similar in markings and apparently in the shape of the caudal appendages to *belyshevi.* A female from the same locality has mesostigmal plates slanting upward so that the anterior margins are distinctly elevated, but they do not form an abrupt ridge as in the Mongolian *E. risi* female; in this respect the Chinese specimen is more like North American *E. cyathigerum* and *E. boreale.* It appears possible, although again far from certain, that *E. risi* may not be specifically distinct from *E. boreale.* If that were to prove so, then quite conceivably only two fully differentiated species make up this group, since *E. nigrolineata* seems only weakly distinct from *E. cyathigerum* and, as noted above, *E. boreale* may be synonymous with *E. deserti.* Alternatively, several infraspecific or heretofore unrecognized forms may actually be good species or semispecies. This group of taxa cries out for molecular and/or quantitative morphometric study.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the advice and assistance of S. Asahina and H. Dumont in determining the identities of *Enallagma melanotum* and *Enallagma strouhali,* respectively. I also wish to thank Nancy Adams and O. S. Flint (NMNH), U. Aspöck (NHMV), P. Grootaert (IRSN), K. K. Gunther and G. Peters (MNB), and M. J. Westfall (FSCA) for the loan of specimens in their care, K. Maramorasch for translating papers from Russian, and F. L. Carle, H. B. White and an anonymous reviewer for helpful comments on the manuscript. This is New Jersey Agricultural Experiment Station Publication #D-08002-13-96, supported by State funds.

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BOOK REVIEW

DAMSELFLIES OF NORTH AMERICA. Minter J. Westfall, Jr. and Michael L. May. 1996. Scientific Publishers, Gainesville, FL. 650pp; ISBN 0-945417-93-4, $69.50 Cloth.

The order Odonata (dragonflies) includes the suborders Anisoptera and Zygoptera. However, in North America, the term "dragonfly" normally refers only to the Anisoptera. Thus, in 1955 when James G. Needham and Minter J. Westfalt Jr. published their *A Manual to the Dragonflies of North America,* it did not include the damselflies. For more than 40 years "The Manual" has awaited its companion often referred to as "the book" among those interested in the Odonata. Wait no more. *Damselflies of North America* appeared in 1996 and is excellent. It surely will become the standard reference in the field supplanting Volume One of Edmund Walker's *The Odonata of Canada and Alaska* (1953) and Sidney Dunkle's *Damselflies of Florida, Bermuda, and the Bahamas* (1990), excellent regional works that have served in the absence of a continental resource.

In a sign of the times, the imminent publication of *Damselflies of North America* was announced last June 6 by an e-mail message from the International Odonata Research Institute in Gainesville, Florida to members of the Dragonfly Society of the Americas. By now, likely all have purchased a personal copy of this monograph that covers each of the 161 species of damselflies known to occur in North America, northern Mexico, and the Greater Antilles. Unlike field guides that focus on adult insects and cater to novices with common names and color photographs for identification, this volume is a more scholarly work. While there are color photographs of almost 20% of the fauna; thorough keys, detailed descrip-

(Continued on page 96)

PERLESTA XUBE, A NEW STONEFLY SPECIES FROM NEBRASKA (PLECOPTERA: PERLIDAE)[1]

Bill P. Stark[2], Howard A. Rhodes[3]

ABSTRACT: *Perlesta xube*, a new stonefly species, is described from male, female, egg and nymphal stages, and a holotype male is designated. Adults are similar to *Perlesta adena* but differ most significantly in aedeagal shape and pattern of armature. The new species is known from a single location in northwestern Nebraska.

For most of this century, *Perlesta placida* (Hager) was regarded as a common, but variable, species found throughout eastern North America. Stark (1989) recognized twelve members in a complex of species differentiated primarily on the basis of internal male genitalia and egg morphology. In this study we call attention to an additional member of this complex found in Nebraska. Terminology and methods follow Stark (1989).

Perlesta xube, NEW SPECIES

Male. Forewing length 7 mm. General color dark brown. Head and pronotum brown, patterned with dark brown, but with a pair of oval pale spots anterolateral of posterior ocelli (Fig. 1). Basal antennal segments pale, becoming dark brown beyond segment 8. Forefemora longitudinally striped in yellow and brown. Wing membrane and veins dark brown except for pale areas proximal to the arculus, in the mid-costal region, along the median vein anterior to the cord, and in the intercubital area (Fig. 7). Basal cereal segments banded, becoming dark brown beyond segment 8. Paraprocts in lateral aspect slender, curved forward and bearing a subapical tooth (Fig. 4). Tergum 10 mesal sclerite almost divided by membranous band; sensilla basiconica patch sparse (Fig. 3). Penis tube slender and sinuate, dorsal hair patch (DP) narrow subapically but broadly expanded apically around base of caecum (C); apex of caecum bare (Fig. 6).

Female. Forewing length 9-10 mm. Color pattern similar to male. Subgenital plate lobes truncate and separated by a U-shaped notch. Plate dark laterally and membranous mesally (Fig. 5).

Egg. Length ca. 0.5 mm, width ca. 0.4 mm. Collar obscure, buttonlike, not shown in orientation of Fig. 8. Chorion finely pitted around poles and coarsely pitted in mesal third (Fig. 8). Micropylar row in posterior region with pitted field (Fig. 9).

Nymph. General color dark brown. Light colored M-line of head pattern distinct (Fig. 2). Abdominal terga brown with dark brown pigment spots around intercalary setae.

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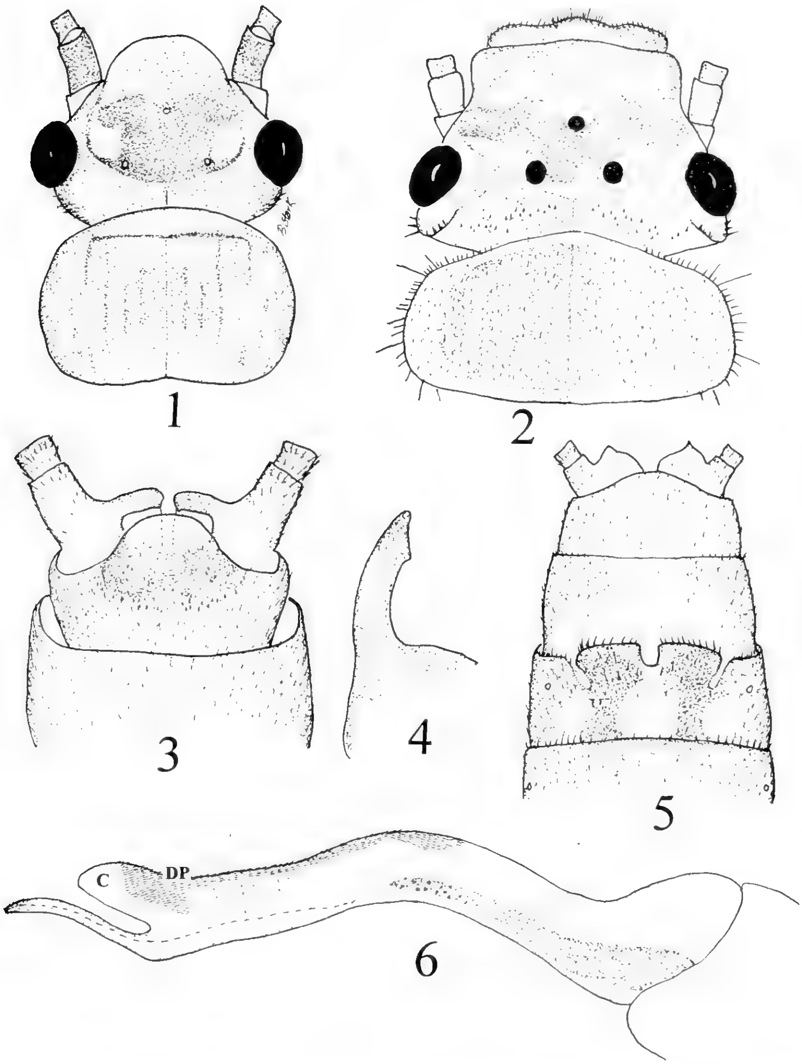
[1] Received August 3, 1986. Accepted September 9, 1996.

[2] Biology Department, Mississippi College, Clinton, MS 39058.

[3] Department of Entomology, Colorado State University, Fort Collins, CO 80523.



Figs. 1-6. *Perlesta xube* morphological features. 1. Adult head and pronotum. 2. Nymphal head and pronotum. 3. Male terminal abdominal segments, dorsal. 4. Male paraproct, lateral. 5. Female terminal abdominal segments, ventral. 6. Penis tube+sac, lateral (C = caecum, DP = dorsal patch).

Types. Holotype ♂, 30 paratype ♂ and 29 paratype ♀ specimens collected in Nebraska, Cherry Co., Dry Creek, Merriman, 26 June 1996, B. C. Kondratieff, H. Rhodes. Additional paratypes reared from nymphs collected at type locality, 6 June 1995, 2 ♂, 9 ♀, B. C. Kondratieff. Holotype and one female paratype deposited in the National Museum of Natural History, other paratypes deposited in the C. P. Gillette Museum of Arthropod Diversity, Colorado State University and in the Stark collection, Mississippi College.

Type locality. Dry Creek flows through Merriman, Nebraska, as a channelized stream with rather steep banks and a swift current. Cottonwoods form a riparian corridor along the stream. Robust populations of the mayflies *Acerpenna pygmaea* (Hagen), *Baetis tricaudatus* Dodds, *Ephemerella inermis* Eaton, and *Heptagenia diabasia* Burks were found along with the damselflies *Calopteryx aequabilis* Say and *Hetaerina americana* (Fabricius). The only stonefly species collected with *P. xube* were *Isoperla quinquepunctata* (Banks) and *Perlesta decipiens* (Walsh).

Etymology. The Native American Ponca lived in the region of northern Nebraska where this species was discovered. Their word *xube* means "supernatural power", which they believed all things possessed in varying amounts (Leitch 1979).

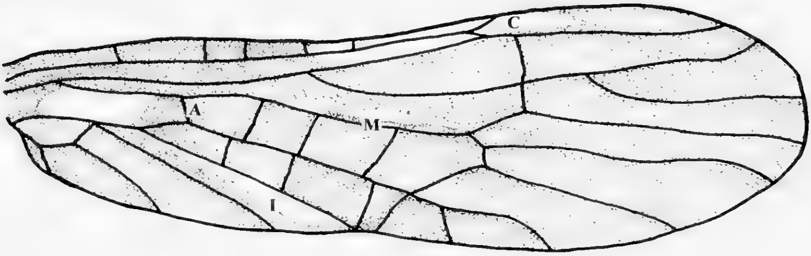


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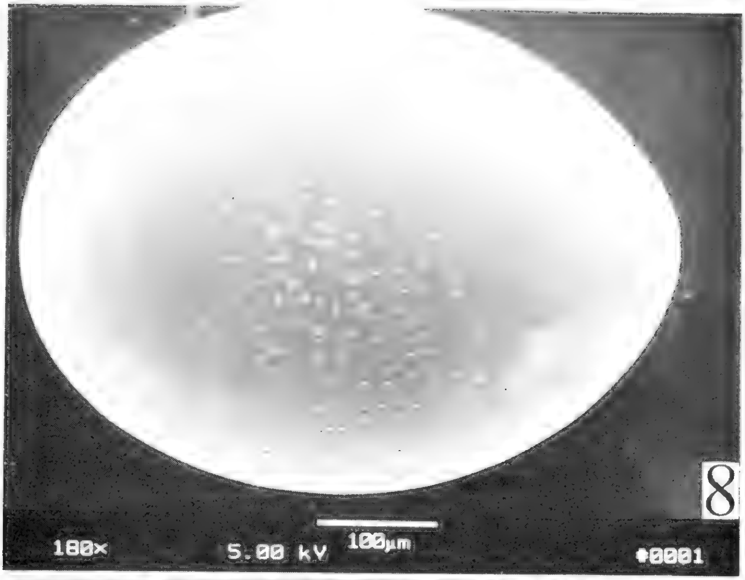
Fig. 7. Forewing of *Perlesta xube* showing pale areas in the costal area (C), proximal to the arculus (A), along the median vein (M), and in the intercubital area (I).

DISCUSSION

Adult specimens of *P. xube* key to couplet 6 in Stark (1989). At that point an impasse occurs because the penis tube is short, slender and has the dorsal patch expanded at the apex (Fig. 6). In these features *P. xube* agrees with neither *P. cinctipes* nor *P. adena,* but the expanded dorsal patch is somewhat similar to that of *P. adena.* The egg is also quite similar to that of *P. adena* and isolated females might prove difficult to distinguish from that species. However, the wing pigmentation pattern of *P. xube* (Fig. 7) should be distinctive enough to



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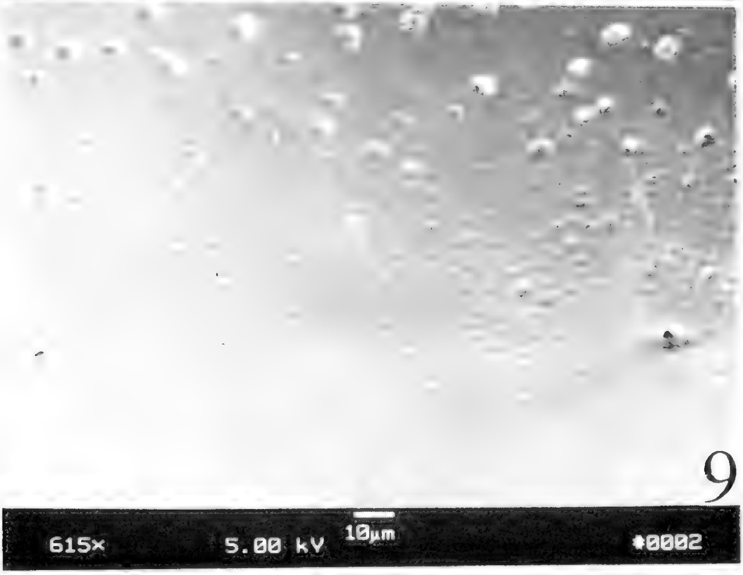

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Figs. 8-9. Scanning electron micrographs of *Perlesta xube* egg features. 8. Lateral aspect. 9. Detail of micropylar region of posterior pole.

permit identification. Nymphal specimens appear distinct from *P. decipiens* (Walsh) and *P. cinctipes* (Banks) by virtue of the darker pigment pattern of the occiput and anterior region of the frons (Fig. 2).

With the addition of *P. xube*, 13 species of stoneflies are now known for Nebraska (Rhodes & Kondratieff 1996).

ACKNOWLEDGMENTS

We thank B. C. Kondratieff for providing specimens and biological notes of this interesting species for our study.

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(Continued from page 91)

tions, scanning electron micrographs, and line drawings of critical taxonomic features serve to identify both larval and adult forms. In fact, a number of previously undescribed larval forms are included in the keys. The authors have not used the "common" names recently given to all North American damselflies.

The book's introduction deals with morphology, classification, fossil record, life cycle, adult and larval behavior, physiology, biogeography, habitats, and conservation. That is followed by color photographs mostly of specimens in natural poses and mostly with good color reproduction. The main part of the book (~80%) contains keys, figures and detailed descriptions of each species. The extensive glossary, bibliography, and index all make this a very accessible book for both novices and old timers who want to learn more about damselflies.

Although as insects go, damselflies are fairly well known, there are still new species and new larval forms to describe, smoldering taxonomic problems to resolve, and much to be learned about behavior and distribution. A particularly useful aspect of this book is that it identifies many of these lacunae and thus provides the sense that much remains to be discovered. Students looking for projects can find one for almost every species. *Damselflies of North America* will be widely used and should further increase the demand for the next book in this area, a much needed field guide.

Harold B. White
University of Delaware

DESCRIPTION OF ADULTS OF *LABIOBAETIS APACHE* (EPHEMEROPTERA: BAETIDAE) WITH ADDITIONS AND CORRECTIONS TO THE INVENTORY OF COLORADO MAYFLIES[1]

Richard S. Durfee, Boris C. Kondratieff[2]

ABSTRACT: Male and female adults of *Labiobaetis apache* are described from specimens collected in northwestern Colorado, USA. Biological notes for this species are given and a key separating the male adults of the six North American species of *Labiobaetis* is provided. Additional Colorado distributions for *L. dardanus* and *Baetis notos* are given. *Cinygmula tarda* is reported for the first time in Colorado.

McCafferty and Waltz (1995) elevated the subgenus *Labiobaetis* Novikova and Kluge to generic rank. They included five North American species formerly placed in the *Baetis propinquus* species group (Morihara and McCafferty 1979a) and described a new species, *L. apache,* based on larvae collected in Arizona and Utah. They also provided an illustrated key to the larvae of all six North American species of *Labiobaetis.* Previously, the larvae in this group were treated diagnostically by Morihara and McCafferty (1979b) and Soluk (1981).

Originally reported as *Baetis propinquus* (Walsh) by McCafferty *et al.* (1993), the larvae collected from Douglas Creek in Rio Blanco Co., Colorado were reexamined and determined to be *L. apache.* Previous to its description, the larvae of *L. apache* would key to *B. propinquus* as characterized by Morihara and McCafferty (1979b).

A key separating adult males of the five North American species now included under *Labiobaetis* was provided by Morihara and McCafferty (1979a). At that time *L. apache* was unknown. Herein, we describe the adults of *L. apache,* thus completing the adult taxonomy of all known species of this genus in North America. During July, 1996, we returned to the Douglas Creek site and collected a large series of mature larvae for rearing. The following description is based on reared adults recently preserved in alcohol.

Labiobaetis apache McCafferty and Waltz

Adult male. Body length 5.0-6.0 mm, forewings 5.0-5.5 mm, hindwings 1.0 mm, caudal filaments 9-10 mm. Head brown; antennal scape and pedicel light brown, flagellum light brown basally, pale apically: turbinate eyes orange. Thoracic nota and sterna dark brown, intersegmental areas white,

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[1] Received September 26, 1996. Accepted October 8, 1996.

[2] Department of Entomology, Colorado State University, Fort Collins, Colorado 80523.

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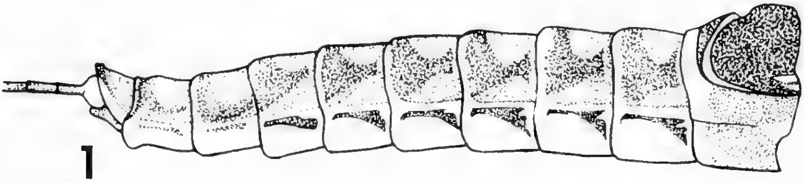
some stained with orange: forelegs smoky, apical 1/5 of foretibia pale, middle and hindlegs pale, inner apical margin of 1st and 2nd tarsal segments produced into a spine, all claws slightly darkened: forewings hyaline, basal area stained with brown, veins colorless. stigmatic area cloudy; hindwings hyaline, with two longitudinal veins and lacking a costal projection. Abdominal terga light brown with distinctive brown markings (Fig. 1): first abdominal sternite stained with brown, remaining abdominal sterna pale: sterna 2-9 with prominent red-brown mark laterally (Fig. 1) sometimes only visible on 2-6. Caudal filaments with basal three segments stained with red-brown, articulations of segments 4-6 also stained with red-brown, remainder of filament pale. Forceps white, basal 1/3 of first segment often stained with brown; basal enlargement of second segment as wide as long, terminal segment short and rounded; ventral posteromedian projection between forceps bases covered with setae, shaped as in Fig. 2.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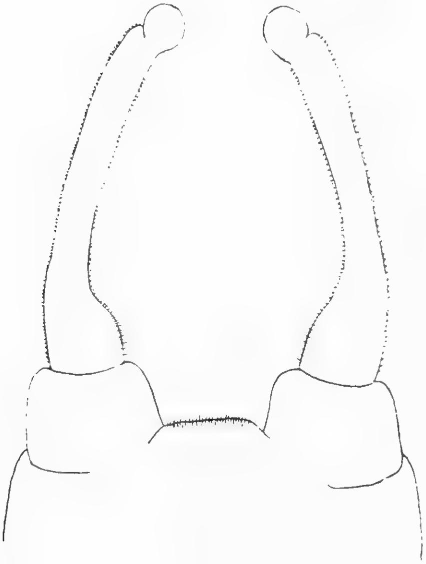
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Figures 1-2 *Labiobaetis apache*. Fig. 1 Adult male abdomen, lateral view. Fig. 2, male genitalia, ventral view.

Adult female. Body length 5.5-6.0 mm, forewings 5.0-5.5 mm, hindwings 1.0 mm, caudal filaments 9-10 mm. Head tan: lateral ocelli ringed with dark brown: antennae as in male. Thoracic nota and sterna generally light brown, metanotum and parts of the metasternum darker brown; all legs pale, tarsal spines as in male but present on forelegs as well. Wings similar to male but with lightly shaded longitudinal veins. Abdominal terga tan; abdominal sterna pale. Dorsal and ventral abdominal markings as in male (Fig. 1). Caudal filaments as in male.

Material examined. Colorado: Rio Blanco Co.. Douglas Creek at Rt. 64. 19 July 1996. B. Kondratieff and R. Durfee, 26 males 23 females and 10 male and 9 female subimagos (reared), deposited in the C. P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, Colorado.

Diagnosis: The abdominal markings (Fig. 1) of both the male and female adults of *L. apache* readily distinguish it from the other North American *Labiobaetis*. These markings are so distinctive that field identification of adults and subimagos is possible. In alcohol preserved specimens these color patterns may fade, particularly the dorsal markings on the male. Male genitalia of *L. apache* are very similar to *L. dardanus* (McDunnough). Specimens of *L. dardanus* from the Arkansas River, Pueblo Co., Colorado and the Niobrara River, Sioux Co., Nebraska were compared to *L. apache* and no major differences in the male genitalia were noted.

We modify the following key to the adult males of North American *Labiobaetis* by Morihara and McCafferty (1979a) to include *L. apache*.

1. Ventral posteromedian projection between forceps bases covered with setae (Morihara and McCafferty, 1979a; Figs. 12. 13. 15, 18) 2
   Ventral posteromedian projection bare, often well sclerotized and pigmented (Morihara and McCafferty, 1979a; Fig. 14) . . . . *L. ephippiatus*
2. Ventral posteromedian projection between forceps bases broadly rounded to broadly truncate (Morihara and McCafferty, 1979a; Figs. 12. 15. 18); abdominal segments 2-6 pale translucent, opaque brown or with distinct pattern 3
   Ventral projection slightly constricted basally (Morihara and McCafferty, 1979a; Fig. 13); abdominal segments 2-6 pale translucent . . . . *L. longipalpus*
3. Basal enlargement of forceps short and robust (Fig. 2); no chitinous internal spine between forceps bases 4
   Basal enlargement of forceps slender (Morihara and McCafferty, 1979a; Figs. 15, 18); chitinous internal spine usually visible 5
4. Abdominal tergites 2-6 with distinct pattern (Fig. 1) . . . . *L. apache*
   Abdominal tergites 2-6 light brown to yellow without distinct pattern . . . . *L. dardanus*
5. Basal enlargement of forceps simple, subquadrate from ventral perspective (Morihara and McCafferty, 1979a; Fig. 15); abdominal segments 2-6 usually opaque brown . . . . *L. frondalis*
   Basal enlargement of forceps with distal, medially directed, acute projection (Morihara and McCafferty, 1979a; Fig. 18); abdominal segments 2-6 usually pale translucent . . . *L. propinquus*

DISCUSSION

McCafferty and Waltz (1995) speculated that the adults of *L. apache* may key out near *L. propinquus* if a close relationship between these two species could be assumed based on similar larval morphology. However, *L. apache* appears to be most closely related to *L. dardanus* based on similarities of the male genitalia. In addition, both *L. apache* and *L. dardanus* have broad overlapping distributions in western North America and may share a common ancestor. *Labiobaetis propinquus* is widely distributed throughout eastern North America (Morihara and McCafferty 1979b) and has been reported from as far west as Texas (Lugo-Ortiz and McCafferty 1995) and eastern New Mexico (W.P. McCafferty, personal communication). Peters and Edmunds (1961) reported this species from the Navajo Reservoir basin, New Mexico, however, that was before the species description of *L. apache.* We have not examined the material from this study, but based on the geographical proximity, we suspect this record to be either *L. apache* or *L. dardanus.*

Douglas Creek becomes highly turbid during precipitation events. Substrate is primarily sand with some gravel. Most mayfly larvae were collected from debris snags near the stream margin. This general habitat description is very similar to the type locality of *L. apache,* the Little Colorado River near St. Johns, Arizona. Other mayflies collected with *L. apache* from Douglas Creek included *Choroterpes inornata* Eaton, *Heptagenia elegantula* Eaton, and *Tricorythodes minutus* Traver. McCafferty and Waltz (1995) indicated that *C. inornata* and *L. apache* may be characteristic species of the Colorado Plateau.

Two species of *Labiobaetis* are currently known from Colorado. *L. apache* and *L. dardanus.* In Colorado, *L. apache* has only been collected from Douglas Creek near Rangely and may be restricted to streams of the Colorado Plateau. *Labiobaetis dardanus* had previously been reported from the Green River in Moffat Co. as *Baetis dardanus* (Durfee and Kondratieff 1994). Additionally, the authors have examined specimens of *L. dardanus* from the Conejos River in Conejos Co, the Arkansas River in Pueblo Co., and the South Platte River in Douglas Co. Although not commonly collected, this species appears to be widespread throughout Colorado.

Baetis notos Allen and Murvosh was previously reported in Colorado from the Gunnison River (McCafferty *et al.* 1993). We have examined specimens from Four Mile Creek in Fremont Co. and the Arkansas River in Pueblo Co. A southwestern species with Mexican affinities, *B. notos* apparently reaches its northernmost limit in Colorado.

A male adult of *Cingymula tarda* (McDunnough) was recently collected from a mating swarm on the South Fork of the South Platte River in Park Co. (elev. 1840 m). Previously recorded from Alberta and Montana (McDunnough 1929), Idaho (Jensen 1966) and northern Utah (Edmunds 1954), the discovery of this species in central Colorado extends its range southward.

With the addition of *C. tarda* and the elevation of *Labiobaetis* to generic rank, a total of 44 genera and 102 species of mayflies are now recorded for Colorado.

ACKNOWLEDGMENT

We thank Lynn Bjork for the illustrations.

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H.P.B.

THE POSITION OF *HEMICAECILIUS* (PSOCOPTERA: LACHESILLIDAE) AND DESCRIPTION OF A NEW SPECIES FROM VENEZUELA[1]

Alfonso Neri Garcia Aldrete[2], Edward L. Mockford[3]

ABSTRACT: *Hemicaecilius venezolanus* n. sp. is described from a single female collected near Trujillo, northern Venezuela. It differs from the generotype and hitherto single species of the genus, *H. bogotanus* from Colombia, in an important venational character. We argue that the generotype specimen, now known only from a fore- and a hindwing, is anomalous in the character, and that numerous venational similarities mark the two species as congeneric. Structural characters, including the nature of the lacinial apex, pretarsal claw, gonapophyses, subgenital plate, ciliation and venation of the forewing indicate that *Hemicaecilius* belongs in the Lachesillidae, subfamily Lachesillinae, rather than in the Elipsocidae where some authors have placed it.

The genus *Hemicaecilius* has been an enigma for psocidologists since its description by Enderlein in 1903. The description was based only on wing venational characters of a single specimen collected in Bogotá, Colombia. No genitalic information about *Hemicaecilius* was provided, and at present all that remains of the type specimen is one fore- and one hindwing, mounted on a slide deposited in the Museum für Naturkunde der Humboldt-Universität, in Berlin.

Enderlein (1903) regarded *Hemicaecilius* as near *Graphocaecilius* Enderlein and noted its close similarity in wing ciliation with that genus. *Hemicaecilius* was included in the Elipsocidae: Lesneiinae by Smithers (1972, 1990), who noted that its position was uncertain and that there was little known of this genus other than its venation and number of tarsal segments.

The present study of a female specimen collected near Trujillo in northern Venezuela, allowed us to determine more precisely the systematic position of *Hemicaecilius* in the Psocoptera (see Discussion, below). Comparison of the wings of this specimen (Fig. 1) with the wings of the holotype of *H. bogotanus* (Fig. 9) convinced us that it belongs in *Hemicaecilius*. Although *Hemicaecilius* was described as having only two median veins in the forewing, we feel this is an anomalous condition of the holotype of *H. bogotanus*. Wing venational anomalies are frequent in the Psocoptera. When an anomaly involving two in-

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[1] Received. May 10, 1996. Accepted August 1, 1996.

[2] Instituto de Biologia, Universidad Nacional Autónoma de México, Departamento de Zoologia, Apartado Postal 70-153, 04510 México, D.F.

[3] Department of Biological Sciences, Illinois State University, Campus Box 4120, Normal, Illinois 61790-4120.

stead of three median veins in the forewing occurs, it usually results in broadening of the distal end of cell R5, as seen in the type of *H. bogotanus* (Fig. 9). If we assume that the normal condition of the forewing of *H. bogotanus* is three median veins and a more slender distal end of cell R5, then the forewing similarities between *H. bogotanus* and the new species become striking. Notable similarities include the following: 1) basal Rs segment gently curved outward; 2) Rs fork stem gently curved anteriad in its basal three-fifths, posteriad in its distal two-fifths; 3) Rs-M crossvein ca. one-fourth length of basal Rs segment; 4) point of branching of R2+3 and R4+5 very slightly distal to basal M branching; 5) median stem gently curved posteriorly in its basal three-fifths; 6) sparse, short setae present on margin and veins except none present on vein Cu 2.

The holotype of the new species was dissected and its parts were mounted in euparal for microscopic study. Standard measurements (FW = forewing; HW = hindwing; F = femur; T = tibia; t1, t2 = tarsomeres 1 and 2; cttl = number of ctenidia on t1; P4 = fourth segment of maxillary palp; IO = minimum distance between compound eyes; d = transverse diameter of compound eye), given in microns, were made on the parts mounted, with a filar micrometer. The measuring unit is 1.36 microns for wings, and 0.53 microns for other parts. The holotype is deposited in the Insect Collection, Zoology Department, Instituto de Biologia, Universidad Nacional Autónoma de México, México City.

Group Homilopsocidea

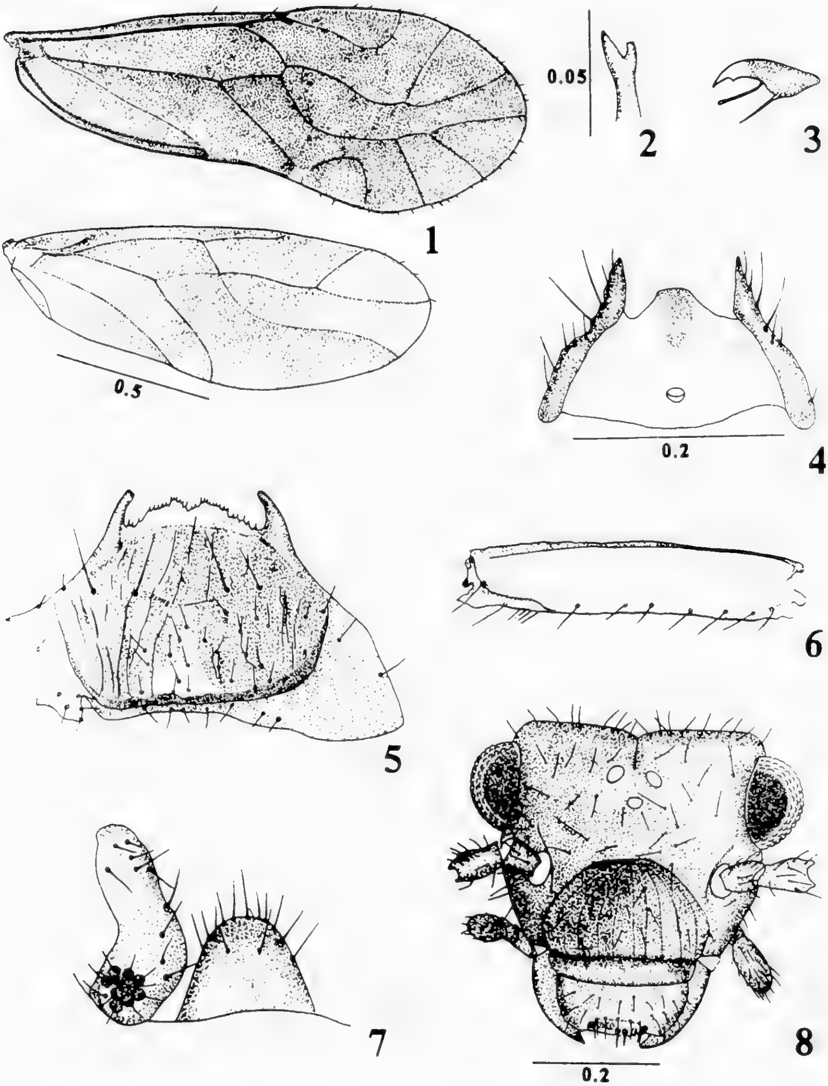
Lachesillidae, Lachesillinae

Hemicaecilius venezolanus NEW SPECIES (female)

Diagnosis. Ocelli present, lacinial tips bifid, outer cusp larger than inner one; pretarsal claw with one preapical denticle and slender pulvillus; forewing with small setae along margin and veins, Rs and M connected by crossvein; hindwing with row of small setae along margin in cell R3, one pair of gonapophyses present; subgenital plate with a slender posterior projection on each side. Differing from *H. bogotanus* by greater wing length, shape of the pterostigma, slightly more sigmoid stem of the Rs fork, shape of the areola postica, Rs-M in the hindwing meeting at a point instead of a fusion, and presence of marginal setae in cell R3 of the hindwing.

Color (in 80% alcohol). Body dark reddish brown. Compound eyes black, ocelli clear, without centripetal crescents. Antennae and maxillary palps brown. Tergal lobes of meso- and metathorax more pigmented than rest of the body. Legs pale brown. Wings reddish brown.

Morphology. Vertex slightly obtusely concave. Epicranial sulcus without lateral arms. Compound eyes below level of vertex. Lateral ocelli larger than median one. Epistomal sulcus well defined (Fig. 8). Lacinial tips bifid, inner cusp short, slender; outer cusp large, conical, apically blunt (Fig. 2). With five distal inner lateral sensilla, three placoids alternating with two trichoids. P4 with two small thin walled sensilla near the base. Pretarsal claws with slender pulvillus (Fig. 3). Hind femur (Fig. 6) with row of long setae ventrally. Forewing with small setae along margin and veins, as illustrated (Fig. 1). Hindwing with small setae on margin, between R2+3 and R4+5. No trichobothria distally on hind femur. Subgenital



Figures 1-8. *Hemicaecilius venezolanus* n.sp. (♀). 1. Fore and hind wings. 2. Lacinial apex. 3. Pretarsal claw. 4. Gonapophyses and ninth sternum. 5. Subgenital plate. 6. Hind femur. 7. Right paraproct and epiproct. 8. Front view of head. Scales in mm. Fig. 3 to scale of Fig. 2. Figs. 5-7 to scale of Fig. 4.

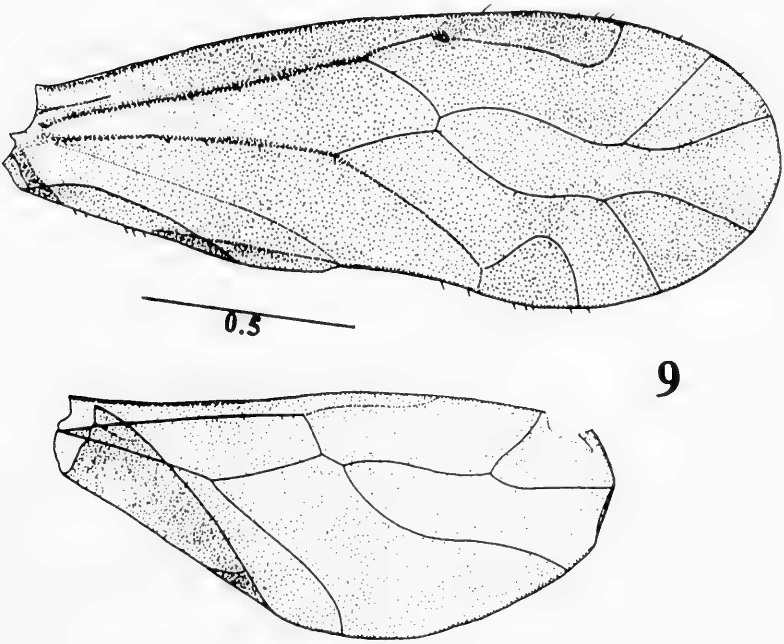


Fig. 9. *H. bogotanus* Enderlein (holotype). Fore and hind wings. Scale in mm.

plate broad, setose, with four mesal macrosetae; with two slightly curved, stout, blunt, posterior projections, with border between them jagged, as illustrated (Fig. 5). Gonapophyses: only V3 present, elongate, slender, basally rounded, with distal one-third pointed; with setae along outer edge. Ninth sternum pigmented, as illustrated (Fig. 4), projected posteriorly in the middle. Spermapore large, near anterior border of ninth sternum. Paraprocts elongate, setose; sensory fields with 10-11 trichobothria on basal rosettes, and a marginal one without basal rosette. Epiproct almost trapezoidal, setose (Fig. 7).

Measurements. FW: 1599; HW: 1339; F: 307; P4: 84; IO: 289; d: 72; IO/d: 4.01.

Type Locality: VENEZUELA. Trujillo, 2,387 m. Old road, 46 km E Trujillo, 6.VIII. 1988, C.W. & L.B. O'Brien & G. Wibmer, Holotype ♀.

DISCUSSION

Two problems concerning *Hemicaecilius* must be considered: 1) its family placement, and 2) its relationships within the family. The size, color, wing venation, nature of the lacinial tip, reduction of the ovipositor valvulae to a single pair (the third), and presence of four macrosetae on the subgenital plate are all characters common in family Lachesillidae, and this particular constellation of characters is not found outside of that family. Assuming that the new species truly represents *Hemicaecilius,* we assign the genus to family Lachesillidae.

Mockford and Sullivan (1986) proposed a classification of the family Lachesillidae, with two subfamilies, the Eolachesillinae and Lachesillinae. We believe that *Hemicaecilius* stands close to *Nadleria* Badonnel and Garcia Aldrete (1979) in the subfamily Lachesillinae. Our basis for placing it here, as opposed to near *Graphocaecilius* and allied genera in the Eolachesillinae is as follows: 1) presence in the new species of a simple outer tine of the lacinial tip (bidentate in most Eolachesillinae); 2) Rs-M crossvein present in forewing in both *Hemicaecilius* species and in *Nadleria* (Rs and M fused for a distance throughout Eolachesillinae); 3) fusion of the ovipositor valvulae with the ninth sternum in the new species and in most Lachesillinae (junction is via the stem of v-1 in the Graphocaeciliini and there is no junction in *Eolachesilla* Badonnel). Wing ciliation, absent in most species of *Lachesilla,* is shared with *Nadleria,* but may be a plesiomorphous character for the family.

ACKNOWLEDGMENTS

We thank Charles W. O'Brien (Florida A & M University, Tallahassee), for the specimen of *H. venezolanus.* We also thank K. K. Günther (Museum für Naturkunde der Humboldt-Universität zu Berlin) for loan of the holotype of *H. bogotanus.* We also thank Lauren Brown, Scott Sakaluk, and two unknown readers for critical reading of the manuscript resulting in useful comments.

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DESCRIPTIONS OF THE FEMALE, NYMPH, EGG AND REDESCRIPTION OF THE MALE OF *AMPHINEMURA MOCKFORDI* (PLECOPTERA: NEMOURIDAE)[1]

Charles H. Nelson[2]

ABSTRACT: The adult female, nymph, and egg of *Amphinemura mockfordi* are described and illustrated for the first time. The male, previously known only from the holotype and paratype male, is re-described in greater detail. Characters serving to distinguish this species from closely related congeners *A. delosa* and *A. nigritta* are also provided.

Amphinemura mockfordi (Ricker) is one of several closely related species that comprise the *Amphinemura nigritta* complex of eastern North America (Ricker, 1952). Presently, this species is known from only two males collected at an unspecified location in Monteagle, TN. Recently, the female, pre-emergent nymph, and egg of *A. mockfordi* were collected by me from the area of the type locality and are described below. To further facilitate identification of this species, the male is more fully described as well. Terminology is after Baumann (1975) and Stewart and Stark (1988).

Amphinemura mockfordi (Ricker)

(Figs 1-15)

Nemoura (Amphinemura) mockfordi Ricker, 1952, holotype male, paratype male, Monteagle, Tennessee.

Male. Macropterous. Body length 5.3 - 7.9 mm. Forewing length 7.5 - 8.5 mm. General body color brown. Epiproct in dorsal view rounded triangular (Figs. 1, 5), in lateral view with a narrow base expanding to greatest width at midline and then tapering to a rounded tip (Figs. 2, 6). Dorsal sclerite of epiproct with dorsal surface lightly sclerotized, covered for most of its distance with hair-like spinulae, lateral surface, below the narrow sclerotized arms that extend nearly to tip, bearing short stout spinulae, and tip exhibiting large stout spinulae (Fig. 14). Keel-like ventral sclerite in ventral view spear-point shaped (Fig. 3), bearing numerous large spines on anterior two-thirds (Figs. 2, 3). Paraprocts divided into 3 lobes (Figs. 4, 7): inner lobe of each paraproct narrow, tip bilobed; middle lobe with broad base narrowing to a bluntly rounded membranous tip bearing 5 - 6 stout spines, posteroventral sclerotized portion with 2 - 3 stout spines apically; outer lobe with large broad base tapering abruptly to become long and narrow and then abruptly expanding apically to form a boot-shaped tip, bearing 7 - 9 stout spines. Basal sclerites triangular with apices meeting the basal lateral corners of the epiproct (Figs. 5, 6).

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[1] Received June 19, 1996. Accepted September 9, 1996.

[2] Department of Biological and Environmental Sciences, 615 McCallie Avenue, University of Tennessee at Chattanooga, Chattanooga, TN 37403.

Female. Macropterous. Body length 7.4 - 9.4 mm. Forewing length 8.6 - 9.8 mm. General body color brown. Seventh sternite produced posteriorly, with broadly rounded posterior margin. Subgenital plate narrow, divided into four posteriorly produced vaginal lobes: inner two lobes broad and with posterior margin rounded, outer two lobes thin and nipple-like (Fig. 8).

Nymph. Body length 6 - 6.5 mm. Two anterior thoracic gills on each side of ventral cervical region, each gill with 6 - 7 branches. Pronotum with lateral margins bearing a fringe of bluntly pointed bristles. Mesonotum and metanotum with medium sized bristles near anterior margins and anterolateral corners. Mesonotum also with a patch of medium to long bristles located along anterior margin of wingpad base (Fig. 9). Abdominal segments sparsely covered with short bristles, with short to medium bristles, interspersed occasionally with longer hairs, forming a posterior marginal fringe (Figs. 10 - 12). Cercal segments with whorls of long spines along apical margins, spines of mesal segments about one third to one half length of segment, intercalary hairs becoming longer and more numerous toward apical segments (Fig. 13).

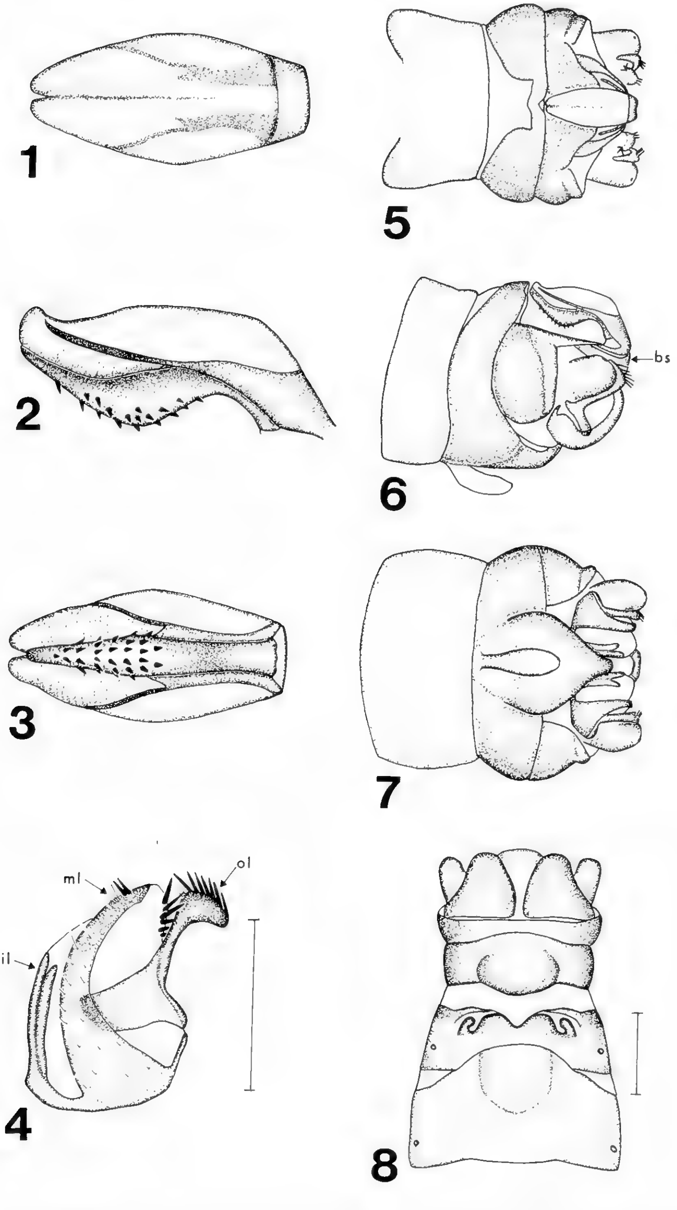
Egg. Length and width 0.34 - 0.39 mm. General shape spherical. Chorionic surface smooth (Fig. 15).

Specimens Examined. TENNESSEE: Grundy Co., nr. Monteagle, small seep across Rt. 41 approx. 0.7 mi NE jct Rts. 64, 41A and 41, C. H. Nelson, 29-IV-1993, 2 males; 5-V-1993, 1 male, 1 female; 7-V-1993, 6 males, 7 females; 6-V-1996, 1 nymph, 1 exuvium; 10-V 1996;1 male; 16-VI-1996; 1 female.

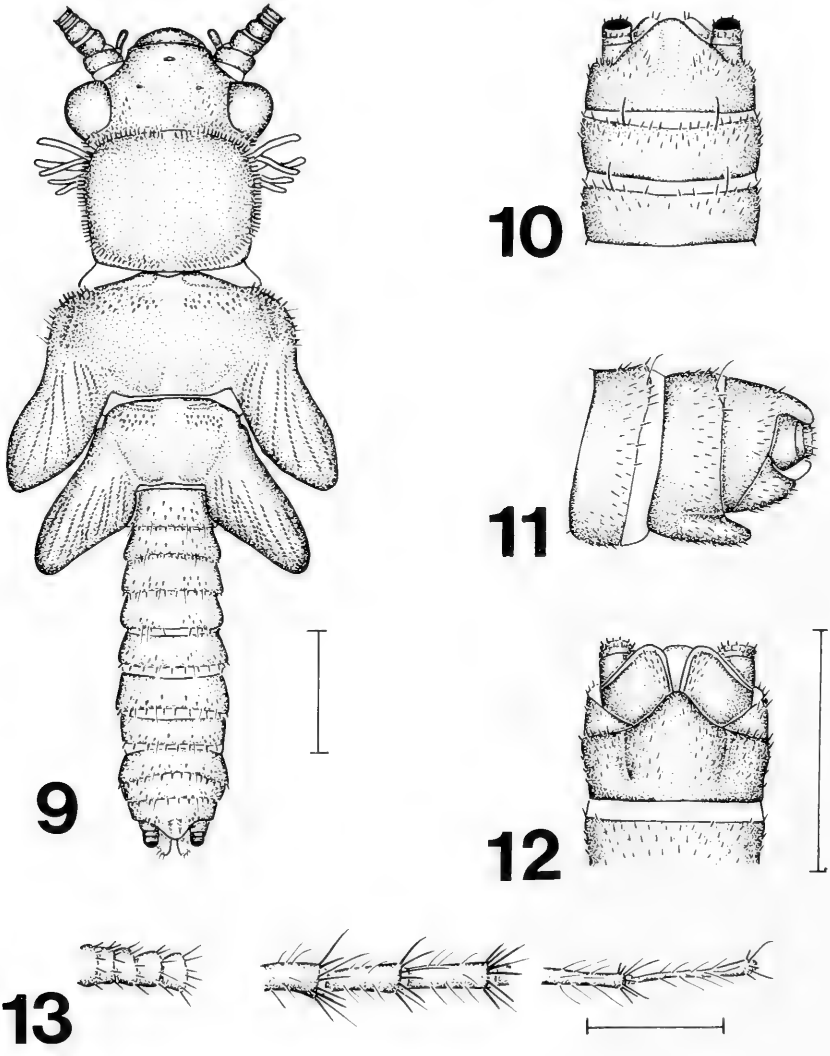
DISCUSSION

Amphinemura mockfordi is very similar to *A. nigritta* (Provancher) and *A. delosa* (Ricker). *A. mockfordi* males can be distinguished most easily by the apically expanded outer lobe of the male paraproct that in profile appears boot-shaped, whereas, in *A. nigritta* and *A. delosa* the sclerotized apical region of the outer lobe is a narrow band. The *A. mockfordi* female subgenital plate with its four vaginal lobes most closely resembles that of *A. delosa.* In general the posterior margins of the inner lobes of *A. mockfordi* exhibit a somewhat more rounded appearance than those of *A. delosa.* However, there is some overlap in the range of variation of this feature as some specimens of *A. mockfordi* have a more truncated posterior margin. The nymph of *A. mockfordi* is distinguished from this stage in *A. nigritta* and *A. delosa* by the paucity of long hairs comprising the marginal fringe of the abdominal segments.

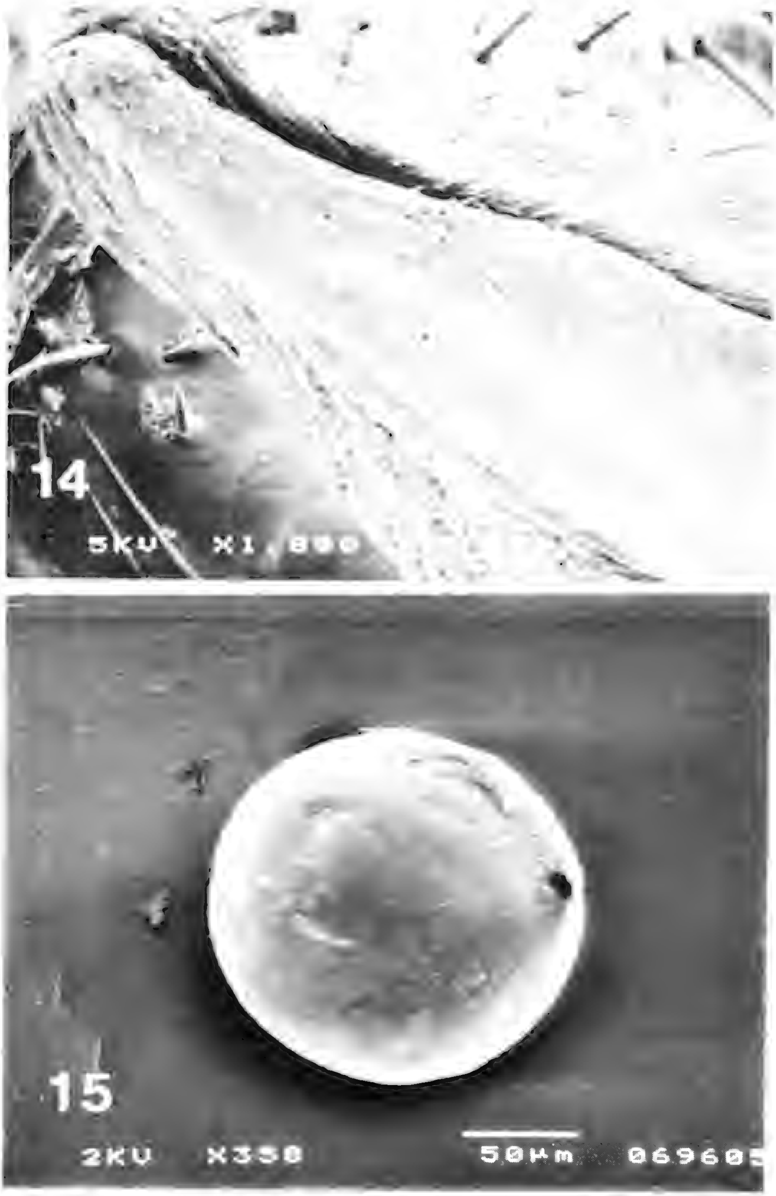
A. mockfordi is an inhabitant of small headwater streams or seeps of the Cumberland Plateau. Other stonefly species collected with this species were *Amphinemura nigritta, Ostrocerca truncata* (Claassen), *Leuctra biloba* Claassen, *Leuctra rickeri* James, and *Diploperla robusta* Stark and Gaufin.



Figs. 1 - 8. *Amphinemura mockfordi*, adult terminalia. 1. Epiproct, dorsal. 2. Epiproct, lateral. 3. Epiproct, ventral. 4. Ventral aspect of male right paraproct showing inner (il), middle (ml), and outer lobes (ol). 5. Male terminalia, dorsal. 6. Male terminalia indicating basal sclerite (bs), lateral. 7. Male terminalia, ventral. 8. Female terminalia, ventral. Scale lines = 0.5 mm.



Figs. 9 - 13. *Amphinemura mockfordi*, nymph. 9. Habitus, dorsal. 10. Male terminalia, dorsal. 11. Male terminalia, lateral. 12. Male terminalia, ventral. 13. Right cercus, dorsal. Scale lines = 1 mm.



Figs. 14 - 15. *Amphinemura mockfordi*, scanning electron micrographs. 14. Epiproct apex, biased dorsal. 15. Egg.

ACKNOWLEDGMENTS

I thank Ross Durham and Gene Van Horn for their critical reading of earlier versions of this manuscript.

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FIRST ADULT DESCRIPTION OF THE UNUSUAL BAETID MAYFLY GENUS *ECHINOBAETIS* (EPHEMEROPTERA: BAETIDAE)[1, 2]

C. R. Lugo-Ortiz, W. P. McCafferty[3]

ABSTRACT: The female adult of the Indonesian species *Echinobaetis phagas* (Ephemeroptera: Baetidae) is described. The adult of *Echinobaetis* has not been known previously. It is distinct from other baetid adults in that the forewings have an R_3 sector, which is formed by the basal union of R_{3a} and R_{3b}, multiple marginal intercalaries between MP and A, and a CuA that is attached to CuP. In addition, the pronotum has a deep, V-shaped anteromedian emargination, and the meso- and metasternal sclerites are ventrally extended.

Mol (1989) erected the genus *Echinobaetis* (Ephemeroptera: Baetidae) for *E. phagas* Mol, a species from Sulawesi (formerly Celebes) known from the larvae only. The genus has been notable because the larvae have depressed, peripherally expanded heads with prognathous mouthpart orientation [Mol (1989): Figs. 1, 2], triads of elongate, posteriorly oriented spines on terga 1-8 [Mol (1989): Figs. 22, 23], and mouthparts modified for predation [Mol (1989): Figs. 3-17]. Although highly atypical of baetid mayflies in general, this "flat-headed" small minnow mayfly does possess the unique baetid epicranial suture with lateral branches anterior to the lateral ocelli [Wang and McCafferty (1996): Fig. 6] and ventral orientation of the dorsal apical lobe of the femora. These latter characteristics distinguish all baetid larvae.

In our recent examination of baetid material from Sulawesi, we discovered the adult of *E. phagas*. Although female, it, like the larvae, is highly unusual for the family and therefore deserving of this special report. The material examined is housed in the Purdue Entomological Research Collection, West Lafayette, IN.

Echinobaetis phagas Mol, 1989

Female adult. Body length: 10.6 mm; wing length: 9.7 mm; caudal filaments length: 25.3 mm. Head (Figs. 1, 2): Face pale brown to medium brown. Vertex with medium brown fleur-de-lis marking. Flagella, scapes, and pedicels whitish dorsally, pale brown ventrally. Compound eyes black. Thorax: Pronotum (Fig. 1) pale brown to medium brown, with deep, V-shaped anteromedian emargination. Meso- and metanota dark brown. Sterna cream. Meso- and metasternal sclerites (Fig. 3) enlarged, extending ventrally. Legs cream. Midfemora (Fig. 4) with two triangular processes distally. Tarsi each with ovoid claw and acute claw. Fore-

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[1] Received July 6, 1996. Accepted August 6, 1996.

[2] Purdue Agricultural Research Program Journal No. 15117.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

wings (Fig. 5) dark brown between C and R_1 and in most crossveins; 2.71x longer than wide; single marginal intercalary between R_1 and R_2; area between R_2 and MP with elongate double marginal intercalaries, except between IMA and MA_2 with three; area between MP and A with two, three, four, and five marginal intercalaries of various lengths, mostly elongate; R_{3a} and R_{3b} basally attached, forming a fork; CuA basally attached to CuP. Hindwings absent. Abdomen: Terga dark brown. Larval spine remnants on terga 1-8, barely visible. Gill socket remnants on abdominal segments 1-7. Sterna medium brown to yellow-brown. Caudal filaments dark brown, turning cream distally.

Material examined. SULAWESI, Utura Prov., Toraut R, Dumoga-Bone Nat. Park, 211 m, 0°44'N, 123°54'E, IX-3-1985, J. T. and D. A. Polhemus, female adult (forewing mounted on slide).

DISCUSSION

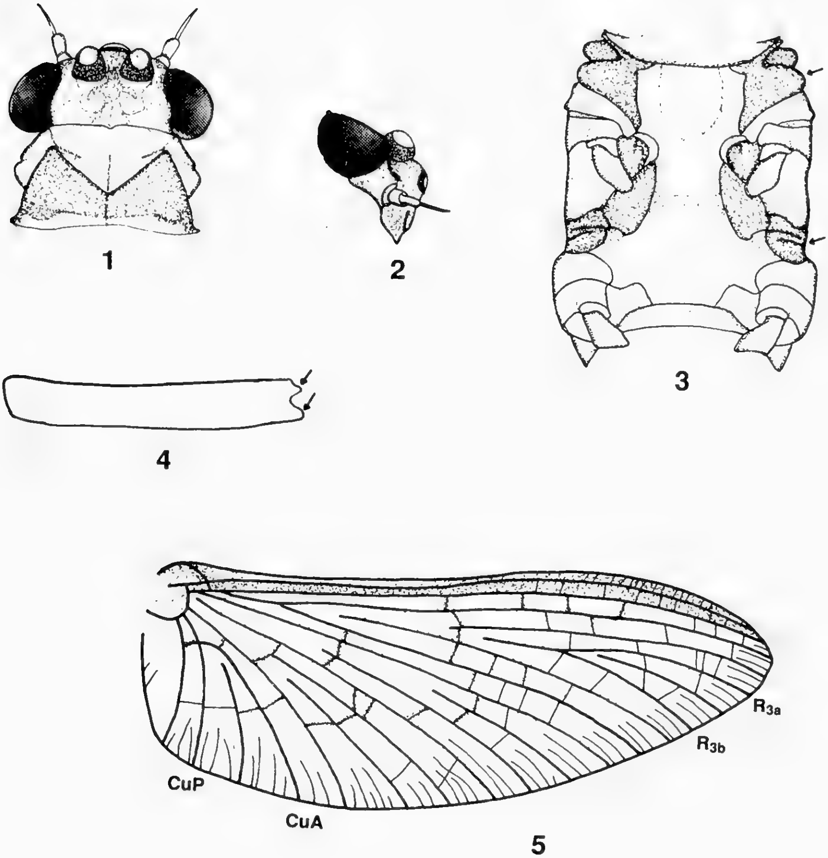
The specimen upon which the above description is based was not reared. However, we are confident that it belongs to *E. phagas* because it possesses vestiges of the three spines that are present on terga 1-8 of the larvae as well as possessing spiny gill socket remnants on abdominal segments 1-7. Both characteristics are diagnostic of the species. Also, the head shape (Figs. 1, 2) is indicative of the nature of the larval head. The adult was collected from the same general area and season as the original material described by Mol (1989).

The adult of *E. phagas* possesses characteristics that are unique or highly unusual among the Baetidae. Wings are narrow-elongate, with atypical venation. A striking venational characteristic is the presence of an R_3 sector in the forewings (Fig. 5). This sector, formed by the basal union of R_{3a} and R_{3b}, is not present in other baetid adults, and may possibly represent an ancestral condition within Baetidae because it is present in Siphlaenigmatidae [see Penniket (1962): Fig. 1], some members of the Heptagenioidea [see McCafferty (1991): Figs. 26, 28], and some Siphlonuroidea [see McCafferty (1991): Fig. 24].

The union of CuA to CuP (Fig. 5) is another unusual characteristic for Baetidae. Only one other baetid genus, *Centroptiloides* Lestage, has CuA attached to CuP [see Crass (1947): Fig. 29a]. This condition is variously widespread throughout the Ephemeroptera and is highly subject to homoplasy. Thus, even within Baetidae, *Centroptiloides* and *Echinobaetis* clearly belong to disparate phyletic clades.

The presence of multiple, elongate marginal intercalary veins in the forewing (Fig. 5) is of considerable additional interest. All other baetid genera have relatively short marginal intercalaries. The relatively large number of intercalaries in each space (up to five), particularly between MP and A, and their retention appears related to the lengthening of the cubito-anal area, which is the major contributor to elongation of the forewing.

Despite the unusual and distinctive venation of the forewings of *Echinobaetis,*



Figs. 1-5. *Echinobaetis phagas,* female adult. 1. Head and pronotum. 2. Head (lateral). 3. Meso- and metasterna (pointers towards meso- and metasternal sclerites). 4. Left midfemur (pointers towards distal processes). 5. Right forewing.

adults are still readily identifiable as Baetidae due to the basally detached IMA, MA_2, IMP, and MP_2, and three-segmented mid- and hindtarsi. Also, based on larvae, the male adults should have turbinate eyes, although it has been recently shown that this is not a universal characteristic of Baetidae (Lugo-Ortiz and McCafferty 1996).

The deep anteromedian emargination of the pronotum (Fig. 1) and enlarged, ventrally extended meso- and metasternal sclerites (Fig. 3) of *E. phagas* are not present in other baetid adults. We consider them additional apomorphies defining *Echinobaetis.*

The only other flatheaded baetid mayfly genus known at present is *Jubabaetis* Müller-Liebenau (1980). It is known from larvae only of one species from the Philippines. It is apparently related to *Echinobaetis,* and therefore its adults may demonstrate some of the adult characteristics that we have established for *Echinobaetis.* In any case, adults of *J. pescadori* Müller-Liebenau should be readily distinguished from *E. phagas* because *J. pescadori* will possess small hindwings and should have a single tergal spine vestige on abdominal segments 1-9, while *E. phagas* lacks hindwings and has three tergal spine vestiges on abdominal segments 1-8.

ACKNOWLEDGMENTS

The specimen upon which this study was based was collected by J. T. and D. A. Polhemus with support from a research grant from the National Geographic Society. The specimen was donated to the Purdue Entomological Research Collection by G. F. Edmunds, Jr. (Salt Lake City, Utah).

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MATING BEHAVIOR OF *PELECINUS POLYTURATOR* (HYMENOPTERA: PELECINIDAE)[1]

A.P. Aguiar[2]

ABSTRACT: The mating behavior of *Pelecinus polyturator* is described and briefly discussed. It is suggested that the mating behavior of the male *P. polyturator* may have evolved in response to the female's highly specialized gaster.

In spite of its usually large size and peculiar morphology, *Pelecinus polyturator* (Drury) has not attracted much attention and remains poorly known, notably with respect to its biology and behavior. This species is better known as a parasite of Scarabaeidae larvae (Davis 1919; Hammond 1944), but Clausen (1940) believes that the true hosts are probably Coleoptera larvae living in decaying wood. Hammond (*op.c.*) observed larval and pupal stages on *Phyllophaga,* and discussed the economic importance of this parasitism, and Lim *et al.* (1980) described the pupa. The development is internal, and pupation takes place outside the host (Clausen, *op.c.*). Adult males are extremely rare in North America, where females are believed to be mainly parthenogenetic (Brues 1928; Young 1990). In the Neotropics, however, males seem to be as common as females (Masner 1995). In any case, *P. polyturator* is not commonly collected, and no rearing technique is known for this species, making biological studies about it a task usually difficult to achieve. This study was performed after the collection of a male and female in the Atlantic Forest of southern Brazil (Lapa, Paraná State, 25°46´S 49°44´W) on March 14, 1991. Both the male and female were placed in a 400ml jar and observed during the entire mating process, and an additional 20 minutes. Each was then independently mounted as similarly as possible to its respective observed copulatory posture, as reference material for illustrations.

MATING BEHAVIOR

The male mounted the female immediately after they were put together, grasping her first gastral segment with the apex of his fore tibiae (fig. 1). The basitarsal antennal brush and apical spurs apparently helped the male grip the female's gaster. The male vibrated his wings in brief periods of less than one second, at intervals of 1-4 seconds, throughout the mating process. He vibrated

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[1] Received April 22, 1996. Accepted May 31, 1996.

[2] Museum of Biological Diversity, Dept. of Entomology, 1315 Kinnear Rd., Columbus, OH 43212-1192.

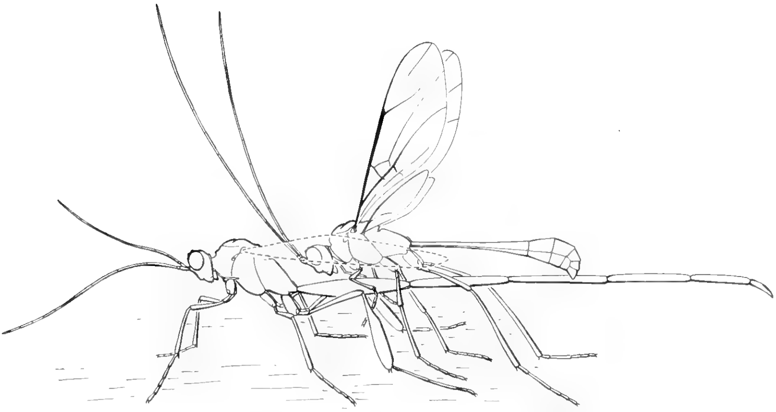
his antennae, in a simple and steady alternate pattern, touching the female with them. The female assumed a passive position at this time, with antennae showing no movement, wings partially retracted, and thorax and gaster stationary, almost touching the substratum. After 1.5 minutes, the female touched the male gaster with her own, by elevating it gently. The male reacted by sliding backwards along the female gaster, while still holding her with his tibiae. The tip of his gaster also slid over the female's until the two tips met. The hook-like male genitalia was then exerted. Soon after copulation started (fig. 2), the male bent his gaster downwards, while the female slightly arched hers upwards. This first copulation ended 15 seconds later but the male kept holding the female while vibrating his wings and antennae. After a few seconds, the male dismounted, walked briefly around, and remounted the female. A second copulation took place 30 seconds after the first one, with male and female showing the same behavior. During the interval between the two copulations, the female kept her gaster laying sideways on the substratum curved in a "C" shape, and was apparently in a very relaxed state. After three more minutes of courtship, the female lashed energetically at the male with her gaster, causing an immediate dismount. The female then entered into a strongly quiescent state, laying sideways, completely motionless, on the substratum during a period of three minutes, after which she recovered totally and started to fly inside the jar. The entire mating process lasted five minutes. During the following 20 minutes no more trials for copulation were observed, and the experiment was terminated.

DISCUSSION

Mounting in *P. polyturator* is singular among Apocrita Hymenoptera in that the male does not mount the female on her thorax as usually observed (*e.g.*, Assem *et al.* 1980a, 1980b, and Assem & Povel 1973 for Pteromalidae, Camargo 1972 for Apidae, Mertins 1980 for Bethylidae, Michener 1948 for Ants, and Vinson 1972 for Ichneumonidae). Nonetheless, gastral mounting in *P. polyturator* may improve efficacy in copulating, since the two genitalia are approximately 40% closer than they would be in a head-over-head mounting, making it easier and/or quicker for the male to access the female's genitalia.

Wing and antennal vibration during courtship seems to be an almost universal behavior of courting male Hymenoptera (Matthews 1975), though the latter can usually show considerable variation among Hymenoptera (*e.g.*, Assem & Povel 1973). For *P. polyturator*, however, both antennal and wing vibration follow a very simple pattern, indicating a generalized courtship behavior.

In spite of the female's inactivity during most of the time, she seems to play a decisive role in starting (and ending, see further below) copulation, since the male slid backwards to copulate only after the female touched his abdomen with hers, apparently signaling her willingness. The need of an acceptance sign



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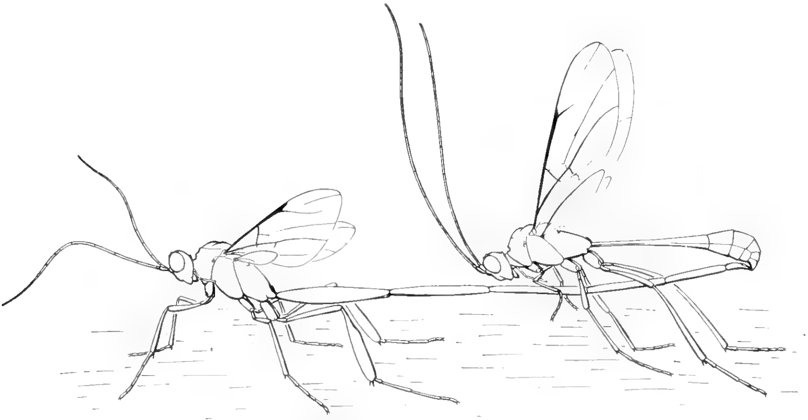

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Mating behavior of *Pelecinus polyturator.* Fig. 1. Mounting. Fig. 2. Copulation.

appears also in a number of Hymenoptera species, albeit it can be expressed in a variety of forms. In several species of Pteromalidae for example, the female signals by a tight flagellar and "chin" retraction (Assem & Povel 1973; Assem *et al.* 1980a).

The possibility of the female simply retracting her gaster to copulate with the male mounted on her thorax (for example by bending it upwards, reducing its length by curving it in a bell-shaped fashion, retracting it through telescoping, or even combining these possibilities) may be a simple evolutionary solution to the problem, but some important flexibility restrictions apply to the female gaster of *P. polyturator*. Mason (1984) discussed the complex mechanics of the gastral articulation in this species; the articulation between gastral segments 1 and 2 allows only a vertical movement, and the posterior segment cannot deflect upwards by more than 10°-20°. Rotary and vertical movements are also restricted in the subsequent segments. In fact, the muscular and sclerotic structure shows a high degree of specialization to a downwards action, used for digging the soil. Thus, if the restricted flexibility of the gaster, crucial for digging the soil for larval hosts, was more valuable to the survival of the species than a more flexible gaster, useful for an "easier" mating, then *P. polyturator* must have had to overcome the "longer female's gaster" problem in an alternative way. The more immediate solution may have been a more active role of the male, by simply sliding backwards to copulate. Selection favoring males using the front legs for grasping the female's gaster can easily follow this sequence, since this behavior helps reduce the chances of losing the female, especially during the male's backward slide.

The short copula suggests a great availability of receptive females, since more prolonged copulations tend to occur only when the probability of acquiring multiple mates is low (Thornhill & Alcock 1983). This apparently implies that females of *P. polyturator* are more numerous than males in the area where the specimens were collected. However, the availability of receptive females may also be increased by other factors, as male/female efficiency in locating each other, and female willingness in copulating with more than one male. Inferences on sex ratio are, therefore, premature.

The firm refusal of the male in trying to copulate again after being lashed by the female gaster strongly indicates that this behavior may serve as a sign for the end of the mating. The succeeding quiescent state of the female was also observed for *Tetrastichus incertus* (Eulophidae, Miller 1966) and *Laelius pedatus* (Bethylidae, Mertins 1980), but not so intense as here observed for *P. polyturator*. Its significance is unknown.

In conclusion, it can be suggested that most of the current mating behavior of *P. polyturator* may have evolved in response to the female's acquisition of a highly specialized gaster.

ACKNOWLEDGMENTS

My sincere thanks to Linda J. Mason, Clifford Sadof, John F. MacDonald, Luciana Musetti, John Wenzel, and two anonymous reviewers, for valuable suggestions, and to Arwin V. Provonsha for preparing the illustrations.

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THE RATE OF SPECIES DESCRIPTIONS IN ODONATA[1]

K. J. Tennessen[2]

ABSTRACT: The rate of new species descriptions of Odonata over the last 150 years yields an essentially straight line, indicating that many species are yet to be discovered within the Order. More than 5,300 species are now known, and the rates of description in the suborders Anisoptera and Zygoptera have been relatively equal. However, a decline in the number of new species appearing in the three largest families over the last six decades, despite an increasing number of authors, indicates that the Odonata are now at least half known and that fewer than 10,000 species exist worldwide.

Examining the trend curve of the rate at which species have been described indicates whether nearly all species in a particular group are known or whether many remain to be discovered. For example, Steyskal (1965) found that the curve for the butterflies of North America has leveled off, indicating that alpha taxonomy for this group is essentially complete. By contrast, the curves for fleas, wasps, and mosquitoes show that many species still are undescribed. The curves for *Aedes* mosquitoes (Zavortink 1990) and the stoneflies of the world (Steyskal 1976) show no slowing in descriptive rate. In this paper, I present the status of the trend curve for the world Odonata, an Order generally purported to be well-known.

METHODS

Using Bridges' catalogue (1993), I tallied the number of valid species described in each decade, beginning with Linnaeus in 1758. Subspecies, forms and known synonyms were omitted from the counts. A decade was defined as extending from January 1 of the zero year to December 31 of the ninth year (e.g., the 1980s began on Jan. 1, 1980 and ended on Dec. 31, 1989). Exceptions were made for the first and last decades: the 1750s, from Jan. 1, 1758, to Dec. 31, 1759 (2 years); and the 1990s, from Jan. 1, 1990 to Dec. 31, 1994 (5 years). I derived the number of descriptions appearing after Bridges (1993) by searching literature and abstracts.

RESULTS

Approximately 5,300 valid species have been described from Linnaeus' time through 1994. A significant increase in the rate of Odonata descriptions did not begin until 70 years after Linnaeus (Fig. 1). Since then, the rate has been fairly

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[1] Received June 11, 1996. Accepted August 1, 1996.

[2] 1949 Hickory Ave., Florence, AL 35630.

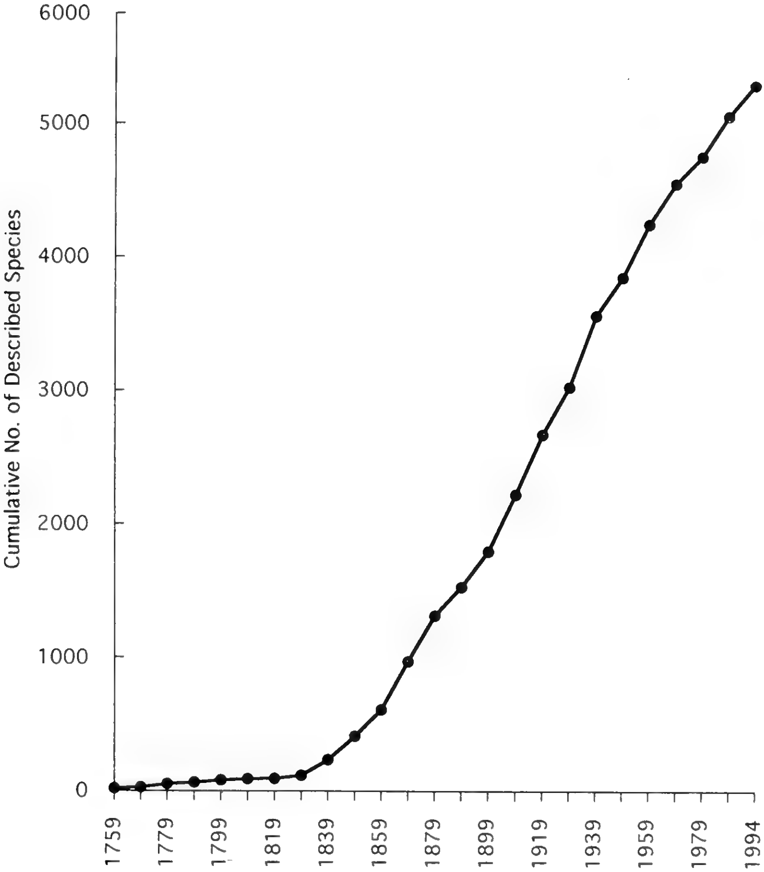

Figure 1. Trend curve of the number of world Odonata species described per decade since Linnaeus.

constant. The decade of greatest activity so far was the 1930s, when 548 species were described. A relatively low number of new species appeared in the 1970s (208), indicating that the line might begin to level off. However, in the 1980s, the rate increased again. As Steyskal (1965) pointed out, ". . . if the curve appears to be leveling off, we have no assurance that we are approaching the stage at which all species are known." The steeper inclination of the line in the first half of the 1990s, during which more than 235 species were described, indicates that we are far from nearing completion of odonate species discovery.

The number of species described to date within the two suborders, Anisoptera and Zygoptera, are remarkably similar (about 2,770 and 2,540 species, respectively). In the first half of the current decade, more Anisoptera (145) have been described than Zygoptera (90). a trend opposite that of the 1980s. In the last three decades, families in which the most species were described were Gomphidae, Coenagrionidae, Libellulidae, Corduliidae, Aeshnidae, Protoneuridae, Platycnemididae, and Megapodagrionidae, listed in descending order.

The majority of new species described recently came from tropical areas of the world (Neotropical. 92: Oriental. 74; Australasian, 40). The fauna of Europe is almost certainly known, as over 95 percent of the European fauna was described prior to 1900, and only five new species descriptions have appeared since then (see Askew 1988). Knowledge of the Nearctic fauna appears to be nearing completion (Fig. 2), although 8 species have appeared thus far in the 1990s and a few new species still await description.

The rate of new species discovery in the three largest families (each with approximately 1,000 species known) might be a clue to the status of knowledge for the Order as a whole. For example, in the Coenagrionidae and Libellulidae, the descriptive rate over the last 4 decades has slowed (Table 1). The future rate in Coenagrionidae will probably be higher than in the Libellulidae, however, as several colleagues have informed me that many undescribed species of these small, taxonomically-difficult damselflies exist in tropical areas. In contrast to these two families, the rate in the Gomphidae increased. Reasons that new species continue to appear in this family is that gomphid dragonflies are rather local in distribution, have relatively brief adult flight ranges, and are relatively secretive in their habits, factors which make them difficult to collect. In summary, the declining rate in two of the largest families, coupled with the fact that significant numbers of new species are being found in only three of the six biogeographic regions, indicates that over half the Odonata are now known.

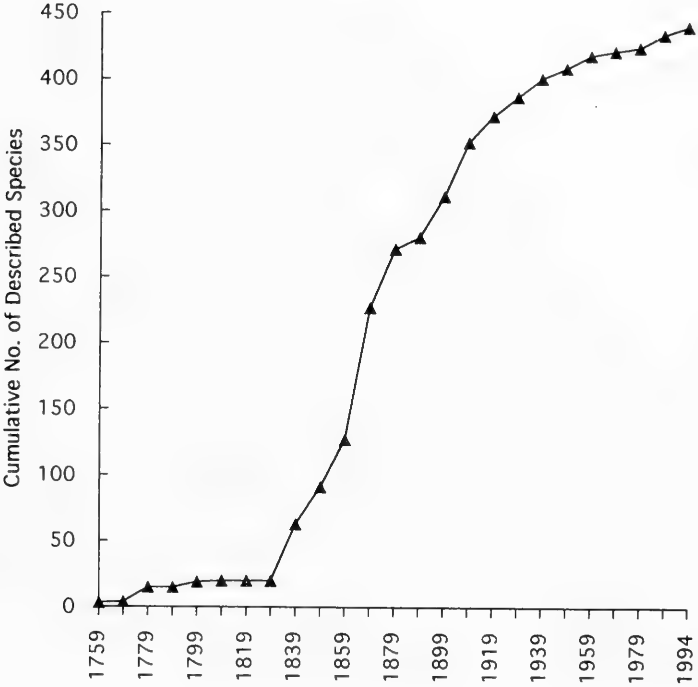

Fig. 2. Trend curve of species descriptions for North American Odonata.

Furthermore, the increasing number of authors has not increased the rate of description, although odonatologists are not evenly distributed around the world, and there are few or none in many of the tropical countries where diversity is greatest. The combined circumstances of these three factors lead me to speculate that over half the Odonata are known and thus there are fewer than 10,000 species in the world.

Higher classification within the Order is highly controversial and in need of revision. Phylogenetic studies of Odonata have lagged behind studies of other aquatic insect Orders. Progress in these two areas will continue to be slow because funding for such efforts is difficult to obtain. Most currently active Odonata taxonomists expend personal resources to support research at the species level and higher, including costs for collecting, curating, analysis, and publishing.

Table 1. Change in number of new species descriptions per decade in the three largest families of Odonata from 1900 to 1994, and the associated percent increase or decrease in the last five decades of 20th century compared with first half of century.

	Gomphidae	Libellulidae	Coenagrionidae
Mean No. New Species per Decade (1900 to 1949)	66	70	89
No. New Species/Decade			
1950-59	57	77	87
1960-69	55	50	84
1970-79	67	20	46
1980-89	83	31	37
1990-94	85	19	24
% Increase (+) or Decrease (–)			
1950-59	–14	+10	– 2
1960-69	–17	–29	– 6
1970-79	+ 2	–71	–48
1980-89	+26	–56	–58
1990-94	+29	–73	–73

ACKNOWLEDGMENTS

My thanks to Sid Dunkle and Dennis Paulson for reviewing the initial version of the manuscript, and two anonymous reviewers for additional comments.

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ACTIVITY AND REPRODUCTION OF *CALOSOMA FRIGIDUM* (COLEOPTERA: CARABIDAE) IN NORTHERN MICHIGAN FORESTS[1]

Renate M. Snider[2], Richard J. Snider[2]

ABSTRACT: From 1985 to 1991, activity patterns of *Calosoma frigidum* were assessed by means of pit-trapping at weekly intervals from early May to late October in two deciduous forest sites in northern Michigan. Females were dissected in order to document ovarian development. The species was spring-breeding, with activity of gravid females peaking in May-June, and with spent females present from late May to July and occasionally into August. In 1988, only one of 85 females was gravid, a phenomenon apparently related to delayed emergence from hibernation. Asynchronism between time of emergence and early spring shifts from short-day to long-day (critical for vitellogenesis) was postulated as the underlying cause for reproductive failure in 1988. In both sites, the species essentially disappeared after 1988.

Results presented here stem from a long-term ecological study in Michigan's Upper Peninsula. The study was designed to assess potential effects of Extremely Low Frequency (ELF) electromagnetic fields, created by the U.S. Navy's ELF antenna, on soil and litter invertebrates. One of the project goals was to document activity patterns of forest-dwelling arthropods by pit-trapping prior to (1985-1988) and after (1989-1991) antenna activation in two sites: a Test site adjacent to the ELF antenna, and a Control site removed from its influence (Snider & Snider 1987). Among the Carabidae obtained from 1985 to 1991, *Calosoma frigidum* Kirby exhibited a reproductive anomaly. This anomaly occurred in 1988, the year prior to ELF antenna activation, and it occurred in both sites; i.e., it was unrelated to potential effects of electromagnetic fields.

METHODS

Both sites were located in hardwood forest dominated by *Acer saccharum* Marsh, and were divided into 20 (10 x 10 m) quadrats. Twenty pit-traps were installed per site, one each in the same corner of each sampling quadrat (site descriptions, sampling design and quadrat layout are given in Snider & Snider 1987). Traps were made of opaque plastic and consisted of a permanently installed outer cup (9 cm diameter), and a funnel which snapped into its rim and led to an inner collection cup. When traps were not in use, only the outer cup, covered with a tight-fitting lid, remained in the field. Four 1 m lengths of green plastic garden edging, protruding approx. 8 cm above ground and abutting to

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[1] Received July 29, 1996. Accepted August 24, 1996.

[2] Department of Zoology, Michigan State University, East Lansing, Michigan 48824.

the trap at 90° angles were used as barriers. At intervals of 1 week from early May to late October, inner collection cups partly filled with ethylene glycol were inserted at dusk and collected at dawn (= night catch), replaced, and collected again the following dusk (= day catch). Specimens were rinsed and stored in 95% ethyl alcohol. Intact females of *C. frigidum* (i.e., those which had not been cannibalized while in the trap) were later dissected, mature ova were counted, and the developmental state of each specimen was classified as follows: **T** = teneral females, ovaries undeveloped, integument soft; **W** = females with well-developed, slightly distended ovaries, mature ova absent; **G** = gravid females, mature ova present; **S** = spent females. Results span seven seasons, from 1985 through 1991.

RESULTS AND DISCUSSION

Basic information on annual catch size, diurnality, and sex ratios of *C. frigidum* is summarized in Table 1. In both sites, activity-density as measured by total catches increased toward a peak in 1987, declined in 1988, and abruptly decreased to near-zero thereafter. In 1987, peak populations of *C. frigidum,* which feeds on a variety of defoliating insect larvae (Sanders & Frankenhuyzen 1979; Crins 1980; Burgess & Collins 1917; Gidaspow 1959), coincided with particularly severe defoliation of sugar maples and other tree species. Site-specific data on defoliators were not obtained. In the area at large, however, densities of Bruce's spanworm *(Operophtera bruceata* (Hulst)), fall cankerworm *(Alsophila pometaria* (Harris)), linden looper *(Erannis tiliaria* [Harris]), and forest tent caterpillar *(Malacosoma disstria* Hübner) were recorded as unusually high; large numbers of active *Calosoma* sp. were noted as well (Department of Natural Resources, Dr. Robert Heyd, pers. comm.). Within Test and Control sites, beetles were conspicuously active on the litter surface in 1987, indicating that the large numbers trapped (Table 1) were partly due to increased activity. Crins (1980) also reported high numbers and increased mobility of *C. frigidum* in maple-dominated forests in Ontario during a year of severe defoliation.

Observations on other *Calosoma* species may aid interpretation of 1988 data on *C. frigidum.* Male *C. sycophanta* L. become less active when prey is scarce (Weseloh 1985); a reduced proportion of males in trap catches would be the result, as observed in *C. frigidum* (Table 1). Reduced prey availability also diminishes *C. sycophanta* mobility in general (Weseloh 1985), and may have been instrumental in the 1988 decline in *C. frigidum* catches (Table 1), despite normal reproduction in 1987 (discussed below). In addition, severe rainfall deficiency and rapidly decreasing soil moisture from May through July 1988 (Snider & Snider 1995) probably had negative effects on activity-density of *C. frigidum* (Epstein & Kulman 1990; Martel *et al.* 1991). Drought, rather than prey density (as observed in *C. calidum* Fabricius by Jeffords & Case [1987]), may also have influenced diel activity patterns (Table 1).

Pronounced between-year fluctuations in carabid numbers have been documented for other species as well (Desender & Alderweireldt 1990). However, the extreme scarcity of *C. frigidum* after 1988 requires further explanation. Basic patterns of activity and reproduction are evident in 1985-1987 data. The species was clearly spring-active (Fig. 1) and spring-breeding (Fig. 2 shows combined Test and Control site data on the developmental state of females). Two teneral females were captured in the first week of May 1987, indicating that a small proportion of larvae may overwinter and mature in early spring. A few individuals with slightly distended ovaries were occasionally present at the same time. One to two weeks later, virtually all females were gravid (Fig. 2), and their activity peaked mid-May to early June. On average, females carried approximately 14 to 17 mature ova (Table 2). Although these data are in agreement with an estimated 17 eggs per female produced in laboratory culture (Burgess and Collins 1917), actual fecundity was probably higher: in many females carrying 20-30 fully mature ova, ovarioles in intermediate stages of development were also present. A few spent females were trapped from late May to July, and occasionally in mid- or late August (data beyond the tenth trapping week not shown in Figs. 1 and 2).

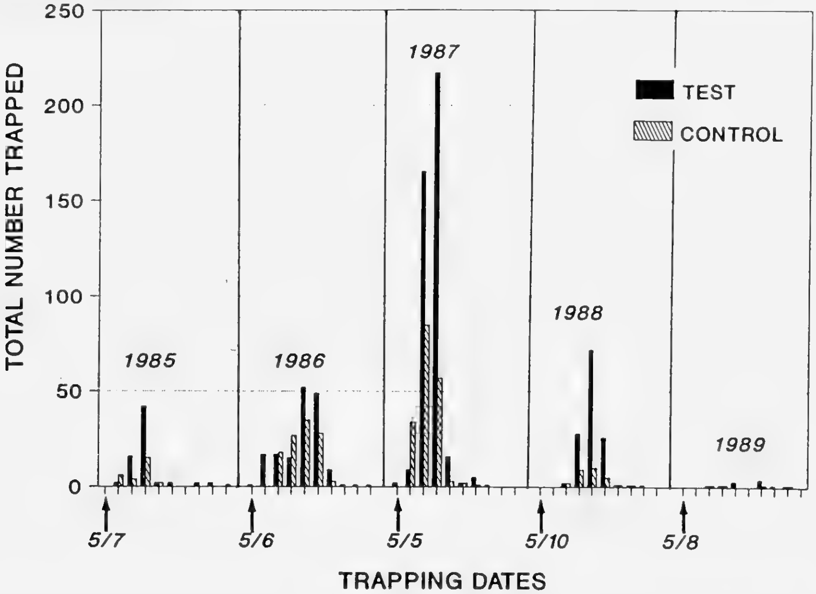

Fig. 1. Weekly catches of *C. frigidum* in Test and Control sites, from the first trapping date in May (arrows) to the 10th week (early July) of 1985 through 1989; later dates and years omitted due to low numbers trapped. Day and night catches, and males and females, combined for each site.

In 1988, the temporal pattern of activity was reminiscent of that observed in 1986, peaking in early June (Fig. 2). However, the developmental state of females differed sharply from all previous years. Of 85 females dissected, only one was gravid, and no spent individuals were ever found (Table 3). Lack of food, which can cause arrested ovarian development (Jeffords & Case 1987), and has been linked to curtailed reproduction in *C. sycophanta* (Weseloh 1985) may have been a contributing factor, although all individuals were obviously well-fed, with plump abdomens distended by extensive fat body development. Another explanation for undeveloped ovaries may be found in delayed emergence of imagines from hibernation. Although soil temperature data prior to May 1 are not available to support this hypothesis, onset of activity (May 24) and appearance of tenerals (May 24 to June 7) occurred 2 to 3 weeks later than in previous years. One could postulate that ovarian dormancy in *C. frigidum* is overcome by exposure to the photoperiodic shift from short-day to long-day, which triggers vitellogenesis in other spring-breeding species (Thiele 1971, 1977). Prolonged hibernation thus may have caused *C. frigidum* to "miss" the period of shifting day-length critical for vitellogenesis.

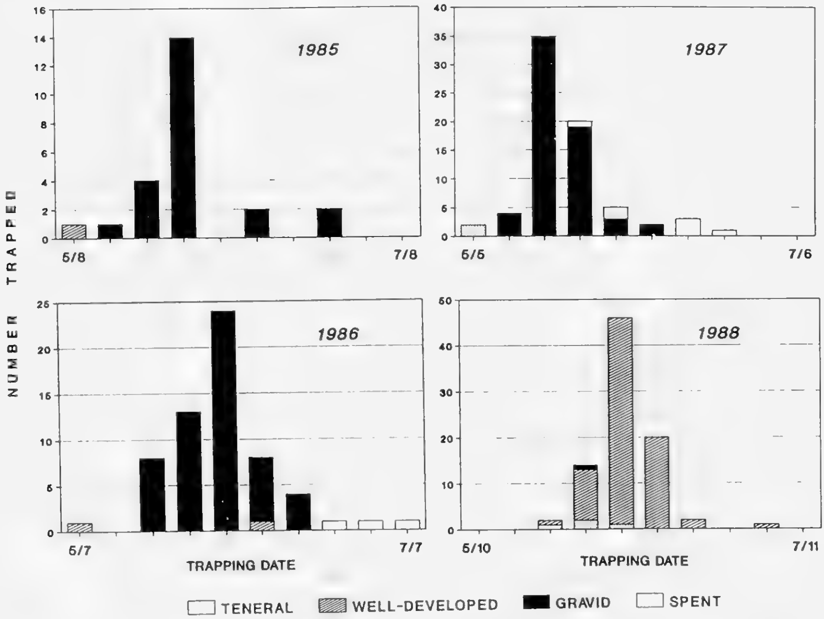

Fig. 2. Numbers of *C. frigidum* females in each developmental stage captured during the first 10 weeks of 1985 through 1988. Control and Test site data, and day and night catches, combined.

Virtually complete reproductive failure in 1988 was undoubtedly a main factor in population reduction over the subsequent 3 years (Table 1). Burgess and Collins (1917) stated that adult *C. frigidum* survive into a second or third year in the field. In the present study, a small proportion of the 1988 adults may have survived to 1989 and beyond, but population recovery was not achieved during the 3 years following reproductive failure.

Table 1. Annual summaries of trap catches of *C. frigidum*, 1985 to 1991: total number of females and males, sex ratios (% males), and percent captured during the day (% diurnal); T and C = Test and Control sites.

YEAR	SITE	Females	Males	**TOTAL**	% males	% diurnal
1985	T	18	49	**67**	73.1	98.5
	C	6	23	**29**	79.5	86.2
1986	T	34	106	**140**	75.7	85.6
	C	28	83	**111**	74.8	86.0
1987	T	59	372	**431**	86.3	80.8
	C	33	160	**193**	82.9	71.4
1988	T	74	57	**131**	43.5	56.1
	C	14	13	**27**	48.1	38.7
1989	T	6	6	**12**	—	—
	C	3	1	**4**	—	—
1990	T	1	1	**2**	—	—
	C	1	0	**1**	—	—
1991	T	1	1	**2**	—	—
	C	0	0	**0**	—	—

Table 2. Number of mature ova carried by *C. frigidum:* means ± SD, range, and N gravid females dissected in parentheses.

YEAR	1985	1986	1987	1988	1989
Test site					
mean ± SD	13.9 ± 8.0	15.9 ± 7.4	17.7 ± 6.1	12.0	10.7 ± 3.1
range	3-35	4-34	4-30	—	8-14
(N)	(17)	(29)	(43)	(1)	(3)
Control site					
mean ± SD	15.8 ± 10.2	16.3 ± 6.0	17.3 ± 6.1	—	—
range	3-31	6-31	4-28	—	—
(N)	(6)	(27)	(28)	—	—

Table 3. Total annual number of female *C. frigidum* in each developmental category (T = teneral; W = non-gravid, ovaries slightly distended; G = gravid; S = spent)

	TEST SITE				CONTROL SITE			
	T	W	G	S	T	W	G	S
1985	0	1	17	0	0	0	6	0
1986	0	2	29	3	0	0	27	0
1987	1	0	43	5	1	0	28	2
1988	1	69	1	0	3	11	0	0
1989	0	1	3	2	0	0	1	2
1990	0	0	1	0	0	0	0	1
1991	0	0	0	1	0	0	0	0

ACKNOWLEDGMENTS

Support for this research was provided by the Naval Electronic Systems Command through a subcontract to IIT Research Institute under contract N00039-81-C-0357.

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NEW GENERIC SYNONYMIES IN BAETIDAE (EPHEMEROPTERA)[1]

R. D. Waltz[2], W. P. McCafferty[3]

ABSTRACT: Several substantive errors in the classification of the family Baetidae have resulted from revisions of mayflies identified as *Baetis*. Revised synonymies of the valid genera *Alainites, Baetiella, Baetis, Diphetor, Labiobaetis, Nigrobaetis*, and *Takobia* are provided and include necessary new synonyms as follows: *Alainites* [= *Baetis (Acerbaetis)*, n. syn.]; *Baetiella* [= *Baetis (Tenuibaetis)*, n. syn.]; *Baetis sensu stricto* [= *Baetis (Tatubaetis)*, n. syn.]; *Labiobaetis* [= *Baetis (Mullerbaetis)*, n. syn.]; and *Nigrobaetis* [= *Baetis (Margobaetis)*, n. syn.]. Species name emendations include *Alainites atagonis*, n. comb., *Alainites clivosus*, n. comb., *Alainites chocoratus*, n. comb., *Alainites florens*, n. comb., *Alainites talasi*, n. comb., *Alainites yehi*, n. comb., *Alainites yoshinoensis*, n. comb.; *Baetiella ardua*, n. comb., *Baetiella inornata*, n. comb. (and corrected orthography), *Baetiella pseudofrequenta*, n. comb.; *Labiobaetis morus*, n. comb.; *Nigrobaetis facetus*, n. comb., *Nigrobaetis gombaki*, n. comb., *Nigrobaetis gracilentus*, n. comb., *Nigrobaetis mirabilis*, n. comb., *Nigrobaetis mundus*, n. comb., *Nigrobaetis numidicus*, n. comb., *Nigrobaetis taiwanensis*, n. comb., *Nigrobaetis terminus*, n. comb.; *Takobia acuticostalis*, n. comb., *Takobia kogistani*, n. comb., and *Takobia solangensis*, n. comb.

Kang *et al.* (1994) published five new subgenera and 13 new species of Baetidae from Taiwan that they placed in the genus *Baetis* Leach. Novikova and Kluge (1994) provided several new recombinations and descriptions of two new species within their concept of *Baetis (Nigrobaetis). Baetis* has been the subject of other revisionary efforts that have included Müller-Liebenau (1970) (Europe); Morihara and McCafferty (1979a), Waltz and McCafferty (1987a), and McCafferty and Waltz (1990) (North America); Novikova and Kluge (1987) (Palearctic); and Waltz *et al.* (1994) and McCafferty and Waltz (1995) (world).

Possession of the villopore, located at the base of the larval femora was found by Waltz and McCafferty (1987a, 1987b) and McCafferty and Waltz (1990) to be a significant synapomorphy uniting a number of genera of Baetidae. This monophyletic grouping of genera is presently referred to as the *Baetis* complex (see e.g., Waltz *et al.* 1994, Lugo-Ortiz and McCafferty 1996) and includes *Acentrella* Bengtsson, *Baetiella* Uéno, *Baetis, Barbaetis* Waltz and McCafferty, *Cymulabaetis* McCafferty and Waltz, *Gratia* Thomas, *Heterocloeon* McDunnough, *Labiobaetis* Novikova and Kluge, *Liebebiella* Waltz and McCafferty, *Platybaetis* Müller-Liebenau, many (but not all) *Pseudocloeon sensu auctt.*, and *Tanzaniella* Gillies. In addition to having the unique villopore, all

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[1] Received July 29, 1996. Accepted August 3, 1996.

[2] IDNR, Division of Entomology and Plant Pathology, 402 West Washington, Room W-290, Indianapolis, IN 46204.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

ENT. NEWS 108(2): 134-140, March & April, 1997

members of the *Baetis* complex have lost the plesiotypic cluster of bristles located between the incisors and mola of the mandibles. Species that were formerly classified in *Baetis,* but that are not members of the *Baetis* complex have obviously required reclassification into other genera, including some new genera. Highly distinctive and monophyletic lineages within the *Baetis* complex, many with species that were also once known as *Baetis,* have been recognized as the various genera listed above.

Kang *et al.* (1994) were evidently not aware of concepts and genus group names that were already established, beginning in 1987, for elements of the formerly broad and polyphyletic concept of *Baetis.* Thus, most species described from Taiwan, in various new subgenera of *Baetis,* by Kang *et al.* (1994) are actually members of other presently recognized genera. All subgenera described by Kang and Yang in Kang *et al.* (1994) are junior synonyms of nominal genera, including both *Baetis* complex and non-*Baetis* complex genera. Novikova and Kluge (1994) retained a highly conservative and polyphyletic concept of the genus *Baetis,* including a broad subgeneric grouping they identified as the subgenus *Nigrobaetis,* which incorporated elements of *Nigrobaetis s.str.,* *Alainites* Waltz and McCafferty, *Diphetor* Waltz and McCafferty, and *Takobia* Novikova and Kluge. The bases of each of these genera were addressed by Waltz *et al.* (1994). Necessary corrections to the Kang *et al.* (1994) and Novikova and Kluge (1994) works by way of new generic synonymies and short discussions of the pertinent genera follow.

Alainites Waltz and McCafferty

Baetis gracilis group Müller-Liebenau, 1970:174, in part.
Baetis muticus group Müller-Liebenau, 1974:34.
Alainites Waltz and McCafferty, in Waltz *et al.,* 1994:34 [type, *Baetis muticus* Linn., 1758].
Baetis (Acerbaetis) Kang and Yang, in Kang *et al.,* 1994:35 [type, *Baetis clivosus* Chang and Yang, 1994], **n. syn.**
Baetis (Nigrobaetis) muticus group: Novikova and Kluge, 1994: 630.

Alainites was characterized by Waltz *et al.* (1994) and separated from other genera of the *Baetis* complex by tergal setae and armature characteristics previously discussed by Müller-Liebenau (1970) and by the apomorphic development of special paraproct prolongation (see Waltz *et al.,* 1994:34). Species included in *Acerbaetis* Kang and Yang possess all of these characteristics and clearly belong to *Alainites. Alainites atagonis* (Gose), **n. comb.,** *A. chocoratus* (Gose) **n. comb.,** *A. clivosus* (Chang and Yang), **n. comb.,** *A. florens* (Imanishi), **n. comb.,** *A. talasi* (Novikova and Kluge), **n. comb.,** *A. yehi* (Kang and Yang), **n. comb.,** and *A. yoshinoensis* (Gose), **n. comb.,** should be added to the list of *Alainites* species given by Waltz *et al.* (1994). Placement of *A. atagonis* is based on adult morphology. *Alainites* is widely distributed throughout the Palearctic, the Mediterranean/northern Africa area, and parts of southeast and east Asia, including southern China and Taiwan.

Both the Kang *et al.* (1994) and the Waltz *et al.* (1994) papers bear December, 1994 publication dates. Based on International Commission of Zoological Nomenclature (ICZN) convention, the priority of names published with contemporaneous issue dates must be resolved on the basis of date of availability. The genus *Alainites* description in the Bulletin de la Société d'Histoire Naturelle de Toulouse, with an issue date of December, 1994 (which by ICZN convention is regarded as December 31, 1994), was distributed and met the criteria of availability on January 15, 1995, as confirmed by editors of the journal. This was prior to the verifiable availability date of April 15, 1995, for the *Acerbaetis* description in the Journal of the Taiwan Museum, with an issue date of December 31, 1994. This was confirmed by the Assistant Curator of the Taiwan Museum. The name *Alainites* therefore met the criteria of availability approximately three months prior to the date of availability of the name *Acerbaetis.* (see also Acknowledgments).

Baetiella Uéno

Baetiella Uéno 1931:220 [type, *Acentrella japonica* Imanishi, 1930].
Pseudocloeon Klapálek, in part: Bogoescu and Tabacaru, 1957:483.
Pseudocloeon (Baetiella): Kazlauskas, 1963:318 (English version pagination).
Neobaetiella Müller-Liebenau, 1985:103 [type, *Neobaetiella uenoi* Müller-Liebenau, 1985], synonymized by Waltz and McCafferty 1987b: 561.
Baetis (Baetiella): Novikova and Kluge, 1987:16.
Baetiella: Waltz and McCafferty, 1987b:561.
Baetis (Tenuibaetis) Kang and Yang, in Kang *et al.*, 1994:26 [type, *Baetis pseudofrequentus* Müller-Liebenau, 1985], **n. syn.**

The genus *Baetiella* was most recently characterized by Waltz and McCafferty (1987b) to include those species of the *Baetis* complex that have an elongate segment 2 and conical segment 3 of the labial palps, among other distinctive characteristics. Species placed in *Tenuibaetis* by Kang *et al.* (1994) possess the characteristics of *Baetiella.* Species included in the genus were listed by Waltz and McCafferty (1987b). *Baetiella ardua* (Kang and Yang), **n. comb.,** *B. inornata* (Kang and Yang), **n. comb.,** and *B. pseudofrequenta* (Müller-Liebenau), **n. comb.,** should be added to that list. The species name *Baetis (Tenuibaetis) inornaturs* Kang and Yang, was a *lapsis calami,* obvious from the etymology given for the species and figure citations accompanying the description (Kang *et al.* 1994). *Baetiella* is Palearctic and Oriental in distribution.

Baetis Leach

Baetis Leach, 1815:137 [type, *Ephemera fuscata* Linn., 1761].
Brachyphlebia Westwood, 1840:25 [type, *Ephemera fuscata* Linn., 1761].
Baetis (Tatubaetis) Kang and Yang, in Kang *et al.*, 1994:23 [type, *Baetis tatuensis* Müller-Liebenau, 1985], **n. syn.**

The genus *Baetis* is a member of the *Baetis* complex, and because *B. fuscatus* is the type species, the genus is most typified by the *B. fuscatus* species group (Müller-Liebenau 1970). *Baetis* also includes species of the *rhodani* and *vernus* groups in the Holarctic region (see Müller-Liebenau 1970 and Morihara and McCafferty 1979a) as well as possibly certain species from non-Holarctic parts of the world that have yet to be associated with any species groups. Based on body coloration, mouthpart characteristics (esp. of the labium and maxillae), tergal armature, and setation of the legs, *B. tatuensis* is clearly a member of the *B. fuscatus* group. *Baetis tatuensis* is therefore a member of *Baetis sensu stricto* and should not be placed in a separate subgenus *Tatubaetis* as was done by Kang *et al.* (1994). Species currently classified in *Baetis* from sub-Saharan Africa, South America, and Australia require additional study before they can be confirmed to be members of the genus. As a result, the only recently up to date and confirmed listing of *Baetis* species for a large geographic area is for North America (see McCafferty 1996).

Diphetor Waltz and McCafferty

Diphetor Waltz and McCafferty, 1987:669 [type, *Baetis hageni* Eaton, 1885].
Baetis (Nigrobaetis): Novikova and Kluge, 1994:627.

The distinctiveness of *Diphetor* from other described taxa was presented by Waltz *et al.* (1994). The genus is known from three species in North America and Algeria as listed by Waltz *et al.* (1994). The placement of species of *Diphetor* (a non- *Baetis* complex genus) in a subgenus of *Baetis* by Novikova and Kluge (1994) is untenable.

Labiobaetis Novikova and Kluge

Baetis atrebatinus group Müller-Liebenau, 1970:150.
Baetis propinquus group Morihara and McCafferty, 1979b:130.
Baetis molawinensis group Müller-Liebenau, 1984:260.
Baetis (Labiobaetis) Novikova and Kluge, 1987:13 [type, *Baetis atrebatinus* Eaton, 1870].
Labiobaetis: McCafferty and Waltz, 1995:20.
Baetis (Müllerbaetis) Kang and Yang, in Kang *et al.*, 1994:32 [type, *Baetis molawinensis* Müller-Liebenau, 1982], **n. syn.**

The genus *Labiobaetis is* a member of the *Baetis* complex of genera and was most recently characterized by McCafferty and Waltz (1995). Synapomorphies defining the genus include, among others, the excavate tip of the maxillary palps and usually the notched antennal segment 1. McCafferty and Waltz (1995) indicated that the Oriental *Baetis molawinensis* group, originally recognized by Müller- Liebenau (1984), clearly belonged to *Labiobaetis.* Kang *et al.* (1994) considered 11 previously described Oriental species in the subgenus *Müllerbaetis* (type, *B. molawinensis).* These are all species of *Labiobaetis* and were listed as such by McCafferty and Waltz (1995), along with all other species of the genus. The Taiwan species *L. morus* (Chang and Yang), **n. comb.,** should be added to the list of known species of this Holarctic and Oriental genus.

Nigrobaetis Novikova and Kluge

Baetis niger group Müller-Liebenau, 1970:163.
Baetis gracilis group Müller-Liebenau, 1970:174, in part.
Baetis (Nigrobaetis) Kazlauskas: Novikova and Kluge, 1987:8 [type, *Ephemera nigra* Linn., 1761].
Nigrobaetis Novikova and Kluge: Waltz, McCafferty and Thomas, 1994:34.
Baetis (Margobaetis) Kang and Yang, in Kang *et al.*, 1994:11 [type, *Baetis mundus* Chang and Yang, 1994], **n. syn.**
Baetis (Nigrobaetis): Novikova and Kluge, 1994: 627, in part.

Nigrobaetis is a non-*Baetis* complex genus that was most recently characterized by Waltz *et al.* (1994). Species from Taiwan assigned to *Margobaetis* by Kang *et al.* (1994) demonstrate *Nigrobaetis* generic characteristics, and thus, *Margobaetis* must be placed as a junior synonym of *Nigrobaetis.* The genus is known from the Holarctic and Oriental regions, and species included were listed by Waltz *et al.* (1994). To that list the following species should now be added: *N. facetus* (Chang and Yang), **n. comb.,** *N. gombaki* (Müller-Liebenau), **n. comb.,** *N. gracilentus* (Chang and Yang), **n. comb.,** *N. mirabilis* (Müller-Liebenau), **n. comb.,** *N. mundus* (Chang and Yang), **n. comb.,** *N. numidicus* (Soldán and Thomas), **n. comb.,** *N. taiwanensis* (Müller-Liebenau), **n. comb.,** and *N. terminus* (Chang and Yang), **n. comb.** Novikova and Kluge (1987,1994) incorrectly ascribed the name *Nigrobaetis* to Kazlauskas when in fact, by rules of nomenclature, they are recognized as the inadvertent authors of the genus group name. Novikova and Kluge (1994) also incorrectly placed species of *Diphetor* and certain species of *Alainites* and *Takobia* in *Nigrobaetis.* That concept is polyphyletic because it includes species of both the *Baetis* complex and non-*Baetis* complex. In any case, *Nigrobaetis* is not a subgenus of *Baetis.*

Takobia Novikova and Kluge

Baetis (Takobia) Novikova and Kluge 1987:10 [type, *Centroptilum maxillare* Braasch and Soldán, 1983].
Takobia: Waltz, McCafferty, and Thomas, 1994:35.
Baetis (Nigrobaetis) maxillaris group Novikova and Kluge, 1994:630.

The genus *Takobia* and its systematic status was discussed by Waltz *et al.* (1994). Novikova and Kluge (1994) regarded it as part of a subgenus *Nigrobaetis* of the genus *Baetis.* We regard *Takobia* as a distinct taxon at the genus level. Additional species to those listed by Waltz *et al.* (1994) include *Takobia acuticostalis* (Dubey), **n. comb.,** *T. kogistani* (Novikova and Kluge), **n. comb.,** and *T. solangensis* (Dubey), **n. comb.** The genus *Takobia* is known from Central Asia including the western Himalayas. The terminal segment of the male forceps is elongated and not spherical. This is a correction to the description of the male genitalia reported in Waltz *et al.* (1994) and should be noted.

ACKNOWLEDGMENTS

We thank A. Thomas (Toulouse) for confirming dates of availability at the Paris Museum and with the publisher of Bulletin de la Société Histoire Naturelle de Toulouse; Robert Skarr (Senior Reference Librarian, Smithsonian Institution Libraries, Washington, D.C.), for providing dates of receipt of the journals at the Smithsonian Institution; Chia-Hsiang Wang (Associate Curator of the Taiwan Museum) for confirming availability dates of the Bulletin of the Taiwan Museum based on date of first distribution; T.-Q. and Y. Wang (Purdue University) for their assistance in obtaining information from Taiwan. This paper has been assigned Purdue ARP Journal No. 15082.

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CRITICAL COMMENTARY ON THE GENUS *SIPHLONISCA* (EPHEMEROPTERA: SIPHLONURIDAE)[1,2]

W. P. McCafferty[3], George F. Edmunds, Jr.[4]

ABSTRACT: Data are presented that contravene certain unfounded statements that have been published regarding *Siphlonisca aerodromia,* a siphlonurid mayfly from extreme northeastern U.S.A. and eastern Canada. The species is shown to be locally common in restricted habitats within its geographic range. A large number of mayfly species in North America are known from fewer locale records and specimens. Paleontological data indicate that *Siphlonisca* is not represented in the fossil record, the Holarctic family Siphlonuridae *sensu stricto* is not represented prior to the Tertiary, and *S. aerodromia* should not be considered a living fossil. Cladistic data place *Siphlonisca* as a sister group of the genus *Parameletus.* The presence of lateral abdominal flanges in the adults are independent adaptations in a number of distantly related mayfly lineages and are related to gill position and type in the larval stage. The presence of laterally expanded abdomens in some Paleozoic insects does not necessarily denote close relationships with particular lineages of extant mayflies. The fact that *Siphlonisca* is monotypic is not unique among North American mayfly genera.

In an appendix to the 1908 Report of the State Entomologist of New York, James G. Needham described the northeastern Nearctic siphlonurid mayfly *Siphlonisca aerodromia.* The description of the new genus and species was initially drafted for a single female adult from Sacandaga Park, Johnstown, New York, collected by C. P. Alexander. However, based on additional material of both male and female adults also collected by Alexander on June 6, 1909, and also from Sacandaga Park, the male description was also included. The date ascribed to this species has often been 1908 (e.g., Traver 1935; Burian and Gibbs 1988, 1991; McCafferty 1996). The date of the species name should be 1909, as listed by Edmunds and Allen (1957) and Edmunds (1962) because the name was not published or available until 1909 and because the description was in part based on 1909 data. Incidentally, for the same reason, the name *Potamanthus inequalis* Needham, which appeared in the same appendix, should also be dated 1909, as has been historically recognized in the literature. With respect to this somewhat awkward chronology, Bae and McCafferty (1991), in their comprehensive revision of the family Potamanthidae, referenced the name *P. inequalis* under the synonymy of *Anthopotamus myops* as "*Potamanthus inequalis* 1909 Needham *In:* Needham 1908. . ."

The larval stage of *S. aerodromia* was originally described by Clemens (1915)

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[1] Received August 20, 1996; Accepted September 9, 1996.

[2] Purdue Agricultural Research Program Journal No. 15146.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

[4] Department of Biology, University of Utah, Salt Lake City, UT 84112.

from larvae collected by Alexander at the species' type locality. Alexander's collecting notes were included in the paper by Clemens. Various other works essentially reviewed data from the original materials of this species from Sacandaga Park up until the time that Magnin and Harper (1970), Fiance (1978), and Hutchinson (1989) reported it from parts of eastern Canada; Gibbs (1980) and Burian and Gibbs (1991) reported specimens from several localities in Maine; Gibbs and Mingo (1986) provided some life history and feeding data; Burian and Gibbs (1988) thoroughly redescribed the species; and Gibbs and Siebenmann (1996) most recently critically studied the biology of the species. In the latter paper, another record from New York was mentioned, but with no data associated with it. No other species of *Siphlonisca* have been discovered, and the genus remains monotypic and restricted to northeastern North America.

Two primary conceptions associated with this relatively large sized and striking species seem to have preoccupied both researchers who have recently worked with the species and others who have written about it. The first is the presence of unusually large lateral flanges on the abdomen of the adults that are conspicuous in flight. The other is the continually repeated idea that *S. aerodromia* is one of the rarest mayflies. Both of these conceptions have now apparently been linked with an idea that *S. aerodromia* is unique among recent mayflies and is somehow a "living fossil" (Anonymous 1995). We argue herein that these conceptions are not valid. Abdominal flanges are found in a number of pisciform mayflies, including both siphlonurids and non-siphlonurids, but are more common outside North America (abdominal flanges are also independently evolved in pannote mayflies and others). *Siphlonisca* appears to be very closely related to another more widespread genus of the family Siphlonuridae. And, based on its abundance and studied populations recently found of the species, *S. aerodromia* should be considered locally common and is not rare compared to many other mayflies in North America.

DISCUSSION

Alexander (pers. comm. with GFE) stated of his 1909 collections of *S. aerodromia,* that "they were abundant and they kept high in the air where they were conspicuous by reason of the wide abdomen (lateral expansions of segments 5-9)." The noted insect morphologist G. C. Crampton was intrigued by the resemblance of the abdominal flanges to similar expansions on the thorax or abdomen of certain Paleozoic insects (Alexander, pers. comm.). This led to additional collecting trips to Sacandaga Park, where Alexander and, later, Crampton obtained more specimens (see Edmunds *et al.* 1976). Needham (1908) compared the abdomen of *S. aerodromia* to that of the New Zealand *Oniscigaster wakefieldi* McLachlan (Oniscigastridae), one of the other species known at the time to have abdominal flanges. We know of no suggestion by Crampton that the abdominal flanges of *Siphlonisca* represented a retention of Paleozoic characteristics or a suggestion that *Siphlonisca* was more primitive than other extant pisciform mayflies. Furthermore, *Siphlonisca* was not compared with Paleozoic insects in Crampton's insect morphology notes (read by GFE in a course given at the University of Massachusetts by J. F. Hanson).

A small, rather curious article about *S. aerodromia* recently appeared in *Fly Fisherman Magazine* (Anonymous 1995). The article was accompanied by a photograph of a female adult mayfly taken in western Pennsylvania that was labeled as "An adult mayfly that may be a rare carnivorous Tomah mayfly." ["Tomah mayfly" is a vernacular name given to *S. aerodromia,* alluding to the stream in Maine where most published scientific studies of the mayfly have been conducted; but the photographed mayfly from Pennsylvania is most certainly not *Siphlonisca,* based on its obvious non-siphlonuroid wing venation.] We take exception to certain impressions conveyed by statements about S. *aerodromia* given in that article because the article will most certainly be seen by some entomologists, and erroneous or unfounded information regarding the species may be cited in the literature. Obviously, popular articles must be taken with " a grain of salt," because errors in fact can be common; however, this article is additionally vexing because an ephemeropterist is evidently the source of the information. We are particularly concerned with impressions of *S. aerodromia* that are conveyed with the statements: ". . . it's so rare—in effect a flying fossil dating from the Paleozoic Era – that it disappeared for 50 years and was considered extinct" and that it "has been called the rarest mayfly in the world." Moreover, the article indicated that in the Spring, 1995 issue of the *Maine Legacy,* the magazine of the Maine Nature Conservancy, the mayfly was cited as standing apart from other North America mayflies by not sharing its genus with any other.

From existing published records of *S. aerodromia* (see references above), it has become apparent that the species – while restricted somewhat geographically to the extreme northeastern United States and eastern Canada, and by habitat availability (stream backwaters and temporary floodplains) – is nonetheless locally common and often abundant where it occurs. Despite this, a recent scientific article continued to promulgate the misconception of rareness by using the phrase "the rare mayfly *Siphlonisca aerodromia*" in its title (Gibbs and Siebenmann 1996). We estimate that at least 100 North American mayfly species, representative of most North American families, are presently known from fewer specimens and fewer locale records. In many of these cases, the "rarity" of such species is a collecting artifact. In other words, efficient sampling historically has not been possible because usual collecting techniques have not been amenable to capturing the species in their peculiar habitats or with respect to their peculiar life histories. A few examples of North American species that are not generally collected as larvae for these reasons include deep-water riverine species such as the heptageniids *Acanthomola pubescens* Whiting and Lehmkuhl, *Anepeorus simplex* (Walsh), and *Raptoheptagenia cruentata* (Walsh); fast-swimming psammophilous species such as *Analetris eximia* Edmunds (Acanthametropodidae) and *Pseudiron centralis* McDunnough (Pseudironidae); very small species such as the baetids *Apobaetis indeprensus* Day and *Paracloeodes minutus* (Daggy); certain clay-burrowing species such as *Pentagenin vittigera* (Walsh) (Ephemeridae) and *Tortopus primus* (McDunnough) (Polymitarcyidae); and early season emergers whose developed larvae are only available in late fall, winter and very early spring, such as the more northern temperate species of Metretopodidae.

Siphlonisca aerodromia should not be considered a fossil any more than any other extant mayfly species. The oldest fossils that have been associated with the family Siphlonuridae *sensu lato* date from the Jurassic (see discussion of McCafferty 1990). However, such data are based on the broadest historical concept ever given to that family (see McCafferty and Edmunds 1979, McCafferty 1990). The actual clade to which *Siphlonisca* belongs is a much more restricted Holarctic grouping [Siphlonuridae sensu McCafferty (1991) and Kluge *et al.* (1995)], and includes along with *Siphlonisca,* the genera *Edmundsius* Day, *Parameletus* Bengtsson, *Siphlonurus* Eaton, and provisionally *Siphluriscus* Ulmer (see McCafferty and Wang 1994a). Fossils that are possibly assignable to this particular clade include members of the genera *Aphelophlebodes* Pierce from the Miocene of California and *Baltameletus* Demoulin and *Siphlonurus* from Eocene Baltic amber. Siphlonuridae *sensu stricto* is not an archaic group and is comparable in age to most other extant mayfly families.

Neither *Siphlonisca* and its close relatives (other Siphlonuridae), nor any other extant group of mayflies are fossils "dating from the Paleozoic." Most extant families of mayflies (McCafferty 1991) are also represented by fossils from the Tertiary as is Siphlonuridae, but only seven of them, not including Siphlonuridae, apparently have representative fossils from the Mesozoic, and no extant families have representative fossils from the Paleozoic, although there are strictly fossil families of mayflies from that era (see Hubbard 1987, McCafferty 1990).

Although cladistic analyses of all lineages of pisciform mayflies have not yet been performed satisfactorily to reach comprehensive conclusions regarding the entire group, all siphlonuroid genera have been studied independently by both of us, and we have reached the same conclusion regarding the phylogenetic position of *Siphlonisca. Siphlonisca* apparently is the sister genus of *Parameletus.* Illustrative of this hypothesized relationship are the very similar apomorphic male genitalia and short hindtarsi shared by adults of the two genera. Of further possible consequence in this regard, *Parameletus* larvae in Utah are found in flooded *Carex* (Edmunds 1957), very similarly to that which has been reported for *Siphlonisca* in Maine by Gibbs (1980). Like *Siphlonisca,* *Parameletus* has been a genus with species that are often difficult to find and collect.

It is evident that *Siphlonisca's* erroneous relationship with the Paleozoic has been associated with the observation that certain Paleozoic insects possessed somewhat similar laterally expanded abdomens. A number of extant mayflies have a larval abdomen that is variously expanded laterally. In every instance where this occurs, the abdominal gill lamellae originate dorsally rather than laterally on the abdomen and tend to overlay the lateral abdominal flanges. This feature is typical of the entire subgroup of mayflies known as pannote mayflies (McCafferty and Edmunds 1979). In genera with highly developed flanges, e.g., those of the *Timpanoga* complex of the family Ephemerellidae (McCafferty and Wang 1994b), the larval flanges remain evident in the adults. In the non-pannote and non-pisciform burrowing mayfly subfamily Palingeniinae of the family Ephemeridae, flanged larval abdomens are also carried over into the adults. Besides *Siphlonisca,* other examples of this phenomenon among the pisciform mayflies include the genera *Oniscigaster* McLachlan and *Siphlonella* Needham and Murphy (family Oniscigastridae) from the Southern Hemisphere. Given the wide variety of mayflies from disparate Ephemeroptera lineages demonstrating broad lateral flanges and the fact that it is apparently related to larval gill adaptation, we can not assume from such data, alone, any common derivations. This includes deducing a primordial relationship of *Siphlonisca* with Paleozoic forms having similar modifications.

We do not know if the adult abdominal flanges are entirely non-adaptive vestiges of the larval structures or whether there may be some advantage (e. g., aerodynamic) accrued to the adult by their retained presence that explains their nearly full retention in such mayflies as *Siphlonisca.* Only very slight lateral expansions are found in larvae of other Siphlonuridae (with no appreciable adult vestiges of such). Abdominal flange development in *Siphlonisca* and the loss of the fork of the MP vein in the hindwings of *Parameletus* are autapomorphies that allow us to continue to regard the two lineages as separate genera.

The claim that *S. aerodromia* disappeared for 50 years is not correct. It is true that 55 years occurred between the time Clemens (1915) discussed the species and the next publication reporting records of the species (Magnin and Harper 1970). However, the species was collected in New York up until the 1930's, when the type locality was altered due to the construction of the Sacandaga Reservoir. Fiance (1978) reported material that had been collected in 1952 in Canada. Lapses in records are most logically explained by the fact that there were few if any ephemeropterists collecting the habitats of *S. aerodromia* in the Northeast between the time when Alexander and Crampton were collecting the type locality in New York and the time when intensive local research was begun more recently in Maine by Gibbs and her students.

Finally, *S. aerodromia* does not stand alone among the North American mayflies in being monotypic. At the current time, 10 other North American genera in various families are known from only one species (see McCafferty 1996). All of these can be considered just as unique in this respect as *Siphlonisca.* Certainly, S. *aerodromia* is a striking species from its size and some details of its morphology. Many other mayflies in North America, however, are equally extraordinary, and others from around the world possess more highly unusual morphological attributes.

Local fascination with a particular species of aquatic insects can have very positive effects because it often leads to productive biological studies. The recent studies of *Siphlonisca* are just one case in point. Some examples of other species that are fascinating in their own respect and that have received concentrated local attention in North America have included the behningiid *Dolania americana* Edmunds and Traver in Florida (e.g., Peters and Peters 1977, Peters *et al.* 1987), the polymitarcyid *Ephoron album* (Say) in Utah (e.g., Edmunds *et al.* 1956), and the heptageniid *Stenacron interpunctatum* (Say) in Indiana (e.g., McCafferty and Huff 1978, McCafferty and Pereira 1984, McShaffrey and McCafferty 1986). The only possible down side to such concentrated attention is that in interpreting and popularizing such data for general readership, distortions and exaggerations of information can and do occur to affect a degree of sensationalism, as has obviously been the case with *Siphlonisca.* Our intent here has been simply to set the record straight.

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ESTABLISHMENT OF *ALEIODES* (= *ROGAS*) *INDISCRETUS* (HYMENOPTERA: BRACONIDAE), AN INTRODUCED PARASITE OF THE GYPSY MOTH IN NORTH AMERICA[1]

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

ABSTRACT: *Aleiodes indiscretus* (Reardon);, an introduced braconid endoparasite released as a part of the gypsy moth biological control program, was recovered from *Dasychira basiflava* larvae collected in 1994 at Brandywine, Prince Georges County, Maryland. This confirms establishment of the parasite for the first time in North America.

Aleiodes (= *Rogas*) *indiscretus* (Reardon), a solitary braconid endoparasite of *Lymantria obfuscata* Walker (Lepidoptera: Lymantriidae), was initially collected in Kotgarh, Kashmir, India. It was imported from India to the United States for rearing and release as a part of a biological control program against the gypsy moth, *Lymantria dispar* (L.) by the USDA, APHIS, Otis Air National Guard Base (ANGB), Massachusetts (Reardon, 1970). The parasite was first reared in 1967, at Otis ANGB and then released in 1968 at Ledyard, CT and Falmouth, MA. A total of 30,847 adults were released from 1968 to 1977 in New Jersey, Massachusetts, Connecticut and southeastern Pennsylvania (Metterhouse, 1981). According to Anderson *et al.* (1977), extensive efforts were made to establish *A. indiscretus* and other new species for control of gypsy moth in North America, but no success was achieved in recent years except for the recovery in 1978 by Schaefer *et al.* (1989) of the pupal parasite *Coccygomimus disparis* (Viereck) (Hymenoptera: Ichneumonidae) on alternate hosts. According to Schaefer the parasite is well established in North America.

One of the reasons given for the failures of *A. indiscretus* and some other exotic parasites was the lack of suitable alternate hosts (Hedlund and Schroder, 1981). The gypsy moth is a univoltine species that is normally active from late April through July. The egg stage is present during the remainder of the year. Therefore, larval parasites including *A. indiscretus* and other pupal parasites must adapt to this short period of activity or find other alternate hosts. In 1974, studies were initiated and continued through 1994 in designated Maryland woodlots to identify potential alternate hosts available prior to the arrival of introduced gypsy moth parasites, and potential native parasites that may select the gypsy moth upon its arrival at the study sites. We report here on the first establishment of *A. indiscretus* in North America.

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[1] Received January 22, 1996. Accepted October 9, 1996.

[2] USDA, ARS, PSI, Insect Biocontrol Laboratory, Beltsville, Md 20705.

ENT. NEWS 108(2): 148-150, March & April, 1997

MATERIAL AND METHODS

Twenty woodlot sites were selected in central and western Maryland in 1974 (Fig. 1). At each site, 10 hardwood trees were each banded with burlap. During the growing season, we periodically examined the burlap bands and collected all the lepidopteran insects and any associated parasitic cocoons present under burlap. This study was conducted from 1974 to 1994. In addition to this study, we banded trees in southern Maryland during the 1993 - 94 growing season. We were particularly interested in the native lymantriids and associated parasites present at the sites. The insects collected were fed on leaves in our laboratory at 20° C, 50% RH and under natural light for emergence of parasites. Specimens of each species were submitted for identification to the USDA, Systematic Entomology Laboratory (SEL).

RESULTS AND DISCUSSION

During the course of our alternate host studies over the past 19 years, it became apparent that *Dasychira* (Lepidoptera: Lymantriidae) was one of the

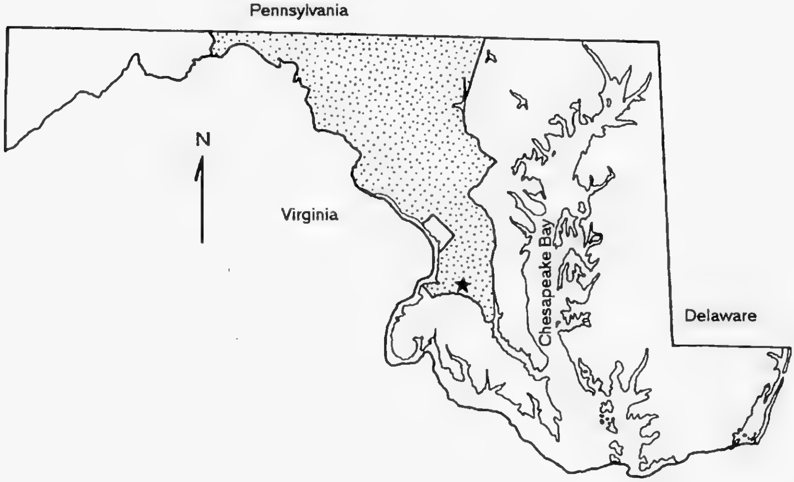

Fig 1. Area of woodlot sites in Maryland selected for survey of alternate hosts of imported gypsy moth parasites, including established site of *Aleiodes indiscretus*.

Shaded portion was area where woodlot sites were located. Star represents site in Prince Georges County where *A. indiscretus* was discovered.

predominant species present (R.F.W.S., unpublished data). According to Ferguson (1978), *Dasychira* species all overwinter as partly grown, diapausing larvae. We therefore considered them as potential alternate hosts for introduced parasites of the gypsy moth.

As one sample among hundreds collected in the ongoing study in 1994, we recovered 9 braconid parasites from 38 *Dasychira basiflava* (Packard) larvae collected 5/8 - 5/16 at Brandywine, Prince Georges County, Maryland (Fig. 1). The parasites were identified as *Aleiodes indiscretus* by P. M. Marsh, Research Entomologist (retired), SEL. The genus *Aleiodes* was resurrected out of synonymy with the genus *Rogas* by van Achterberg (1982). According to Marsh (personal communication), the genus *Rogas* is restricted to tropical areas, and all North American species listed in catalogues as *Rogas* should be called *Aleiodes*. The closest release site of this parasite was near Philadelphia in Schuylkill County, Pennsylvania, where it was released in 1971. This parasite was never recovered from gypsy moth larvae or other *Dasychira* collected in the study. Perhaps more extensive surveys like this one should have been conducted. The fact that this parasite was never recovered from gypsy moth larvae collected at our study sites, would suggest that it has chosen *D. basiflav*a as its primary host. Ferguson (1978) states that *D. basiflava* is one of the closely knit complex of 16 North American species limited to the United States and Canada. Further studies can only verify if *A. indiscretus* has made the permanent transition to *Dasychira* or if its primary host is still the gypsy moth. After nearly 20 years of searching for alternate hosts of introduced gypsy moth parasites, we can now confirm the establishment of one more parasite, the impact of which must now be determined.

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A NEW NORTH AMERICAN SPECIES OF THE GENUS *CLUZOBRA* (DIPTERA: MYCETOPHILIDAE)[1]

Edward I. Coher[2]

ABSTRACT: The first North American species of the principally Neotropical genus *Cluzobra* is described from a short series of males and females taken in Ohio.

Twenty-nine species of the sciophiline genus *Cluzobra* have been described, all from the Neotropical Region. Matile (1996) described twenty new species and reviewed nine species described by Lane (1948, 1956, 1959, 1960) and Edwards (1934, 1940, 1941). Excluding two questionable records of females, nineteen species are known from a single country and ten from a single collection.

Only 2 species, *C. aitkeni* and *C. spinulifera* are reported as being widely distributed, although *C. binocellaris* and *C. lanei* would also fall into this category if collections from Mexico for the former and Nicaragua for the latter are confirmed by capture of males. Except for *C. lanei*, the other three species have been collected virtually year-round.

Cluzobra Edwards, 1940

Type species: *Acnemia binocellaris* Edwards, 1934

Edwards , 1940. Rev. Entomol. 11:463.
Vockeroth, 1981. Agric. Canada, Monogr. No. 27:231,237.
Matile, 1996. Ann. Soc. Entomol. France (N.S.) 32(1):3-57.

Cluzobra has been characterized in great detail by Matile (1996). Briefly, these sciophiline flies are distinguished by wings with Sc_2 absent, Sc ending in C, and Cu simple.

Cluzobra antennulata Coher, NEW SPECIES

Habitus: a moderately slim, orange-yellow fly.

Male. Head (Fig. 1) with vertex and occiput light red-brown, vertex light between antennae: each ocellus about its diameter from the eye with an irregular row of short setae between them; frons yellowish, narrow, 5:2 and setose: clypeus yellowish, setose; palpus brown, length of apical segment subequal to basal three segments; antenna (2+14) with scape and pedicel and first two flagellar segments cream-colored with base of darker distal segments narrowly infuscated giving antenna a ringed appearance; scape and pedicel with strong dorsal apical setae; ventral apical setae of pedicel short and stout. Thorax with mesonotum yellowish with brown acrostichal stripes from midway

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[1] Received February 10, 1995. Accepted August 10, 1996.

[2] Division of Natural Sciences, Southampton College, Southampton, N.Y. 11968.

that are contiguous anteriorly with broad humeral stripes, dorsocentral stripe narrow or absent; pleura variably pigmented yellowish or brownish except katepisternite that is always darker but light ventrally; pleurotergite with a pair of long central setae; scutellum and postnotum concolorous with pleura; long scutellar setae in a row; posterior postnotum with an irregular row of large, long setae. Wing: (3.0-3.2mm); patterned, (Fig. 2); 1stA barely divergent from Cu and ending beyond fM as a line of setae; 2dA nearly obsolete, represented by a row of setae and paralleling basal posterior wing margin; fully trichiate. Halter with stem yellow, knob variously pigmented but at least partially darkened. Legs with coxae brownish, anterior forecoxa, distal 2/3 of midcoxa, lateral apical fourth of hindcoxa setose, hindcoxa with a single long basal posterior seta; femora lighter with tibiae and tarsi yellowish; tibial spurs long, foretibia with an apical comb; foretibia/ forebasitarsus/ tarsus 2, 6/8/5. Abdomen orange yellow, very setiferous; TVIII (Fig. 3): SVIII (Fig. 4). Terminalia: (Fig. 5, dorsal).

Female. Description as for male. Terminalia: The paired cerci (fig. 6,c, lateral, setae omitted), are borne on tergite X (fig. 6, TX, dorsal,) which is bare and lightly pigmented.

Material examined: Holotype, male, Ohio: Pike Co., Benton Twp., 4/8/79, GA Dahlem. In the collection of Michigan St. University.
Allotype. Female. Same data as the holotype.
Paratopotypes: 1 male and 1 female.

DISCUSSION

C. antennulata is most closely related to the Brazilian *brunneicauda* Matile, 1996 from which the male of the new species may be easily distinguished by the form of its dark broadly bifid internal style and lack of median dorsal styles. The shape of the female cercus is closest to that of *C. annulicornis* as figured by Matile (loc. cit.), but with the apex of the basal cercal segment distinctly narrowed in *C. antennulata.*

Vockeroth (1981), in a key to genera of the Mycetophilidae, noted a *Cluzobra* from Louisiana. Inquiries concerning this material have been to no avail; its identity cannot presently be determined. Thus, *antennulata* is the first Nearctic species of *Cluzobra* to be described.

Biology: Limited capture data suggest that October to February may be the peak activity period for many of the continental South American species although *aitkeni, binocellaris* and *spinulifera* have been collected virtually throughout the year. Nothing is known of the bionomics.

ACKNOWLEDGMENTS

R.L. Fischer of Michigan State University made this material available for study. Annette Vollers prepared the drawings.

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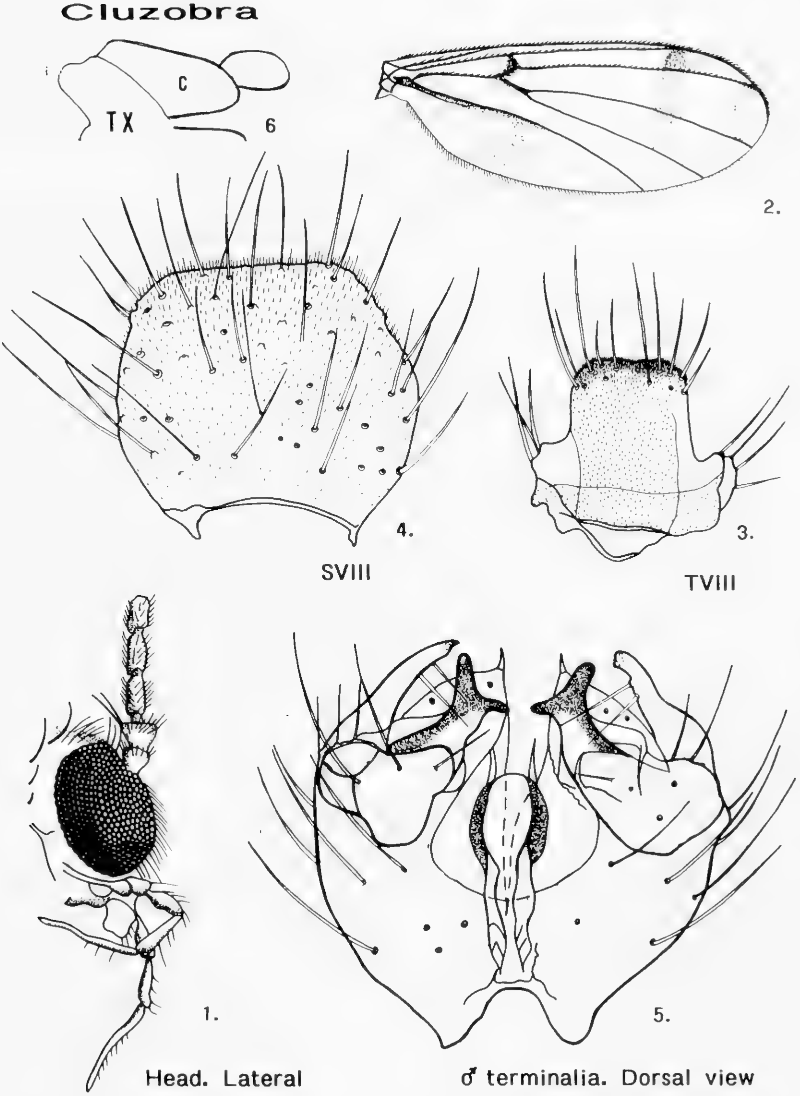

Plate. *Cluzobra antennulata* n.sp. Fig. 1. Head, lateral view. Fig. 2. Wing. Fig. 3. Tergite VIII, male. Fig. 4. SVIII, male. Fig. 5. Male terminalia, dorsal aspect. Fig. 6. Cercus (c, lateral) and tergite X (TX, dorsal), female.

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FIRST RECORD OF *ANTHOPOTAMUS VERTICIS* AND NEW RECORDS OF *A. DISTINCTUS* (EPHEMEROPTERA: POTAMANTHIDAE) IN NEW ENGLAND[1]

Steven K. Burian[2]

ABSTRACT: The species *Anthopotamus verticis* is recorded for the first time in New England from the Housatonic River in western Connecticut. Notes on the larval habitat and observations on the sympatric occurrence of this species with *A. distinctus* are presented. New distribution records for *A. distinctus* are presented for Massachusetts and Vermont.

In North America the family Potamanthidae is represented by a single genus, *Anthopotamus* McCafferty & Bae, which contains four species and is broadly distributed over central and eastern North America (Bae & McCafferty 1991). Currently only one species, *A. distinctus* (Traver), has been reported from New England (Bae & McCafferty 1991, Burian and Gibbs 1991). Throughout New England *A. distinctus* occurs unpredictably in medium to large streams with loose cobble bottoms. In October of 1994, routine sampling of a river in western Connecticut produced specimens of *Anthopotamus* larvae that were clearly not those of *A. distinctus*. In June of 1995, a series of specimens was reared from this site and determined to be *A. verticis* (Say). This is the first record of this species in New England. The new record is presented here, along with notes on the larval habitat and its co-occurrence with *A. distinctus*. New distribution records are presented for *A. distinctus* in Massachusetts and Vermont.

METHODS

Benthic samples were obtained with a D-frame aquatic net and standard kick technique. Live material for rearing was placed in foam cups and chilled for transport to the laboratory. Other specimens were kill-fixed by placing them directly into a modified Carnoy's fluid (Edmunds *et al.* 1976) and later transferred to 80% ethanol. Reared adults and larvae were identified using the most recent taxonomic keys (Bae & McCafferty 1991). Specimens of *A. verticis* were deposited in the Ephemeroptera Research Collection at Southern Connecticut State University. New locality records for *A. distinctus* were based on specimens recorded by Betsy Colburn of the Massachusetts Audubon Society, Steve Fiske of the Vermont Department of Environmental Conservation (DEC), and

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[1] Received May 16, 1996; Accepted September 17, 1996.

[2] Dept. of Biology, Southern Connecticut State University, 501 Crescent Str., New Haven, CT 06515.

specimens in the insect collection of the Peabody Museum, Yale University. Voucher specimens supporting new localities of *A. distinctus* were deposited with each of the three collections. For specimens from the Vermont DEC, reference collection code numbers are cited as part of the new locality records. Latitude and longitude coordinates were not available for new Massachusetts records. Coordinates for Vermont sites were taken from U.S.G.S. 7.5' Quadrangle Maps. The Connecticut coordinates were determined using a Trimble Geoexplorer® G.P.S. receiver and checked using a U.S.G.S. 7.5' Quadrangle Map.

New Potamanthidae Record

Anthopotamus verticis (Say) 1839

Specimens: 7 Imagos (3 Males, 4 Females - Reared); 2 Subimagos (Male - Reared); and 6 Larvae, S.K.Burian 16-VI-1995; 7 Larvae, S.K.Burian 14-X-1994.

CONNECTICUT: Litchfield Co., Housatonic River at Housatonic Meadows State Park (Fly fishing Area) off Route 7[41°49'25"N/73°22'39"W].

Habitat: The channel of the Housatonic River at the site of the new record is about 40 to 45 m wide. Depth was variable because flow was regulated by a hydroelectric dam upstream of the collection site. Larvae of *A. verticis* were collected from side-channel areas in water about 0.5 m deep during low-flow conditions. Substrates at these locations were dominated by a mixture of medium to large cobbles. Larger particles were covered by a thick periphyton layer. Deposits of poorly-sorted medium gravel and sand occurred on the downstream sides of piles of cobbles and small boulders. Packs of coarse particulate organic matter were lodged among the cobbles in places. Filamentous green algae was present in tufts on the tops of some of the larger particles. Beneath the deposits of gravel and sand were thick deposits of fine sediments composed of gray-brown fine sand mixed with silt.

Most larvae were obtained from piles of mixed cobbles overlaying deposits of poorly sorted gravel and sand in areas out of the main flow. No specimens were obtained from similar substrates in the deeper and swifter mid-channel area.

At this locality, larvae of *A. verticis* share the river with larvae of *A. distinctus*. Larvae of both species were obtained simultaneously in kick samples. Field counts of larvae in samples obtained in October 1994 and June 1995 indicated that *A. distinctus* was more abundant on both dates than *A. verticis*. In fact, very few larvae of *A. verticis* were obtained in June of 1995 after repeated sampling, whereas numerous specimens of *A. distinctus* occurred in almost every sample. Although the life history and microhabitat preference of *A. verticis* have been studied (McCafferty & Bae 1994, Bae & McCafferty 1994) little is known about multiple species interactions. The co-occurrence of *A. verticis* and *A. distinctus* at this site provides a unique opportunity to investigate their interactions and microhabitat distribution patterns.

New Localities for *A. distinctus*

A. distinctus has a range that spans the New England States; however, this is based on only a few published locations. Many suitable habitats between known localities are unoccupied, resulting in an erratic distribution pattern. The following new records provide a clarification of the actual distribution of *A. distinctus* in New England:

MASSACHUSETTS: Franklin Co., (Larvae, Female Imago) East Branch of the North River, Colrain, B. Colburn and F. Garretson 9-VII-1992, 15-XI-1994, 23-VI-1995; (Larvae) Burrington Brook (headwaters of the West Branch of the North River), B. Colburn and F. Garretson 15-XI-1994; (Larvae) West Branch of the North River, B. Colburn and F. Garretson 17-XI 1994; (Larvae) Green River, B. Colburn and F. Garretson 17-XI-1994.
VERMONT: Addison Co., (Larvae) Lewis Creek, code 91.046a [44°14'55"N/73°14'01"], 29-IX-1991; **Bennington Co.,** (Larvae) North Branch of the Deerfield River, code 89.075a&b [42°54' 50"N/72"50'16"W], 4-X-1989; (Larvae) Walloomsac River, code 89.077a [42°55'08"N/73°16'08"W], 5-X-1989; **Caledonia Co.,** (Larvae) Passumpsic River, code 90.041a [44°23'37"N/72°01'23"W],2-VIII-1990; **Chittenden Co.,** (Larvae) Lamoille River, code 92.055a&b streams L44°41'00"N/73°03'57"W], 29-IX-1992; (Larvae) Winooski River, code 91.023a [44°20'35"N/72°46'20"W], 5-IX-1991; **Franklin Co.,** (Larvae) Missisquoi River, code 91.062b [44°49'10"N/72°39'50"W], 4-X-1991; **Lamoille Co.,** (Larvae) Lamoille River, Hyde Park, [44°35'30"N/72°38'30"W], W.G. Downs 20-VI-1975; Orange Co., (Larvae) First Branch of the White River, code 92.011b [43°58'34"N/72°27'24"W], 1-IX-1992; (Larvae) Connecticut River, code 92.034b [44°09'05"/72°02'32"W], 17-IX-1992; **Windam Co.,** (Larvae) Saxtons River, code 92.112b [43°08'27"N/72°30'02"W], 4-X-1993; (Larvae) Williams River, code 92.043a&b [43°11'30"N/72°29'17"W], 18-IX-1992; **Windsor Co.,** (Larvae) White River, code 88.083a&b [43°49'30"N/72°34'00"W], 26-IX-1988.

New locality records for Massachusetts and Vermont all occur in streams between the Connecticut River and the Hudson River. Records for Vermont are the most extensive for any of the New England States and show *A. distinctus* to be broadly distributed with populations in all major physiographic regions. In southern New England the only records east of the Connecticut River were those reported by Burian and Bednarik (1994). In Maine *A. distinctus* has only been recorded from streams in Aroostook County (Burian and Gibbs 1991). Currently, no records are available for New Hampshire and Rhode Island.

ACKNOWLEDGMENTS

I would like to thank Betsy Colburn and Fran Garretson of the Massachusetts Audubon Society for providing the data on *A. distinctus* in the Deerfield River System, Steve Fiske and his staff for generously providing specimens and site data from Vermont, and Leonard E. Munstermann of the Peabody Museum, Yale University, for the loan of specimens from the entomology collection.

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FIRST ALABAMA RECORD OF THE PALE-BORDERED COCKROACH, *PSEUDOMOPS SEPTENTRIONALIS* (DICTYOPTERA: BLATTELLIDAE)[1]

T'ai H. Roulston, Arthur G. Appel[2]

ABSTRACT: *Pseudomops septentrionalis* was collected at two sites near Auburn, Alabama during the spring and summer of 1996, and appears well established locally. These sites are approximately 560 kilometers east of the published range for the species and probably reflect accidental human introduction.

Pseudomops septentrionalis Hebard is an outdoor cockroach most commonly found on foliage and in ground litter (Helfer 1972). In May, 1996 one male *P. septentrionalis* was captured during the day at the Auburn University Arboretum (Auburn, Lee County, Alabama). The individual was perched 1 m off the ground on the foliage of privet (*Ligustrum* sp.), which grew along a small stream. In June, 1996 we returned to the same site and caught 13 *P. septentrionalis* (two females, 11 males) in less than two hours by scanning the vegetation at night with a flashlight. All individuals collected were perched 0.5 - 2 m above the ground on the foliage of various herbs and shrubs. No *P. septentrionalis* came to two black lights set up adjacent to the same area during the same evening. Also, no *P. septentrionalis* were caught in five, adjacent boll weevil pheromone traps, as they have been in Louisiana (Chapin 1980).

Another specimen was taken in June, 1996 in ground litter at an Auburn University Fish Hatchery pond approximately eight kilometers from the arboretum. A specimen from Lee County was also turned in to an Auburn University entomology course during the 1996 spring quarter (J.T. Vogt, pers. comm.). All specimens were adults and agreed with Helfer's (1972) description. Specimens are deposited in the Auburn University Entomological Museum.

The genus *Pseudomops* contains 40 species (Princis 1969), all of which are New World and most of which are tropical. Only *P. septentrionalis* reaches the United States. It has also been collected in Costa Rica (Princis 1969), and at least three states of northern Mexico (Atkinson *et al.* 1991).

Hebard (1917) initially described *P. septentrionalis* from Texas, but later also recorded specimens from southern Oklahoma (Hebard 1938). Chapin (1980) published a range extension into much of Louisiana and Atkinson *et al.* (1991) extended the range into the southwestern corner of Arkansas. Since these are

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[1] Received July 29, 1996. Accepted August 28, 1996.

[2] Department of Entomology, Auburn University, Auburn, Alabama 36849-5413.

the first collections reported from Alabama and since none has been reported from Mississippi, which separates Alabama from the rest of the range of *P. septentrionalis,* we consider local collections of the species to reflect recent human activity rather than a natural range extension.

The adventive introduction and establishment of cockroaches by human transport is common among distant exotic species but apparently rare among native American species into new regions of the United States. Atkinson *et al.* (1991) consider 69 species of cockroaches to have breeding populations within the continental United States and Canada. Of those species, 24 are considered exotic species introduced through human transport. The authors state that there is no evidence of native species having extended their range in that way. If *P. septentrionalis* remains established in Auburn and spreads further into Alabama, and if we are correct in treating their occurrence as adventive rather than as an overlooked, eastern arm of their range, then this could be the first case of a native American cockroach spreading in the United States by means of human transport.

ACKNOWLEDGMENTS

The authors wish to thank Eddie Watkins for providing the specimen from the Fish Hatchery. We also wish to thank Robert Rush for permitting us access to the Auburn Arboretum for research. This is Alabama Agricultural Experiment Station Journal No. 17-965251.

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US ISSN 0013-872X
L. 108 MAY & JUNE, 1997 NO. 3

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NEW SPECIES OF *ATOPSYCHE* FROM COSTA RICA (TRICHOPTERA: HYDROBIOSIDAE)[1]

Roger J. Blahnik[2], Robert M. Gottschalk[3]

ABSTRACT: Three new species in the caddisfly genus (Trichoptera: Hydrobiosidae) from Costa Rica are described and illustrated: *A. jaba, A. minimajada,* and *A. tapanti.* Eleven additional species are known from the country. Illustrations of male genitalia and wing venation are provided for the new species. A correction is made in the distribution of *A. trifida,* mistakenly reported by Schmid (1989) to occur in Costa Rica.

RESUMEN: Tres nuevas especies de (Trichoptera: Hydrobiosidae) de Costa Rica son descritas e ilustradas: *A. jaba, A. minimajada* y *A. tapanti.* Ilustraciones de la venación de las alas y de los genitales de los machos de estas nuevas especies son incluídas. Once especies más son reportadas pare el país. Finalmente, se presenta una corrección a la distribución de *A. trifida,* erroneamente registrada por Schmid (1989) en Costa Rica.

The caddisfly genus *Atopsyche* is very species diverse and predominantly Neotropical in distribution, ranging from northern Argentina to Texas and Arizona (Ross and King 1952). Larvae are typically found in cool streams and are free-living and predacious, characterized by unusual chelate front legs, undoubtedly adapted for securing prey (Wiggins 1996). Larval morphology is illustrated by Wiggins (1996). The genus was first revised by Ross and King (1952) when less than 30 species were known. Biogeographical and evolutionary relationships of the species were also discussed by Ross and King and expanded on by Ross (1953), who also described several additional species. Their biogeographical conclusions require reassessment in light of more recent developments in the field. Schmid (1989) presented a complete treatment of the family Hydrobiosidae, including a review of the genus and also described many new species. He criticized the phylogenetic framework erected by Ross and King, but chose to retain it because a phylogenetic analysis of the genus was outside the scope of his work. A comprehensive phylogenetic analysis of the genus is needed before relationships between species can be stated with confidence. Although the diversity in the genus is much better understood than when Ross and King did their revision, additional species continue to be described and undoubtedly many more remain to be discovered. Schmid (1989) commented that a more thorough knowledge of the genus may be necessary

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[1] Received August 29, 1996. Accepted October 19, 1996.

[2] University of Minnesota, Department of Entomology, 219 Hodson Hall, 1980 Folwell Avenue, St. Paul. Minnesota 55108-6125 USA.

[3] Louisiana State University, Department of Plant Biology, 502 Life Sciences Building, Baton Rouge, Louisiana 70803-1705 USA.

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for a meaningful phylogenetic treatment. Descriptions of new species contribute to that base of knowledge and therefore serve as an important prelude to a new phylogenetic analysis of the genus. Since the treatment of the genus by Schmid, additional new species from Ecuador were described by Sykora (1991) and a new species from Haiti by Botosaneanu (1991). With the inclusion of the three species described here, 116 species have been described to date. The species descriptions presented here represent part of an ongoing research project by Ralph W. Holzenthal, University of Minnesota, and his colleagues to fully document and describe the caddisfly fauna of Costa Rica.

Including the three new species described below, 14 species are now known to occur in Costa Rica. The 11 previously described Costa Rican species are: *A. callosa* (Navás, 1924), *A. chimpuocllo* Schmid 1989, *A. cira* (Mosely, 1949), *A. dampfi* Ross and King 1952, *A. erigia* Ross 1947, *A. huainacapac* Schmid 1989, *A. implexa* (Navás. 1924), *A. majada* Ross 1947, *A. pachacamac* Schmid 1989, *A. paucartampu* Schmid 1989, and *A. talamanca* Flint 1974. Species of *Atopsyche* in Costa Rica have been collected between 30 m and 3120 m above sea level. However, most of the Costa Rican species were collected at middle elevations between 1400 m and 1650 m.

Schmid (1989) listed *A. trifida* Denning as occurring in Costa Rica, probably as a *lapsus*. The holotype locality was given as Puerto Rico by Denning (1948). Despite intensive collecting by Holzenthal, *A. trifida* has not been found in Costa Rica, and we have concluded that this species does not occur in Costa Rica.

Terminology used to describe the male genitalia follows Schmid (1989). A summary of genitalic terminology can be found in Fig. 1. Holotypes for the three species are deposited in the collection at the National Museum of Natural History [NMNH], Smithsonian Institution, Washington DC. Paratypes for *A. jaba* and *A. minimajada* are deposited in the University of Minnesota Insect Collection, St. Paul, Minnesota [UMSP], and at Costa Rica's National Biodiversity Institute [INBIO], as stated in the species descriptions. Unless otherwise stated, all specimens are represented by pinned material.

DESCRIPTION OF NEW SPECIES

Atopsyche jaba, NEW SPECIES

Figs. 1A-D, 4A-B, 7

Atopsyche jaba most closely resembles *A. boneti* Ross and King (1952), *A. cordoba* Denning (1968), and *A. dampfi* Ross and King (1952), especially in the armature of the parapods. However, the new species can be distinguished from the others by the shape of the first article of the inferior appendage, which is narrower, projects dorsally, and lacks any trace of an apicoventral projection. There are also differences in the structure of the apical appendages of the

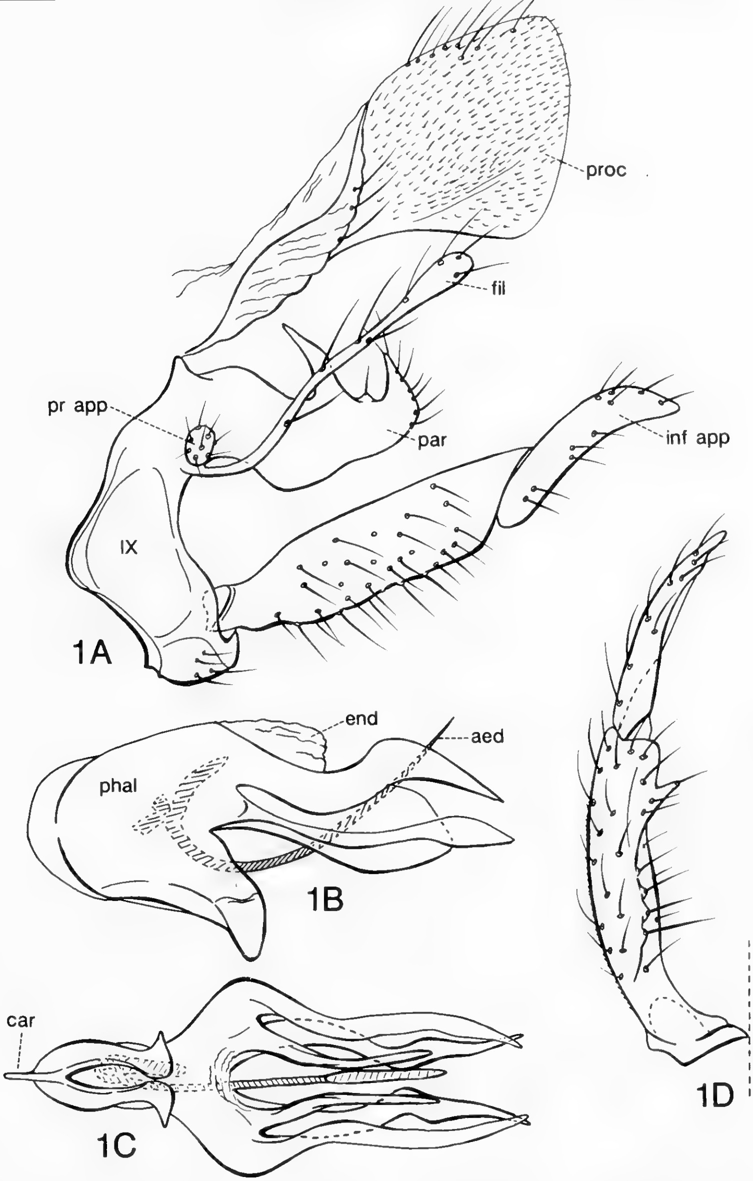


Fig. 1. *Atopsyche jaba* n. sp., male genitalia: A, segments IX, X, and proctiger, lateral; B, phallic apparatus, lateral; C, phallic apparatus, ventral; D, inferior appendage, ventral. **Terminology:** IX = segment IX, proc = proctiger, par = parapod, fil = filipod, pr app = preanal appendage, inf app = inferior appendage, phal = phallotheca, end = endotheca, aed = aedeagus, car = anterior carina of phallotheca.

phallotheca. Unlike *A. cordoba* and *A. dampfi, A. jaba* lacks distinctive black scales associated with a thickened base of Cu2 on the hindwing, but like those species has elongate, curled setae emerging from the first anal cell of the hindwing (Fig. 4B).

ADULT: Forewing length 5.5-6.0 mm (male). Overall body color yellowish brown to light brown; antennae fuscous, yellowish basally; setae of palps fuscous. Wings light brown, erect setae of veins forming mottled pattern of alternate dark brown and amber colored setae, apex of wing fringed with light brown setae at apices of veins and dark brown setae between. Forewing venation (Fig. 4A) complete; R_1 apparently unbranched. apically bordered by dense brown setae in region of pterostigma; fork I near apex of wing, fork II sessile; stem of M distinctly curved between m-cu crossvein and first fork of M; Cu_2 converging near fused anal veins (1A + 2A + 3A), with crossvein near apex forming small cell on posterior margin of wing (Fig. 4A). Hindwing with R_1 incomplete, forked apically to Sc and stem of $R_2 + R_3$; forks II and IV absent; anal veins very strongly arched toward anal margin; male with first anal cell possessing elongate setae (Fig. 4B). Nygmas apparently absent from both wings. Terga III and IV of male (Fig. 7) each with pair of prominent, concavely rounded glands, lined internally with numerous short setae, located at anterolateral margins of respective terga. Sternum V of male with pair of small, convexly rounded glands, located at anterolateral margin of sclerite. Sterna VI and VII of male each with prominent spinelike ventral process on posteromesal margin; process on VII nearly straight, process on VI longer and curved posteriad, with row of short setae along anterior margin and terminating with large, blunt, spinelike seta.

Male genitalia: Segment IX, in lateral view, narrow (Fig. 1A). Parapod with two prominent spines on dorsal edge, both slightly curved anteriad, the posterior spine smaller than anterior spine (Fig. 1A). Filipod long, slender, sparsely covered with elongate setae. Preanal appendage small, irregularly rounded, setose. Proctiger, in lateral view, broadly widened apically, covered externally with numerous minute setae; apicodorsal and lateral margins with elongate, coarse setae, sparse on lateral margin. Inferior appendage with first article constricted basally, otherwise relatively narrow and of uniform width, slightly curved mesad, angularly projecting apicodorsally, mesal surface with small preapical appendage; second article obliquely joined to first, slightly tapering and curved at apex. Phallotheca (Figs. 1B and 1C) with keel-like carina at anterior end; ventrally with short curved process articulating with inferior appendages; apex deeply divided mesally, forming paired lobes, each rather broadly rounded at apex and associated externally with pair of elongate, narrow dorsal and ventral processes, dorsal ones distinctly sinuous, with apices acute and curved ventrad. Aedeagus an elongate, stout, spine-like structure, with distinct curvature.

Type material: *Holotype:* ♂, COSTA RICA: Puntarenas: Río Jaba at rock quarry, 1.4 km (air) W Las Cruces, 8.79°N, 82.97°W, 15.iii.1991, 1150 m, Holzenthal, Muñoz, Huisman (NMNH). *Paratypes:* COSTA RICA: same location as holotype, 9.viii. 1990, 2 ♂ (UMSP), 1 ♂ (INBIO).

Etymology: Named for the Jaba River, near the Wilson Botanical Garden, Las Cruces, Costa Rica.

Atopsyche minimajada, NEW SPECIES

Figs. 2A-D, 5A-B, 8A-B

The wing and body color pattern and structure of the male genitalia of *Atopsyche minimajada* are very similar to *Atopsyche majada* Ross (1947). Specimens of the two species were initially confused by us. However, male genitalia of the two species have several characters which readily serve to separate them. *Atopsyche minimajada,* can be distinguished from *A. majada* by having the apicoventral lobe of the first article of the inferior appendage subequal

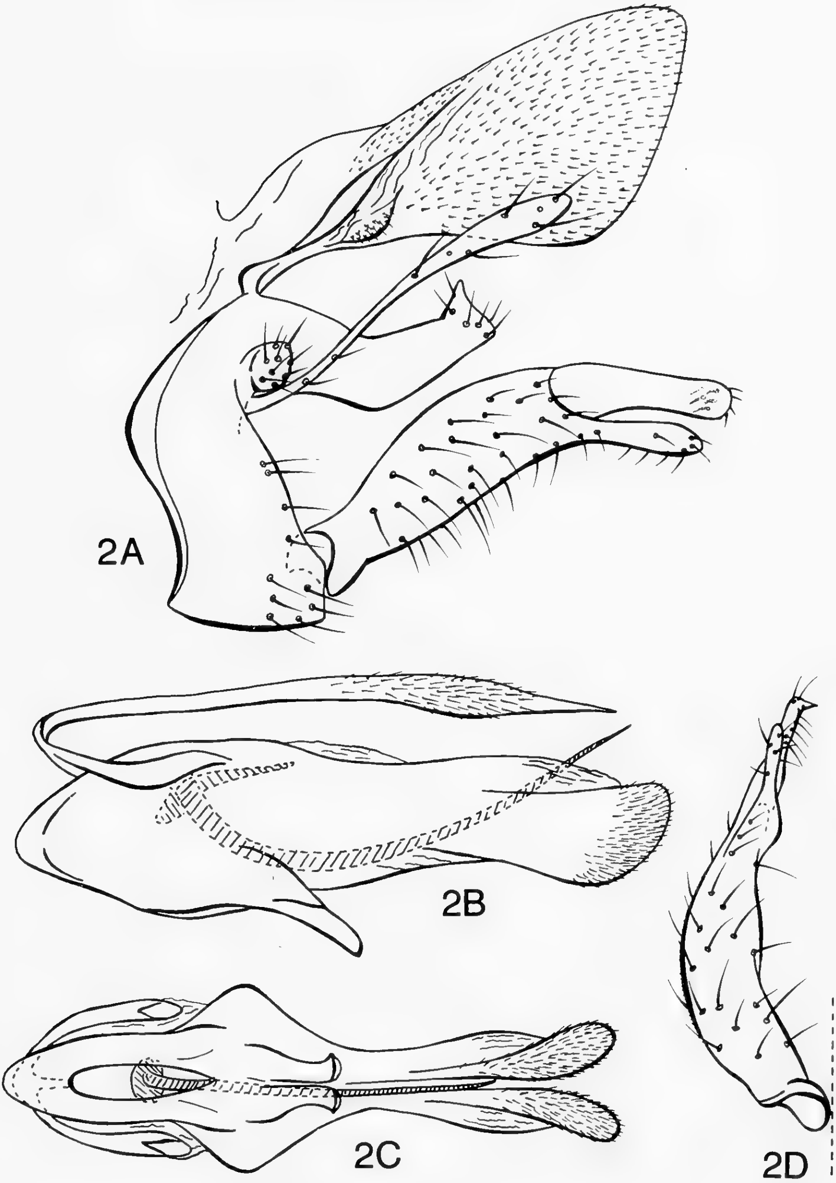


Fig. 2. *Atopsyche minimajada* n. sp., male genitalia: A, segments IX, X, and proctiger, lateral; B, phallic apparatus, lateral; C, phallic apparatus, ventral; D, inferior appendage, ventral.

in length to the second article, as opposed to being distinctly shorter in *A. majada*, and also by the shape of the parapods, which in *A. minimajada* have more prominent apices and are less constricted preapically (Fig. 2A). Additionally, the elongate, recurved dorsal spine, associated with the base of the phallotheca in both species is differently formed; in *A. minimajada* the spine widens preapically and possesses numerous minute setae (Fig. 2B), whereas in *A. majada* the spine is narrow throughout its length and lacks any associated setae. The name for the new species derives from the fact that specimens we examined are smaller on average than those of *A. majada*. The size of *A. minimajada*, however, falls within the range of variability for *A. majada* and size alone is not sufficient to distinguish the two species.

ADULT: Forewing length 5.1-5.5 mm (male), 5.8-6.7 mm. (female). Head, body, and legs pale yellow to light brown, except terga of abdomen fuscous. Setae of head whitish. Palps pale yellow with fuscous setae; antennae yellowish at base, fuscous apically. Wings light brown, with dark brown setae along costal margin, dense in region of pterostigma, and with patch of dark brown along anal margin at midlength; veins with erect setae, alternating in short segments between whitish and dark brown. Forewing venation complete (Fig. 5A); R_1 apparently unbranched apically, bordered by dense brown setae in region of pterostigma; fork I near apex of wing, fork II sessile; stem of M distinctly curved between m-cu and first fork of M; Cu_2 converging near fused anal veins (1A + 2A + 3A), with crossvein near apex forming small cell on posterior margin of wing. Hindwing (Fig. 5B) with R_1 incomplete, forked apically to Sc and stem of R_2+ R_3; forks II and IV absent. Male with Cu_2 possessing elongate, thickened region in proximal part of vein; anal veins very strongly arched toward anal margin, base of 2A with brush of elongate setae extending over thickening of Cu_2. Forewing with nygma near base of fork II, nygma apparently absent from hindwing. Tergum III of male (Fig. 8A) with pair of concavely rounded glands laterally on anteroventral margin. Sternum V of male (Fig. 8B) with pair of short, projecting, saccate glands laterally on anterodorsal margin. Sterna VI and VII of male each with prominent spinelike ventral process on posteromesal margin; process on VII nearly straight, process on VI longer and curved posteriad, with row of short setae along anterior margin and terminating with large, blunt, spinelike seta.

Male genitalia:: Segment IX, in lateral view, relatively narrow. Parapod nearly parallel sided, moderately inflected at middle, apicodorsally with subtriangular, spinelike process (more prominent than in *A. majada* . Preanal appendage small, rounded, with few setae. Filipod elongate, narrow, gradually widened apically, sparsely clothed with elongate setae. Proctiger, as viewed laterally, broadly widened apically, covered externally with numerous minute setae; dorsal, lateral and apical margins without elongate setae. Inferior appendage, as viewed laterally, with first article moderately wide, slightly bulging at middle; posteriorly, with narrow, projecting, apicoventral lobe, nearly equaling second article in length; in ventral view (Fig. 2D), with mesal curvature; second article narrow, emerging from apicodorsal margin of first article, narrowly separated from ventral lobe of first article and only slightly wider and longer. Phallic apparatus relatively simple, similar to *A. majada* (Figs. 2B, 2C); apex divided mesally; in lateral view, apical lobes slightly projecting ventrad and with numerous minute setae; phallotheca with elongate, recurved basal spine, branched at base and membranously attached to phallotheca, widening preapically and covered with numerous minute setae; aedeagus forming elongate curved spine with basal enlargement.

Type Material: *Holotype:* ♂, COSTA RICA: Guanacaste: Estación Pitilla, Río Orosi, 10.931°N' 85.428°W, 700 m, 22-25.v.1990, Holzenthal and Blahnik (NMNH).

Paratypes: COSTA RICA: Alajuela: Cerro Campana, Río Bochinche trib., 6 km (air) NW Dos Ríos, 10.945°N, 85.413°W, 600 m, 22-23.vii.1987, Holzenthal, Morse, Clausen, 1 ♂ (UMSP); Río Pizote, ca. 5 km (air) S Brasilia, 10.972°N, 85.345°W, 390 m, 12.iii.1986, Holzenthal and

Fasth, 4 ♂, 14 ♀ (pinned), 12 ♂ (in alcohol) (UMSP); Río Pizote, ca. 5 km N Dos Ríos, 10.948°N, 85.291°W, 470 m, 9.iii.1986, Holzenthal and Fasth, 1 ♂ (in alcohol) (UMSP); Guanacaste: Parque Nacional Guanacaste, El Hacha, Quebrada Pedregal, 10.983°N, 85.539°W, 300 m, 27.vii.1987, Holzenthal, Morse, Clausen, 1 ♂ (UMSP); Parque Nacional Guanacaste, Estación Maritza, Río Tempisquito, 10.958°N, 85.497°W, 550 m, 30-31.vii.1990, Huisman, Blahnik, Quesada, 1 ♂ (in alcohol) (INBIO); Río Gongora (sulfur mine), 4 km (air) NE Quebrada Grande, 10.887°N, 85.470°W, 590 m, 21.vii.1987, Holzenthal, Morse, Clausen, 1 ♂ (UMSP); Río Los Ahogados, 11.3 km ENE Quebrada Grande, 10.865°N, 85.423°W, 470 m, 7.iii.1986, Holzenthal and Fasth, 4 ♂, 5 ♀ (in alcohol) (UMSP); Heredia: Río Bijagual on road to Magsasay, 10.408°N, 84.076°W, 140 m, Holzenthal, Morse, Fasth, 1 ♂, 1 ♀ (UMSP); Río Sarapiquí, 7 km W Puerto Viejo, 10.452°N, 84.067°W, 50 m 11.ii.1986 Morse and Fasth, 5 ♂ (in alcohol) (UMSP); Puntarenas: Río Ceibo, route 2, ca. 6 km W road to Buenos Aires, 9.149°N, 83.377°W, 250 m, 20.ii.1986, Holzenthal, Morse, Fasth, 2 ♂, 6 ♀ (pinned), 6 ♂, 115 ♀ (in alcohol) (UMSP); San José: Res. Biol. Carara, Río del Sur, 1.5 km (rd) S of Carara, 9.769°N, 84.531°W, 160 m, 13.iii.1991, Holzenthal, Muñoz, Huisman, 1 ♂ (UMSP).

Etymology: Named because of the relatively small size of specimens of this species when compared to those *A. majada*, and because it was the size of the specimens that first drew our attention to differences between the species.

Atopsyche tapanti, NEW SPECIES

Fig. 3A-D

This species is most similar to *Atopsyche paucartampu* Schmid (1989), but can be distinguished by several subtle differences. The inferior appendage of *A. tapanti*, in ventral view, has the first article less sinuously bulging at the middle and the second article is much narrower than in *A. paucartampu*. Additionally, the filipods and parapods of *A. tapanti* are shorter.

ADULT: Forewing length 7.4 mm (male). Overall body color yellowish brown, slightly darker dorsally, terga of abdomen fuscous; palps yellowish, with scant brownish setae; antennae yellowish basally, brown apically. Overall color of wings brownish; erect setae of veins mostly black or blackish with interspersed segments of pale yellow setae. Forewing venation complete (Fig. 6A); R_1 branched apically, covered with dense brown setae in region of pterostigma; fork I near apex of wing, fork II sessile; Cu_2 converging near fused anal veins (1A + 2A + 3A), with crossvein near apex forming small cell on posterior margin of wing. Hindwing (Fig. 6B) with R_1 incomplete, fork at apex intersecting Sc and stem of $R_2 + R_3$; forks II and IV absent; anal veins distinctly arched toward anal margin; anal margin of wing, 2A (sparsely), and base of anal veins with elongate setae. Nygmas apparently absent from both wings. Tergum III of male with pair of concavely rounded glands on anterolateral margin (as in Fig. 8A). Sternum V of male with pair of elongate, projecting glands on anterolateral margin (Fig. 9). Sterna VI and VII of male each with prominent spinelike ventral process on posteromesal margin, nearly equal in size and shape, process on VI without stout apical seta;

Male genitalia: Segment IX, in lateral view (Fig. 3A), relatively wide basally, anterior margin broadly rounded. Parapod short, apex rounded, with one small, blunt tooth on posterodorsal margin. Filipod very short, fingerlike. Preanal appendage small, rounded, setose. Proctiger, as viewed laterally, broadly widened apically, covered externally with numerous minute setae; lateral margin with several elongate setae, apex without setae. Inferior appendage, in lateral view, with first article broadly, evenly widened at middle, second article wide basally, apically narrow and mesally curved; in ventral view, first article mesally curved, with conspicuous, setose, thumblike projection near base on mesal surface, second article narrowed and slightly hooked apically. Phallic apparatus (Fig. 3B) simple, mesally bifurcated, forming paired apical lobes,

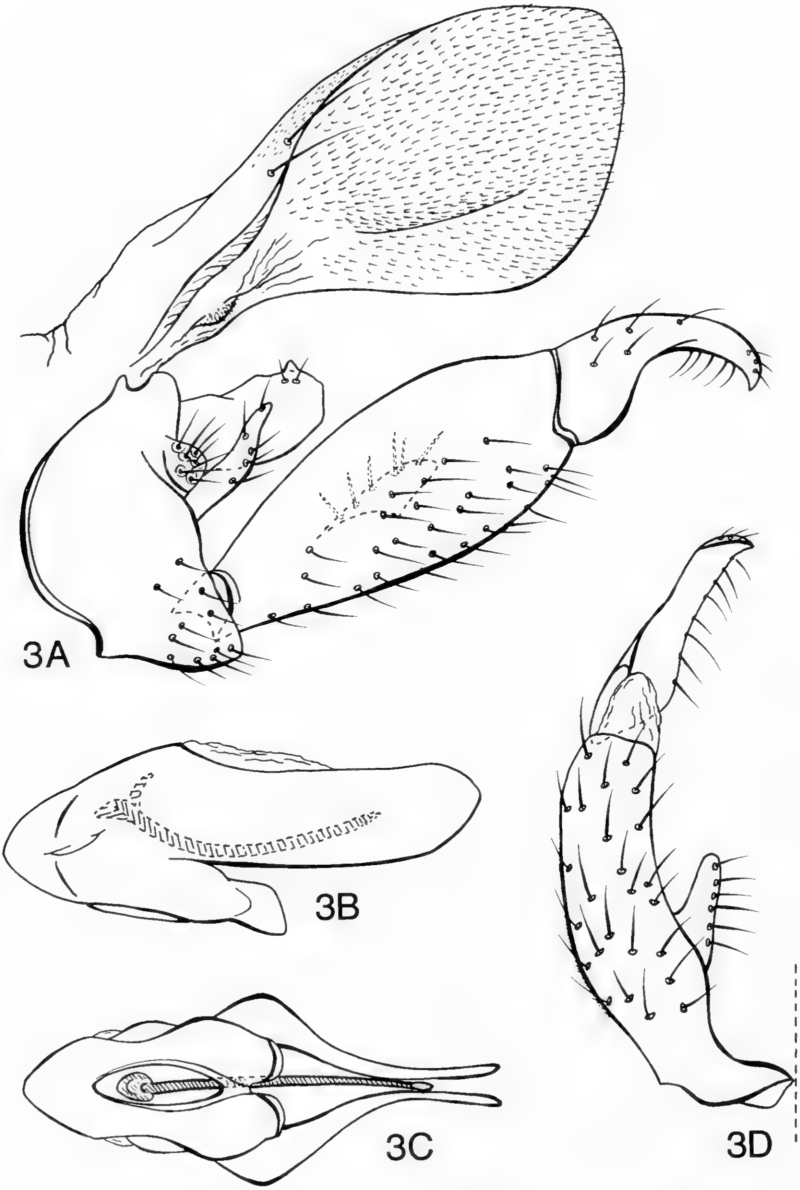
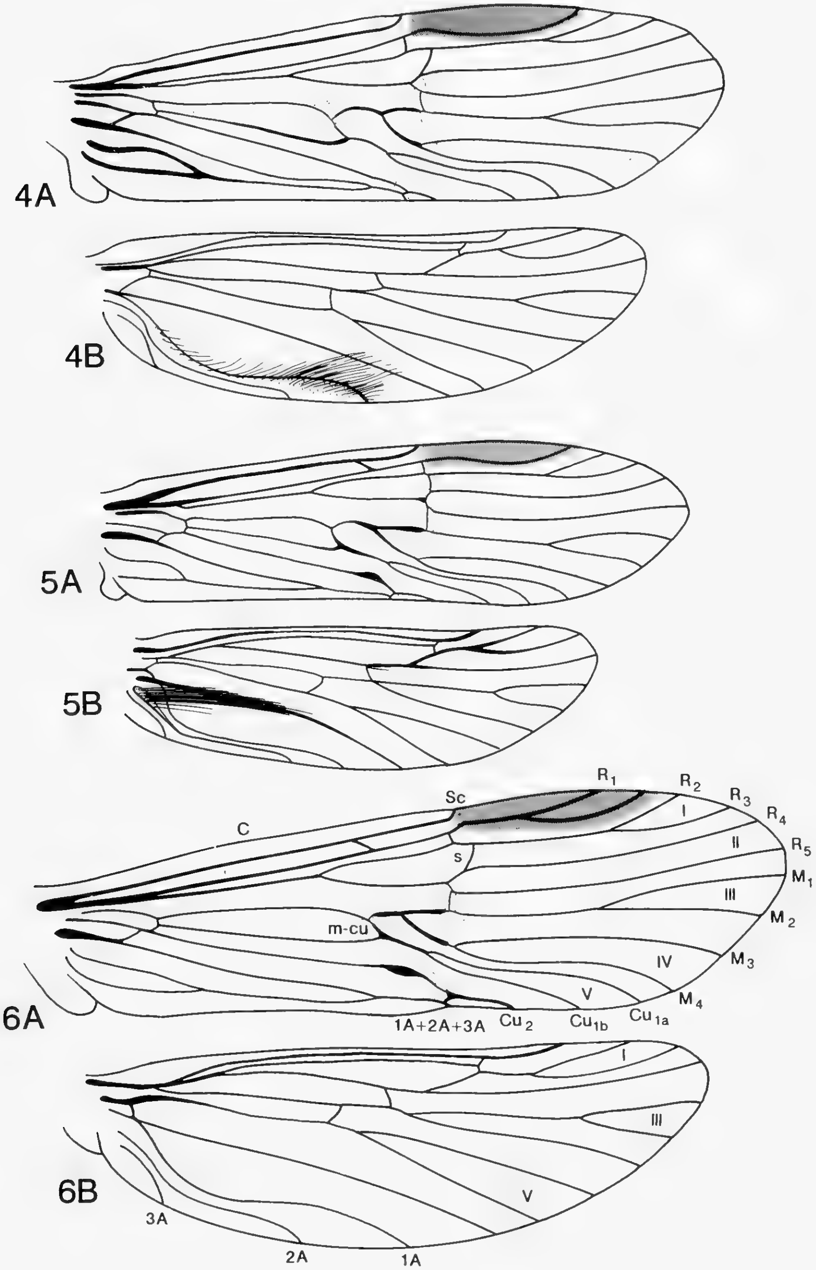
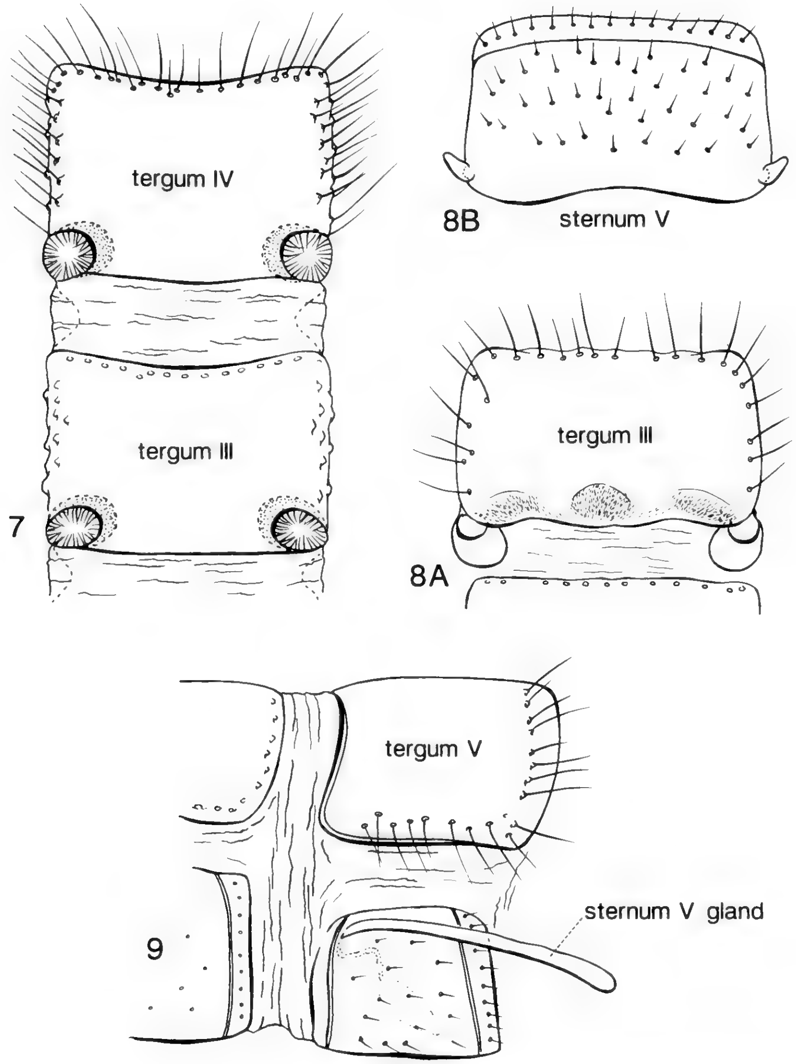


Fig. 3. *Atopsyche tapanti* n. sp., male genitalia: A, segments IX, X, and proctiger, lateral; B, phallic apparatus, lateral; C, phallic apparatus, ventral; D, inferior appendage, ventral.



Figs. 4-6. *Atopsyche* n. spp., wings: A, forewing; B hindwing. 4. *A. jaba;* 5. *A. minimajada;* 6. *A. tapanti.*



Figs. 7-9 *Atopsyche* n. spp., abdominal glands. 7. *A. jaba,* dorsal view of terga III and IV and associated glands; 8. *A. minimajada,* A, dorsal view of tergum III and associated glands, B, ventral view of sternum V and associated glands; 9. *A. tapanti,* new species, lateral view of segment V and associated gland.

broadly rounded at apex, as viewed laterally. Aedeagus a stout, dorsally curved spine with basal enlargement.

Type MateriaL: *Holotype:* Male, COSTA RICA: Cartago: Reserva Tapantí, Río Grande de Orosi, 9.686 N., 83.756 W, 1650m, 8-9.vii. 1986, Holzenthal, Heyn, Armitage (NMNH).

Etymology: Referring to the type locality, Tapantí, National Park, Costa Rica.

RELATIONSHIPS OF THE COSTA RICAN SPECIES

A foundation for the phylogenetic placement of species of *Atopsyche* was erected by Ross and King (1952) and Ross (1953), who used character similarities to define a number of species groups, all of which were placed into two subgenera, *Atopsyche* and *Atopsaura*. Schmid (1989) placed his newly described species, and also those described subsequently to Ross (1953), within the framework erected by Ross and King, based on the characters they used. However, as discussed in the introduction, Schmid noted that these were probably not natural groupings. He also reduced the genus *Dolochorema* to subgeneric status within *Atopsyche*, thereby creating a third subgenus. A newly recognized species group and several additional species were left *incertae sedis* within Schmid's taxonomic outline.

It is possible to place the species described here within the existing taxonomic framework, based on the characters used to define the groups, and we have indicated these relationships below. However, in agreement with Schmid's critique of the existing taxonomic system, we have refrained from formally placing the newly described species within the current taxonomic hierarchy. Instead, we have limited ourselves to a discussion of characters shared by species. This discussion is not intended as a justification for the phylogenetic placement of the species; rather it is intended to provide information that may be of use in an eventual cladistic revision. Despite our reservations about the existing taxonomic system, it is undoubtedly true that a number of species currently placed together are closely related. This statement is based on the fact that some species share a number of ostensible character similarities, at least some of which are likely apomorphic. We discuss below character affinities of members of the Costa Rican fauna, and place the discussion within the contextual reference of the characters used by Ross and King (1952) to define species groups.

Setose glandular structures located on both terga III and IV of males is a character used by Ross (1953) to characterize a subgroup of species in the subgenus *Atopsyche*, including *A. implexa*, *A. banksi*, and *A. vatucra*. He placed this subgroup within his *kingi* group or complex, a new name designation for the *ikonnikovi* group of Ross and King (1952). Schmid (1989) merged the *kingi* group with the *bolivari* group of Ross and King (1952). One of our new species, *Atopsyche jaba*, has males with setose glands located on terga III and IV, and on this basis would be included within the subgroup of species recognized by Ross. In addition to *A. jaba* and *A. implexa*, other species from Costa Rica that possess setose glands on both terga III and IV include *A. pachacamac* and *A. huainacapac. Atopsyche pachacamac* is similar to *A. jaba* and *A. implexa* in a number of respects, including overall coloration and the structure of the apex of the phallotheca. However, *A. huainacapac* is distinctly different. It was placed by Schmid (1989) in the *longipennis* group of Ross and King (1952), and in the subgenus *Atopsaura*, indicating a very distant relationship to these other species. It is possible that the glandular character is homoplasic in this species, or perhaps the character is primitive and not phylogenetically informative. This is difficult to assess because the possession of glandular structures is not often mentioned in species descriptions, despite the fact that all of the species of *Atopsyche* from Costa Rica have glands present on sternum V and also on tergum III, or on both terga III and IV, with the sole exception of *A. chimpuocllo*, which lacks prominent glands on both terga III and IV. However, in none of the other species from Costa Rica are the glands internally setose. *Atopsyche dampfi, A. boneti*, and *A. cordoba*, are all structurally very similar to *A. jaba, A. implexa*, and *A. pachacamac*. However, in the descriptions of none of these species is the presence of setose glandular structures mentioned. In *A. dampfi*, which we had the opportunity to examine, glands are present on both segments, but are much reduced in size and lack setation. Clearly a phylogenetic analysis is required before these glandular structures, either by their morphology or by their presence or absence, can be confidently used to define groups.

Atopsyche minimajada is undoubtedly very closely related to *A. majada*, which was placed by Ross and King (1952) in the *batesi* group of *Atopsyche* and in the subgenus *Atopsaura* by Ross (1953). The defining character of this group is the possession of an unpaired dorsal spine emerging from the base of the phallotheca. Species with this character, and in which the spine is bifurcate at the base and attached membranously to the phallotheca, probably form a monophyletic assemblage, since the character is distinctive enough to make parallel evolution unlikely. The *batesi* group includes all of the species described from the Greater Antilles and also several additional species with distributions in Central America or the northern part of South America, extending as far south as Bolivia. *Atopsyche callosa* is the only additional species from Costa Rica included in this group.

The last new species described in this paper, *Atopsyche tapanti*, is very similar to *A. paucartampu* Schmid, and the two undoubtedly form a closely related species pair. Schmid (1989) placed *A. paucartampu* in the *tripunctata* group of Ross and King (1952). Other species from Costa Rica with a general similarity to these two species include *A. cira, A. talamanca*, and *A. chimpuocllo*. The latter species was placed by Schmid (1989) in the *bolivari* group of Ross and King. However, characters which *A. chimpuocllo* share with the other four species listed above include the possession of a mesally-directed, thumblike protrusion on the first article of the inferior appendage at midlength (Fig. 3D) and elongate glandular structures associated with sternum V (Fig. 9). There is also a general color similarity between the species mentioned above; all have a rounded, blackish spot extending from the costal margin of the wing, bordered by golden setae. As mentioned above, *A. chimpuocllo* lacks noticeable glandular structures on either terga III or IV, whereas all of the other four species have rounded glandular structures without internal setation located on tergum III only. This last character is also found in the members of the *batesi* group found in Costa Rica (Fig. 8A), and is probably a plesiomorphic character.

Atopsyche erigia, also placed by Ross and King in the *tripunctata* group, is different in a number of respects from the other Costa Rican species placed in this group. The character used by Ross and King to define the group is the possession of a second article of the inferior appendage that is simple in structure and broad at the base. *Atopsyche erigia* was used as an archetypal example for the group. This character is rather superficial and species currently placed together on this basis may have only a spurious relationship. It seems likely that the *tripunctata* group is not a natural, or at least not a closely related assemblage of species. Unlike the other species from Costa Rica placed in the group, *A. erigia* has glandular structures on sternum V that are short, and rounded glandular structures without internal setation on both segments III and IV. Also, unlike the other species of the *tripunctata* group discussed above, the first article of the inferior appendage lacks a thumblike process on the mesal surface. On the other hand, in coloration *A. erigia* closely resembles *A. majada,* although it lacks the distinctive phallic spine that characterizes members of the *batesi* group. It is also now placed in a different subgenus. A close relationship of *A. erigia* to other species of the *tripunctata* group from Costa Rica is not well supported by character evidence. Hopefully, a cladistic analysis of the genus at some future date will sort out the seemingly contradictory character relationships existing among the species in the various subgenera and species groups.

ACKNOWLEDGMENTS

This research was supported by National Science Foundation grants BSR-8917684 and DEB 9400632, awarded to Ralph W. Holzenthal, and also by the University of Minnesota Undergraduate Research Opportunities Program and the College of Biological Sciences Honors Program at the University of Minnesota. A special thanks is due Ralph W. Holzenthal, who provided the illustrations of the wings of the new species and served as faculty advisor to the second author for the College of Biological Sciences Honors Program. The advice of Atilano Contreras, Victoria Nations, and Fernando Muñoz, as well as the editing of Susan Weller and Frank Barnwell were greatly appreciated. Paper number 22,541 Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minnesota.

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SCIENTIFIC NOTE

CHAMAEMYIIDS AS PREDATORS OF *DIURAPHIS NOXIA* (HOMOPTERA: APHIDIDAE) IN KONYA PROVINCE, TURKEY[1]

Meryem Elmali[2]

Three species in two genera of Chamaemyiidae (Diptera) have been found to be predators on *Diuraphis noxia* (Kurdjumov) colonies on wheat and other alternate host plants during four years (1989-1992) in Konya province, Turkey. *Leucopis (Leucopis) pallidolineata* Tanasijtshuk was previously reported from Turkey (Düzgünes *et al.* 1982) and as a predator of *D. noxia* (Tanasijtshuk 1984, Kovalev *et al.* 1991). *Leucopis (Leucopis) kerzhneri* Tanasijtshuk and *Parochthiphila* sp. are the first records in the world as predators of *D. noxia*. These two are also first records for Turkish fauna.

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[1] Received September 16, 1996. Accepted December 10, 1996.

[2] Plant Protection Department, Faculty of Agriculture, Selçuk University, 42031 Konya, Turkey.

NEONEIDES MUTICUS (HETEROPTERA: BERYTIDAE): HOST PLANTS AND SEASONALITY IN MID-APPALACHIAN SHALE BARRENS[1]

A. G. Wheeler, Jr.[2,3]

ABSTRACT: The stilt bug *Neoneides muticus*, a characteristic insect of shale barrens, was observed on moss phlox, *Phlox subulata* (Polemoniaceae), in 31 mid-Appalachian shale barrens and outcrops in Maryland, Pennsylvania, Virginia, and West Virginia. Overwintered adults mated and oviposited as early as mid-April, and first-generation adults appeared by late June. A small second generation was found on moss phlox at only two sites. Other hosts in shale barrens were a fern, *Cheilanthes lanosa* (Adiantaceae); the composite *Aster oblongifolius* (Asteraceae); a mint, *Scutellaria ovata* (Lamiaceae); and a beardtongue, *Penstemon canescens* (Scrophulariaceae). The record of *N. muticus* from moss phlox is the first for a berytid from the Polemoniaceae, and its association with woolly lipfern, *C. lanosa*, is the second for this stilt bug on a fern species.

Neoneides muticus (Say), formerly placed in the Old World genus *Neides* Latreille (see Henry 1997a), is one of the most widely distributed North American berytids. Its U.S. distribution includes all 48 conterminous states, and it occurs across much of southern Canada and ranges into northern Mexico (Henry 1997b). Little biological information on this commonly collected stilt bug was available until its seasonality and habits were studied in New York and Pennsylvania (Wheeler 1978). This bivoltine species develops on common mullein *(Verbascum thapsus* L.), adults overwintering in the basal rosettes. Mating and oviposition in New York take place from late April to early May, and first-generation adults appear in late June to early July. A small second generation is produced during midsummer to early fall. Both phytophagous and zoophagous, *N. muticus* feeds on leaves and flower buds of common mullein and on the mullein thrips *(Haplothrips verbasci* (Osborn)). Other scrophulariaceous hosts are moth mullein (*V. blattaria* L.) and hairy beardtongue *(Penstemon hirsutus* (L.) Willd.) (Wheeler 1978, Wheeler and Henry 1981). Its hosts also include members of the Asteraceae *(Hieracium aurantiacum* L. and *H. pratense* Tausch) and Rosaceae *(Potentilla norvegicus* L. and *Rubus* sp.), as well as hayscented fern *(Dennstaedtia punctilobula* (Michx.) Moore) (Wheeler 1978).

Here I report the use of several additional host plants by *N. muticus*, including another fern species and the first polemoniaceous plant, moss phlox *(Phlox subulata* L.), recorded as a stilt bug host. Its seasonal history on moss phlox in mid-Appalachian shale barrens and shale outcrops is summarized.

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[1] Received October 3, 1996. Accepted November 5, 1996.

[2] Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, PA 17110.

[3] Present address: Department of Entomology, Clemson University, Clemson, SC 29634.

STUDY SITES AND METHODS

The seasonality of *N. muticus* was followed during a study of plant bugs (Heteroptera: Miridae) associated with moss phlox in shale barrens occurring from south-central Pennsylvania to southwestern Virginia (see Wheeler 1995). The sample sites included several classic shale barrens: Eagle Rock, Head Waters, Millboro, and Short Mountain in Virginia, and Kates Mountain in West Virginia (see Wheeler 1995 and references therein). Sampling was conducted at irregular intervals from early April to early August 1989 to 1995. All stages of *N. muticus* that were shaken from mats of moss phlox were recorded. Observations on additional host plants were made in several shale barrens that harbored populations of *N. muticus* on moss phlox. Voucher specimens of the berytid are deposited in the collection of the National Museum of Natural History, Washington, D.C.

RESULTS

Phlox subulata

Populations of *N. muticus* were observed on this plant in 31 shale barrens and outcrops in the mid-Appalachians, including 13 in West Virginia (Grant, Greenbrier, Hampshire, and Pendleton counties), 10 in Virginia (Alleghany, Bath, Botetourt, Highland, Roanoke, Rockbridge, and Shenandoah counties), 6 in Maryland (Allegany and Washington counties), and 2 in Pennsylvania (Bedford Co.).

Adults, which apparently overwintered under prostrate mats of moss phlox, began mating by mid-April. Oviposition on the sepals occurred as early as mid-April. Mating and oviposition continued in shale barrens until early May. First instars were found by late April and were present until late May. Overwintered adults were not seen after mid-May. Mid- to late instars were often seen on moss phlox during June and July, adults of the first generation appearing by the last week of June.

A small second generation was observed on moss phlox only at Smoke Hole in Pendleton Co., West Virginia, and in the George Washington National Forest in Rockingham Co., Virginia. Moss phlox colonies often brown during July and August, and in shale barrens *N. muticus* was always more numerous on more succulent hosts during midsummer.

Other Hosts in Shale Barrens

In addition to moss phlox, common first-generation hosts of *N. muticus* in Maryland, Virginia, and West Virginia were Appalachian beardtongue, *Penstemon canescens* (Britt.) Britt. (Scrophulariaceae), and aromatic aster, *Aster oblongifolius* Nutt. (Asteraceae). Early instars of a second generation were present on *P. canescens* in Pendleton Co., West Virginia, in early July. In Bath

Co., Virginia, second-generation nymphs and adults were found on forest skullcap, *Scutellaria ovata* L. (Lamiaceae), in mid-July.

Woolly lipfern, *Cheilanthes lanosa* D.C. Eat., served as a host at the Romney-Oldtown shale barren in Allegany Co., Maryland. In early July 1994, fourth- and fifth instar nymphs and adults were observed on this fern in one area of the barren. The following year, overwintered adults and first through third instars were collected on woolly lipfern colonies throughout the barren in late May.

DISCUSSION

Although a common, polyphagous stilt bug species, *N. muticus* should be considered a characteristic shade barren insect, occurring on moss phlox with specialists such as the mirids *Polymerus tinctipes* Knight and *P. wheeleri* Henry (Wheeler 1995) and the psyllid *Craspedolepta eas* (McAtee) (Wheeler 1994). The pattern of host use by *N. muticus* in mid-Appalachian shale barrens conforms to that previously recorded (Wheeler 1978) and is typical of most other Berytidae—that is, glandular-hairy plants, mostly dicots. Moss phlox is the first member of the Polemoniaceae reported as a berytid host (see Wheeler and Schaefer 1982). In shale barrens, *N. muticus* develops on the glandular subspecies of this plant, *Phlox subulata brittonii* (Small) Wherry. Other shale barren hosts are similarly glandular, pubescent, or both, including the fern *Cheilanthes lanosa,* whose leaves are hirsute. This association, the second for *N. muticus* with a fern species (Wheeler 1978), is atypical within the Berytidae (Wheeler and Schaefer 1982).

Neoneides muticus does not often produce a second generation on moss phlox, which becomes essentially dormant in shale barrens during midsummer. Instead, this stilt bug develops on more succulent hosts, such as the late-blooming *Aster oblongifolius.*

ACKNOWLEDGMENTS

I thank T. J. Henry (Systematic Entomology Lab., USDA, ARS, PSI, c/o National Museum of Natural History, Washington, DC) for providing prepublication copies of his berytid studies, E. R. Hoebeke (Department of Entomology, Cornell University, Ithaca, NY) and G. L. Miller (SEL, USDA, ARS, PSI, c/o NMNH, Beltsville, MD) for useful comments on an early draft of the manuscript, and M. A. Berdine and D. A. Samson (The Nature Conservancy) for permitting access to Maryland's Oldtown Shale Barren Preserve.

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Marvin H. Brunson

Marvin H. Brunson died at age 94 on December 23, 1996 in a nursing home in Moorestown, NJ. He was a former President (1967 and 1968) and Vice-President (1965 and 1966) of the American Entomological Society.

One of 15 children, Marvin was born on a Meridian, Mississippi farm on December 7, 1902. He graduated from Mississippi State College in 1926, and earned his M.S. in entomology from Iowa State College in 1928. Marvin was an extension entomologist at Clemson for two years, before joining the USDA's Oriental Fruit Moth research unit at Moorestown, NJ in 1931.

At Moorestown, Marvin performed research on the chemical and biological control of fruit insects for 27 years, until transferring to Washington State. There, as Research Leader and Station Head, he reorganized and led chemical and biological control research on fruit tree pests at the USDA's Yakima and Wenatchee laboratories from 1959-1963. In 1963, he returned to Moorestown to become Investigations Leader of the USDA Introduced Beneficial Insects Laboratory. During his leadership, and with the assistance of R. I. Sailer in Beltsville, landmark classical biological control successes were developed by this laboratory, in cooperation with one or two other USDA units, to combat the alfalfa weevil (present savings to agriculture of $90 million per year) and the cereal leaf beetle (present savings $20 million/year). This work established the Moorestown laboratory as one of the few to successfully develop permanent biological controls for modern agriculture, and eliminate the need for insecticides over large areas of the United States, and was accomplished despite a limited budget.

Marvin was a forthright leader, and was not reluctant to differ with administrators who had little understanding of how classical biological control or practical agricultural research actually "worked". This protected his researchers from frequent changes in direction or inappropriate goals, and contributed significantly to their successful results. After he retired from the USDA in 1970, he continued to work in the laboratory's library until the unit moved to Newark, Delaware in the fall of 1973.

Marvin remained in Moorestown, enjoying golf and retirement. He was a member of the YMCA's Men's Club and Trinity Episcopal Church in Moorestown. He also served on the Moorestown School Board in the 1950's. His wife Martha ("Matt") (Strickler) died in 1991. He is survived by a daughter, Lois (Mrs. Charles Y. Murphey III) of Cherry Hill, NJ and two grandchildren.

W. H. Day	J. J. Drea, Jr.	D. O. Hathaway	B. A. Butt
Newark, DE.	Oceanside, CA	Wapato, WA	McMinnville, TN

PADDLEFISH *(POLYODON SPATHULA)* AS SAMPLERS OF RIFFLE BEETLES (COLEOPTERA: ELMIDAE)[1]

Steven G. George[2], Jan Jeffrey Hoover[3], Harley P. Brown[4]

ABSTRACT: Stomach contents of 17 paddlefish, collected in the Mississippi delta, yielded 41 specimens of riffle beetle, *Stenelmis* spp. The specimens provide documentation of riffle beetles in the Big Sunflower River and the first record of *Stenelmis parva* in Mississippi.

Riffle beetles (Coleoptera: Elmidae) are sensitive indicators of aquatic environments, with most species occurring in erosional habitats of high water quality (Leech and Chandler, 1956; Hilsenhoff, 1982; Brown, 1987; White and Brighan, 1996). Techniques for their collection include drift nets, light traps, dip nets, and hand-picking from submersed rocks, wood, vegetation, and debris (Cowell and Carew, 1976; Brown 1976). These are effective in most streams, littoral zones, and small water bodies, but occurrences of riffle beetles in some habitats are insufficiently documented. For sampling large, turbid rivers unsuitable for traditional collecting techniques, we recently stumbled upon an unthought of assistant – the paddlefish (Polyodontidae: *Polyodon spathula),* a riverine filter-feeder.

With no thought of riffle beetles, paddlefish diets were studied 1 Mar 94 - 28 Feb 95 in the Big Sunflower River, a turbid, soft-bottomed, frequently hypoxic stream of the Mississippi delta. River stages during this period ranged from 5.2 to 9.6 m National Geodetic Vertical Datum (NGVD), water surface elevation above mean sea level. Adult and sub-adult fish were obtained as bycatch from a commercial fisherman working a 60 km reach daily from Round Lake, Sunflower County, MS, downstream to Osceola, Washington County, MS. The upper boundary of this reach occurs near the mouth of the Quiver River, the lower boundary near the mouth of the Bogue Phalia. Stomachs of 99 fish 411-1161 mm eye-to-fork length were examined. Almost 99% of the food organisms taken from the paddlefish stomachs consisted of copepods and cladocerans, and most of the remaining percentage consisted of ostracods and assorted aquatic insects, but 17 stomachs contained adult riffle beetles.

The mean number of beetles, in those 17 fish, was 2.4 beetles/fish (SD =

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[1] Received October 7, 1996. Accepted October 30, 1996.

[2] Dyntel CZP, CEWES-ER-A, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

[3] U.S. Army Engineer Waterways Experiment Station ER-A, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

[4] The University of Oklahoma, Department of Zoology, Norman, OK 73019-0235.

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1.17), and the maximum number was 5 beetles/fish. Of the 41 beetles, 33 were retained as voucher specimens and deposited in the Oklahoma Museum of Natural History. The species (and numbers of each) were *Stenelmis decorata* Sanderson 1938 (26), *S. grossa* Sanderson 1938 (6), *S. parva* Sanderson 1938 (1). Beetles were obtained from paddlefish collected in late spring (9 May 94-7 Jun 94) at river stages 5.5-7.9 m NGVD, and in late summer/early autumn (2 Sep-10 Oct 94) at river stage 5.2-5.6 m NGVD, during the hours 0500-0930. Fish that contained riffle beetles were 411-724 mm eye-to-fork length. Because the Quiver River enters the Sunflower River not far above the collection sites, it is possible that some – perhaps most – of the beetles taken were derived from that stream. The Quiver River is a smaller, soft-bottomed, turbid stream; length and channel capacity are approximately one fourth that of the Big Sunflower River (USACE, 1955). Considering the paddlefish's feeding mode, all beetles were probably drifting in the water column when ingested.

A previous, unpublished invertebrate survey did not indicate riffle beetles in the Big Sunflower River (Parker and Robinson, 1972), but temporal occurrence and taxonomic composition are consistent with previous descriptions of elmid biology. Because only adults were observed, beetles may have been intercepted during post-emergence migrations. Beetles may also have been intercepted while passively drifting or while surfacing. Drifting is common among elmids, especially at night (Waters, 1972; Brown, 1987), and the periods when riffle beetles were observed in the Big Sunflower River correspond to June and October peak abundances of drifting adults in other southern streams (Cowell and Carew, 1976; Reisen, 1977). Riffle beetles in well-aerated streams seldom ascend to the surface, but may do so when oxygen becomes limiting (Leech and Chandler, 1956). Hydrofuge hairs on the insect's body allow retention of an air bubble that functions as an air store and/or a gill (Chapman, 1969). In the Big Sunflower and Quiver Rivers, mid-day dissolved oxygen is high (> 7.0 mg/l) in late summer and early autumn but low (< 3.0 mg/l) in late spring. Beetles may respond to hypoxia in spring by drifting or surfacing, either of which would increase their risk of ingestion by paddlefish.

S. decorata, the most abundant species, is tolerant of organic pollutants (Brown, 1976) which are high in the Big Sunflower River due to intensive agriculture in the delta (Johnson *et al.* 1994). *S. grossa*, of lesser abundance, is characteristic of sandy streams under logs (Brown, 1976), a habitat that is limited in this drainage by the high rates of silt deposition and removal of submerged wood due to agriculture and flood control activities. *S. grossa* is previously documented from Mississippi (Brown, 1976). *S. decorata* and *S. parva* are not listed for Mississippi by Brown (1983), but Schmude (1992) includes records of *S. decorata* from six counties in Mississippi. The finding of *S. parva* is most surprising because it heretofore has been known only from southeastern Oklahoma, southeastern Texas (Edna, between Houston and Corpus Christi), and western Arkansas, and occurs chiefly on submerged wood.

Low numbers of beetles, and the precarious nature of paddlefish populations, make exclusive sampling of paddlefish for elmids inefficient and extravagant. Because paddlefish are commercially exploited, however, and because numerous diet studies have been and are being conducted, existing samples may be utilized by curious coleopterists. Previously, only crawling water beetles (Haliplidae) have been recorded from paddlefish stomachs (Gannon and Howmiller, 1973), but "Insecta" are frequent and sometimes abundant foods (Ruelle and Hudson, 1977; Russell, 1983). Riffle-beetles ingested by paddlefish are mostly in an excellent state of preservation (i.e., limbs and heads intact). Thus, paddlefish can provide interesting insights into the biology of riffle beetles that would be otherwise unobtainable.

ACKNOWLEDGMENTS

We thank W.E. Lancaster for providing the fish for this study; K.J. Killgore reviewed the manuscript and F. Griggs provided river stage data. Permission was granted by the Chief of Engineers to publish this information. Funding was provided by the U.S. Army Engineer, Vicksburg District.

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SOCIETY MEETING OF FEBRUARY 19, 1997

Dr. Dale F. Schweitzer
The Nature Conservancy, Port Norris, New Jersey

LEPIDOPTERA OF THE NEW JERSEY PINE BARRENS

Dr. Schweitzer presented a richly illustrated overview of the diverse butterflies and moths found in this region. The distinctive character of its fauna was recognized at least as early as 1910 in J.B. Smith's insect list and by mid-twentieth century lepidopterists like Fredrick Lemmer, Otto Bucholz, and Joseph Muller. Many species common in the Pine Barrens are rare elsewhere and there are a number of endemics or near-endemics as well as undescribed species. Groups like saturniid moths that have declined drastically in the Northeast are doing well in the Barrens, and he suggested that overall, the Pinelands Protection Act may have done more for biodiversity than the Alaska Lands Act which was signed into law about the same time.

Dr. Schweitzer discussed the southern affinities of much of the Pine Barrens fauna, particularly with pine-dominated habitats in Florida and the Carolinas.

He went on to describe the key role that fire has played in creating and maintaining habitat for these unusual species. Much of this habitat has been altered or eliminated by fire suppression, and even the dwarf pine plains are changing as a result of fewer fires. Although presumably once more widespread, Pine Barrens reed grass savannas are now found almost exclusively on the Fort Dix impact area, where fires are frequently started by stray munitions and are often allowed to burn themselves out. That many of these fires occur during the growing season may be particularly important, he said. Two out of less than ten known remaining populations of the imperiled Arogos Skipper *(Atrytone arogos arogos)* are found there, along with a number of other rare species, in much greater abundance than elsewhere.

(continued on page 202)

NOTES ON THE ANT *EURHOPALOTHRIX FLORIDANA*, WITH A DESCRIPTION OF THE MALE (HYMENOPTERA: FORMICIDAE)[1]

Mark Deyrup[2], Clifford Johnson[3], Lloyd Davis[4]

ABSTRACT: The basicerotine ant *Eurhopalothrix floridana* is a relatively common woodland species in peninsular Florida. In small (2 liter) litter samples, *E. floridana* usually co-occurs with one or more of at least 32 other species of ants. There is some evidence that *E. floridana* may have been introduced into Florida. We provide a diagnosis and habitus illustration of the previously unknown male

The ant *Eurhopalothrix floridana* Brown and Kempf (Fig. 1) is the only U.S. representative of the tribe Basicerotini, a group of cryptic, slow-moving, pantropical myrmicines. *Eurhopalothrix* species are predatory, and observations of one species suggest that these ants may be somewhat specialized predators of termites (Wilson and Brown 1984). *Eurhopalothrix floridana* was described in 1960 (Brown and Kempf) on the basis of a single specimen, but the species is not nearly as rare as one might expect from the late date of its discovery. In this note we update the distribution and habitat information on *E. floridana*, consider the possibility that it may be an exotic species, and describe the previously unknown male.

DISTRIBUTION AND HABITAT

Eurhopalothrix floridana occurs throughout peninsular Florida (Fig. 2), based on about 130 collections from over 70 sites. Although we sampled leaf litter and rotten wood from all over Florida, we made no effort to sample evenly, and the distribution pattern in Fig. 2 reflects biases based on convenience and access. The total sampling effort, however, involved many thousands of Tulgren funnel extractions, collected in all regions of the state. We collected, for example, hundreds of samples from the western panhandle, without finding any *E. floridana*. The pattern of records reflects the distribution of woodlands in peninsular Florida, including the dry tropical hammocks of the Florida Keys, the Atlantic coastal ridge hammocks, the scrub forests and ecotonal hardwood forests of the southern and central ridges, and the mesic and xeric forests of the northern peninsula.

In a study of *E. floridana* using standardized, unsifted, approximately

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[1] Received October 15, 1996. Accepted November 13, 1996.

[2] Archbold Biological Station, P.O. Box 2057, Lake Placid, FL 33862.

[3] Department of Zoology, 223 Bartram Hall, University of Florida, Gainesville, FL 32611.

[4] 3920 NW 36th Place, Gainesville, FL 32606.

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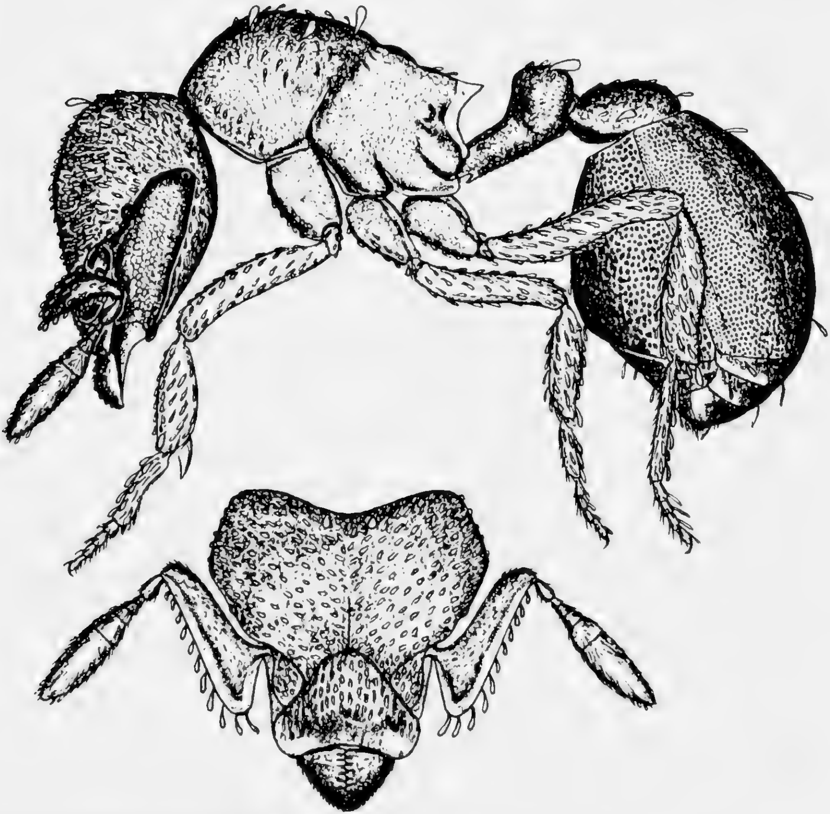

Figure 1. *Eurhopaalothrix floridana,* worker.

2-liter samples of litter, we found *E. floridana* in 65 samples on 32 occasions. The 32 habitat records include: 8 from xeric forest (old growth sand pine scrub, sandhill invaded by large oaks), 11 from mesic forest (usually mixed oaks and pines), 5 from wet forest (mixed pine and hardwoods, usually including oaks and magnolia); and 8 from coastal tropical hardwood forest. This is apparently a woodland species that is not particular about drainage.

The 2-liter litter samples used in this analysis were indexed by site and date, with an ant species list for each sample. This allows us to say that, out of 346 samples collected at a site and date where *E. floridana* was found, 65 (19%) contained in *E. floridana.* At a number of sites less than one out of 10 samples had *E. floridana,* so it is evident that in many cases at least 5, and often more, samples must be extracted to demonstrate the presence on this species at a particular site. This need for large numbers of samples to show presence or absence of a species is a common problem in surveys of litter ants; many species are much rarer.

In our small litter samples, *E. floridana* is usually found with other species of ants, with which it must be somewhat compatible and with which it must share microhabitat requirements. The numbers of co-occurring species are as follows: 6 samples had no other ant species, 12 samples had 1 other species;

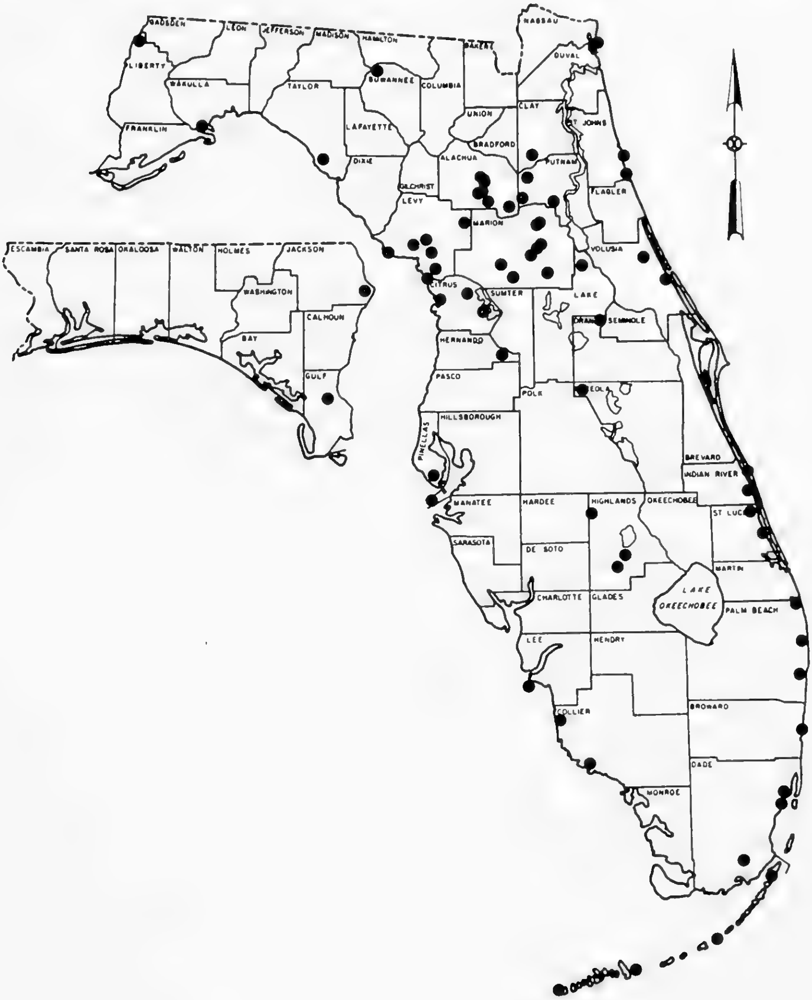

Figure 2. Known distribution of *Eurhopalothrix floridana* in Florida.

15 samples had 2 other species; 13 samples had 3 other species, 11 samples had 4 other species, 6 samples had 5 other species, and 2 samples had 6 other species.The list of 32 co-occurring species and their frequency of occurrence appears in Table 1. A statistically different frequency of species in the samples that did not have *E. floridana* (samples from the same place and date as those that did have *E. floridana)* might hint at another level of ecological relationships. Unfortunately, there were no sites where there were many samples with *E. floridana,* and comparisons between sites brings in larger scale biogeographic factors.

NATIVE OR EXOTIC?

Brown and Kempf (1960) suggest that *E. floridana* could be a recent introduction from the Neotropics. There is additional circumstantial evidence that supports this suggestion. Expanding ranges are typical of exotic species; *E. floridana* is now easily obtained in Alachua and Putnam counties (Fig. 2), where Van Pelt (1958) sampled extensively for dacetine ants without finding *E. floridana. Eurhopalothrix. floridana* has not been found in the West Indies, the source of almost all tropical ants that have, we assume, dispersed naturally to Florida. It is unlikely to be a native from the forests of the southern Appalachians, because such species usually have a large range to the north and west of Florida. *E. floridana* occurs in Mexico (W. L. Brown, Jr., 1985, pers. comm.), so there is a possible source of introduction. There are species of insects, including ants, that occur in southwestern North America, with a disjunct population or closely related congeners in Florida, but these are species of open, desert or savannah habitats, not woodlands (Deyrup 1990).

On the other hand, it could be native to Florida. The oldest record is a damaged specimen found recently by David Smith of the U. S. National Museum of Natural History. This specimen is from Key West (once a major commercial port), dated 1887, and is in the Pergande collection. A record of this antiquity coming from a less settled part of Florida might suggest that *E. floridana* is a native species, but in tropical Florida a great amount of entrepreneurial horticulture occurred well before 1887. Henry Perrine, for example, was in a good position in the 1830's to be an unintentional purveyor of cryptobiotic ants to the Miami area. Perrine displayed a missionary zeal in the importation of plants from southern Mexico, many in boxes or tubs of soil. Marjory Douglas (1978) cites a report of "more than 100 boxes of plants shipped from the Yucatan" by Perrine outside one building in the Miami area. *Eurhopalothrix. floridana* is a cryptic species that could have escaped being noticed by some collectors; it does not show any association with highly disturbed habitats, its ability to live in xeric woodlands might have allowed it to move to Florida from Mexico along with other upland species at the end of the Pliocene or in the early Pleistocene. We conclude that this species is probably introduced into Florida, but would like to see better documentation of the species in Mexico, especially southern Mexico.

Male of *E. floridana*

Diagnosis: the male (Fig. 3) generally resembles a male dacetine in its dense, reticulate sculpture, the facial projection trom which the antennae emerge, reduced venation, and long petiole. It is distinguished from Florida dacetines by the following features: 1.) The post petiole is twice as wide as the petiole, with a strongly concave anterior border and a conspicuous spatulate hair on each side. 2.) The first submarginal cell is clearly developed. 3.) The antennal scape has a strong bristle on the proximal corner of the large bulge on the inner side. This may be a character found throughout the genus (Brown and Kempf 1960) 4.) The size is relatively large.

Figure 3: *Eurhopalothrix floridana*, male.

Total length: 2.02-2. 15 mm Length of forewing: 2.32-2.45 mm.

There are only 2 additional species of *Eurhopalothrix* (both Old World species) whose males have been described (Brown and Kempf 1960). *E. floridana* differs from these, according to the descriptions, in the smooth, shining areas on the mesopleuron (Fig. 3).

Seasonality of males: males were collected with workers on 12 July and 19 August. Fifty males were collected in Townes traps at several sites between 15 July and 5 December. Deposition of males: males, along with workers, have been deposited in the following collections: Harvard Museum of Comparative Zoology (Cambridge, MA), U. S. Museum of Natural History (Washington, D.C), Los Angeles County Museum, British Museum of Natural History (London), Florida State Collection of Arthropods (Gainesville), Canadian National Collection (Ottawa), Collection of Mark Dubois (Washington, IL), Collection of William MacKay (El Paso, TX), Archbold Biological Station Collection of Arthropods (Lake Placid, FL).

Table 1. Species of ants found together with *E. floridana* in small litter samples.

No. of Co-occurrences	**Species**
28	*Hypoponera opacior*
22	*Solenopsis abdita*
19	*Pheidole dentigula*
11	*Strumigenys eggersi*
8	*Solenopsis tennesseensis*
7	*Strumigenys louisianae*
6	*Pheidole moerens, Smithistruma talpa*
5	*Brachymyrmex depilis, Pheidole dentata, P. floridana, Smithistruma ornata, Wasmannia auropunctata*
4	*Aphaenogaster miamiana* or *carolinensis, Paratrechina faisonensis, Quadristruma emmae*
3	*Solenopsis carolinensis*
2	*Myrmecina americana, Odontomachus brunneus, Pachycondyla stigma, Strumigenys rogeri*
1	*Aphaenogaster fulva, Cyphomyrmex minutus, C. rimosus, Hypoponera inexorata, H. punctatissima, Odontomachus ruginodis, Paratrechina guatemalensis, P. wojciki, Smithistruma brevisetosa, S. dietrichi, Trichoscapa membranifera.*

ACKNOWLEDGMENTS

We are especially grateful to Walter Suter (Carthage College, Kenosha, WI) for allowing us to look through a large number of Tulgren funnel residues from all over Florida, and to Virendra Gupta (Florida State Collection of Arthropods) for sending us ants (pre-sorted!) from Townes trap samples collected in Gainesville. Zachary Prusak (graduate student at the University of Central Florida, Winter Park) also contributed specimens from several sites. David Wang (senior at Lake Placid High School) compiled all the data from litter samples collected in the Archbold study of litter ants.

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BOOK REVIEW

FIELD GUIDE TO NORTHEASTERN LONGHORNED BEETLES (COLEOPTERA: CERAMBYCIDAE). Douglas Yanega. 1996. Illinois Natural History Survey Manual 6, Champaign, Illinois.

This field guide has an ambitious goal – to assist nonspecialists in making species determinations of cerambycids. What makes this manual so successful is that it is focused on this goal. It does not attempt to be more than an identification manual. But that is not a criticism. Rather, this book succeeds in its task so well that it may change the format of future field guides for nonspecialists.

The book starts with a brief introduction to beetle terminology using the unique morphological details of the cerambycids. It does not go into any detail that is not easily seen with the naked eye or a 10X hand lens, as that would be of little help with species identification.

Next follows a brief section on the natural history of the Cerambycidae including information on biogeography, climate, life histories, phenology, reproduction, interactions with other species, and variation. There is also a short section on collecting techniques and the curation of specimens. All of this information is presented in the first 23 pages!

The field guide covers 342 species of longhorned beetles which includes all the northeastern species save one which is undescribed. The species identifications are presented in an unusual manner compared to other field guides. Yanega does not use keys in the formal sense. Keys in technical books tend to be of little use to the nonspecialist because they do not convey a sense of confidence for the user. Rather, Yanega presents a system that assumes that the user will scan photographs to compare with the specimen. This is where the manual is exceptional. The author has taken considerable care in finding the best specimens to photograph. Photographs of both sexes are presented and small arrows point to diagnostic features. I have tested the manual with undergraduate students and they had no difficulty in determining the species and the sex of beetles they had collected.

In addition to the photographs, Yanega provides a synopsis of each species giving its flight period, larval feeding habits, size, and general notes. The information is brief. If the user needs more detailed information, then s(he) is referred to the original description and other works.

This field guide is a successful manual in that it is accessible to the nonspecialist and recognizes how nonspecialists go about the process of determining an identification. Anyone interested in cerambycids will benefit from this book and I am sure that it will be the first field guide to be consulted to determine the identification of an unknown cerambycid.

Gene Kritsky, Department of Biology
College of Mount St. Joseph, Cincinnati, OH 45233

DISTRIBUTION AND ABUNDANCE OF *EULONCHUS MARIALICIAE* (DIPTERA: ACROCERIDAE)[1]

Peter H. Adler[2], Stuart R. Reitz[3], Charles N. Watson[4]

ABSTRACT: *Eulonchus marialiciae*, a rare parasitoid of the folding trapdoor spider *Antrodiaetus unicolor*, was recorded from cool, humid, mixed forests at elevations above 1200 m in five counties of western North Carolina. Adults were on the wing during June and August. Smooth blackberry (*Rubus canadensis*) served as a nectar source. Host spiders and nectar sources of this fly are abundant, and most of the habitat in which it has been found is federally protected.

The larvae of all known members of the family Acroceridae are internal parasitoids of spiders; however, the biologies of many of the species are poorly known (Schlinger 1981). Some of the more colorful species are in the genus *Eulonchus* which consists of seven described species and at least 17 species that are undescribed; all but one species in the genus are restricted to western North America (Schlinger 1966, 1981).

Eulonchus marialiciae Brimley, informally known as Mary Alice's small-headed fly (Fig. 1), was described from a single male captured 23 June 1923 on Andrews Bald Mt., Swain Co., NC (Brimley 1925). The only other report of this fly comes from a study of the folding trapdoor spider *Antrodiaetus unicolor*

Fig. 1. Male of *Eulonchus marialiciae* collected 8 June 1965 at Heintooga Overlook, Blue Ridge Parkway, Swain Co., NC (specimen housed in Canadian National Collection).

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[1] Received September 11, 1996. Accepted October 30, 1996.

[2] Department of Entomology, Clemson University, Clemson, SC 29634-0365.

[3] Department of Entomology, University of California, Riverside, CA 92521.

[4] Aquatic Resources Center, P. O. Box 680818, Franklin, TN 37068-0818.

ENT. NEWS 108(3): 190-192, May & June, 1997

(Hertz) (Araneae: Antrodiaetidae) by Coyle (1971). On 1 and 2 August 1966, Coyle (1971) recovered one pupa that produced an adult, one freshly emerged adult, and an unspecified number of pupal exuviae from "several" burrows of *A. unicolor* along Rhododendron Trail at the Highlands Biological Station (1250 m elevation), Macon Co., NC. He also observed 18 adults hovering near burrows, and noted that adults often aggregated around burrows that he was excavating during the day, leading him to suggest that the flies were responding to a chemical released during the excavations. Coyle's original field notes state that of five flies taken from these aggregations, all were males; this observation suggests to us that mating might take place near the host burrows. Although Coyle (1971) unearthed many burrows of *A. unicolor* from Pennsylvania to Alabama, he found no other specimens of *E. marialiciae.*

Eulonchus marialiciae was one of 15 Diptera in the United States formerly placed in Category 2 of the Federal Register (United States Fish and Wildlife Service 1994). This designation denotes taxa for which endangered or threatened status is possibly appropriate but for which conclusive data are lacking. To obtain additional information on the distribution and status of this fly, we spent 42 days from June through mid-September, 1993 and 1994, prospecting at 43 sites in the mountains of western North Carolina and South Carolina. We ran Malaise traps, excavated burrows of *A. unicolor*, and inspected potential nectar sources; we also examined museum collections. Five males from our study have been deposited as voucher specimens in the Clemson University Arthropod Collection.

Other than the holotype (U. S. National Museum), we located only one other museum specimen. The Canadian National Collection in Ottawa contains a male taken on *Rubus* by J. G. Chillcott, 8 June 1965, at Heintooga Overlook along the Blue Ridge Parkway, Swain Co., NC.

During our field work, we found 10 flies (8♂, 2 sex unknown [not captured]) feeding on the floral nectar of smooth blackberry (*Rubus canadensis* L.) along the Blue Ridge Parkway in North Carolina:

Haywood Co., Beartrail Ridge Parking Area, 1790 m, 16 June 1994 (1 sex unknown); **Haywood Co.,** Spot Knob Overlook, 1723 m, 16 June 1994 (1♂); **Jackson Co.,** 1.0 km N of Doubletop Mt. Overlook, 1635 m, 16 June 1994 (1♂); **Jackson Co.,** 1.1 km N of Doubletop Mt. Overlook, 1634 m, 16 June 1994 (1♂); **Swain Co.,** Heintooga Overlook, 1626 m, 15 June 1994 (1♂, 1 sex unknown); **Swain Co.,** Mollies Gap, 1631 m, 13 June 1994 (2♂); Transylvania Co., Mt. Hardy Viewing Area, 1650 m, 17 June 1994 (2♂).

We observed feeding from 1200 to 1600 h on sunny and overcast days. Flies could be approached within less than a meter as they probed individual blooms while stationed on the flowers. One male fed for 3-100 sec (mean + SE = 25.5 + 6.8 sec, 24 °C) per flower. Flies carried a light dusting of pollen on their bodies. Three males that were brought to the laboratory fed on a 10%

solution of honey. Dissections 24 h later revealed a lack of stored nutrient in the abdomen, suggesting a dependence on sugar sources such as nectar. Our small sample suggests that males are more likely to be found nectaring than are females; in fact, we have no evidence that females take nectar, although we suspect that they do. Other described species in the genus *Eulonchus* are usually found probing flowers for nectar and are considered important pollinators (Schlinger 1981).

In total, we account for 32 adult flies that have been seen or collected since the type specimen was taken in 1923. All were found at elevations of 1250 m or higher in five mountainous counties of western North Carolina. This region is characterized by cool, humid woodlands with a liberal humic layer and dominated by hemlock (*Tsuga canadensis* (L.) Carr.), oaks (*Quercus* spp.), and rhododendron and flame azalea (*Rhododendron* spp.). Our records, coupled with those of Coyle (1971), suggest either that two generations of flies are produced yearly, with adults on the wing during June and August, or that a single brood with prolonged emergence occurs. Flies emerging after June would require a nectar source other than *R. canadensis*, which does not bloom beyond that time.

We conclude that *E. marialiciae* is rare but probably not threatened or endangered. Its known spider host and nectar source, as well as habitat, are abundant over much of western North Carolina, southwestern Virginia, and eastern Tennessee, suggesting that it exists over an area greater than our records indicate. Most sites where this fly has been recorded are within federally protected areas.

ACKNOWLEDGMENTS

This study was supported by a grant from the U. S. Fish & Wildlife Service. We thank J. A. Ratzlaff (U. S. Fish & Wildlife Service, Asheville, NC) for facilitating our study, F. A. Coyle (Western Carolina University) for sharing his original field notes, J. D. Culin (Clemson University) for photographing the fly, J. M. Cumming (Eastern Cereal and Oilseed Research Centre, Ottawa) for loaning the specimen in the Canadian National Collection, and A. G. Wheeler, Jr. (Clemson University) for commenting on the manuscript. This is Technical Contribution No. 4232 of the South Carolina Agricultural Experiment Station, Clemson University.

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THE EPHEMEROPTERA OF SPRING CREEK, OKLAHOMA, WITH REMARKS ON NOTABLE RECORDS[1]

W. P. McCafferty[2], R. K. Heth[3], R. D. Waltz[4]

ABSTRACT: A total of 40 nominal species of mayflies are reported from nine sites on Spring Creek, a cold-water, western Ozarkian stream in Cherokee, Delaware, and Mayes Counties, Oklahoma. Of these species, 28 represent new state records, bringing the published total for Oklahoma to 59. The essential geographic affinity of the Spring Creek fauna is eastern North America. Many of the species were predictably found, being part of a typical pattern that includes the Ozarks and Ouachita Mountains of Arkansas, the southern Appalachians and the Cumberland Plateau. A large number are also known from eastern and midwestern North America in general. A few are transcontinental, or previously known only from eastern Canada and northeastern and north-central USA. Most new state records also represent westernmost range extensions. The notable geographic records of *Ephemerella rotunda, Nixe flowersi, Paraleptophlebia jeanae, P. moerens, Rhithrogena impersonata, R. jejuna,* and *Stenonema vicarium* are discussed.

Oklahoma is one of several states in the USA that have been very poorly documented with respect to their mayfly fauna (McCafferty *et al.* 1990). The previous first published reports of 31 nominal Ephemeroptera species in the state are as follows: Traver (1934): *Choroterpes oklahoma* Traver [= *Neochoroterpes oklahoma* (Traver)] and *Habrophlebiodes annulata* Traver; Traver (1935): *Caenis delicata* Traver [= *C. latipennis* Banks] and *Tricorythodes fictus* Traver; Spieth (1938): *Ephemera traverae* Spieth; Spieth (1941): *Hexagenia bilineata* (Say), *H. limbata* (Serville), and *H. rigida* McDunnough; Allen and Edmunds (1965): *Ephemerella excrucians* Walsh; McKinley *et al.* (1972): *Caenis simulans* (McDunnough) [= *C. amica* Hagen] and *Stenonema tripunctatum* (Banks) [= *S. femoratum* (Say)]; Lewis (1974): *Stenonema interpunctatum* (Say) [= *Stenacron interpunctatum* (Say)]; Reisen (1975): *Baetis bicaudatus* Dodds and *Dactylobaetis mexicanus* Traver and Edmunds [= *Camelobaetidius mexicanus* (Traver and Edmunds)]; Wilhm *et al.* (1978): *Heptagenia diabasia* Burks, *H. maculipennis* Walsh [= *Leucrocuta maculipennis* (Walsh)], and *Stenonema ares* Burks [= *Stenonema terminatum terminatum* (Walsh)]; Morihara and McCafferty (1979): *Baetis quilleri* Dodds [= *Fallceon quilleri* (Dodds)]; Bednarik and McCafferty (1979): *Stenonema exiguum* Traver and *S. mediopunctatum arwini* Bednarik and McCafferty; Wilhm *et al.* (1979): *Stenonema luteum* (Clemens); Magdych (1979): *Baetis*

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[1] Received October 18, 1996. Revision received December 7, 1996. Accepted December 9, 1996.

[2] Department of Entomology, Purdue University, West Lafayette, IN 47907.

[3] 2136 Faculty Row, Bacone College, Muskogee, OK 74403.

[4] IDNR, Division of Entomology and Plant Pathology, 402 West Washington, Rm W-290, Indianapolis, IN 46204.

flavistriga McDunnough; Pescador and Berner (1981): *Baetisca lacustris* McDunnough; Henry and Kondratieff (1982): *Leptophlebia bradleyi* (Needham); Kondratieff and Voshell (1984): *Isonychia rufa* McDunnough; Provonsha (1990): *Caenis anceps* Traver, *C. hilaris* (Say), and *C. punctata* McDunnough; Bae and McCafferty (1991): *Anthopotamus neglectus disjunctus* (Traver); McCafferty (1994): *Ephemera simulans* Walker; and Waltz *et al.* (1996): *Baetis intercalaris* McDunnough. Of these published records, only the report of the western species *B. bicaudatus* from south-central Oklahoma by Reisen (1975) is improbable.

We can account for an additional 28 nominal species in Oklahoma based on identification of larval and adult Ephemeroptera collected during a study of Spring Creek in Cherokee, Delaware, and Mayes Counties in the western Ozarks (Table 1, Fig. 1). Many of these species were predictably found in Oklahoma based on their known continental ranges, and particularly if previously known from the Ozark and Ouachita Mountains of Arkansas (McCafferty and Provonsha 1978). Moreover, several of these predictable species have also been collected in southeastern Oklahoma by D. E. Baumgardner (pers. comm.). Some of the new records from Spring Creek, however, constitute significant species range extensions, disjunctions, or reports of poorly known species. The mayflies of Spring Creek are mainly northeastern or southeastern species or both, in terms of the North American geographic regional affinities of McCafferty and Waltz (1990).

As pointed out by Jester *et al.* (1988) in their study of the ecology of Spring Creek, the stream is representative of large creeks in the western Ozarks that have diverse communities of unique cool-water fish species and ubiquitous warm-water fish species. We have found that the mayflies of Spring Creek (Table 1) also constitute a mixture of faunal elements, being composed of 1) several species that are found in the southern Appalachians, Cumberland Plateau and the Ozark-Ouachita Mountains; 2) some species that are basically midwestern fauna typical of low gradient, warm-water habitats; 3) a few species that were previously only known from cold-water trout streams of eastern Canada and northeastern and north-central USA; and 4) some species that are ubiquitous and transcontinental. None of the species were indigenous to western North America.

Sites at which taxa were collected are described below, and their locations along Spring Creek are shown in Figure 1. Additional physical and chemical data associated with Spring Creek and many of our sites may be found in Jester *et al.* (1988). Table 1 gives the site distribution of all species taken at Spring Creek. Following the description of sites, we present a distributional analysis of those species representing significant range extensions or disjunctions based on their discovery in Oklahoma. Voucher specimens are deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana, and at Northeastern State University, Tahlequah, Oklahoma.

DESCRIPTION OF SAMPLE SITES (FIG. 1)

Site A — Delaware County, Coppage Farm, 322m elevation. Spring Creek is a first order stream at this site; it is a ford approximately 2-3m in width; substrate consists of cobble, gravel, and sand; there is partial shading; and there are no backwater areas.

Site B — Delaware County, Oaks Mission, 305m elevation. Spring Creek is a first order stream at this site; it is approximately 3m wide; substrate consists of cobble and gravel; there is complete shade cover; and no backwater areas are present.

Site C — Cherokee County, Rocky Ford, 277m elevation. Spring Creek is a second order stream at this site; it is approximately 9 m wide with bedrock and mixed sand and gravel; there is partial shade present.

Site D — Cherokee County, Teresita at bridge, 256m elevation. Spring Creek is a second order stream at this site; it is very diverse with various currents and backwater areas; it ranges from approximately 6-8m in width; substrate consists of cobble, gravel, and sand; and there is partial shade.

Site E — Cherokee County, Cherokee Cattle Company, 232m elevation. Spring Creek is a third order stream at this site; it ranges from approximately 5-8m in width; substrate consists of small cobble, gravel, and sand; there was partial shade present; some backwater areas are present; and cattle are often present.

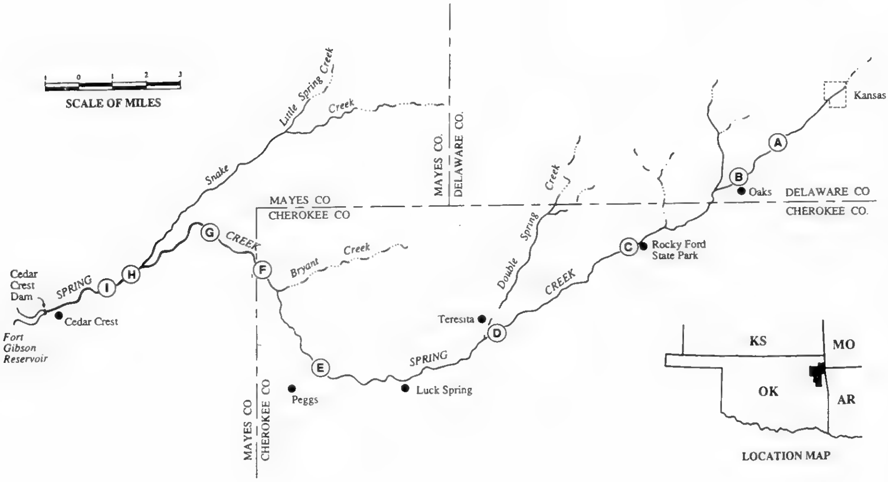

Fig. 1. Spring Creek, Oklahoma study area, with lettered collection sites indicated (described in List of Sites in the text and referred to in Table 1). Location map with Cherokee, Delaware, and Mayes Counties, Oklahoma darkened.

Site F — Cherokee County, Timbercreek Ranch, 213m elevation. Spring Creek is a third order stream at this site; it is at a ford approximately 10m wide; substrate consists of coarse gravel; there is no shade; and backwater areas are present.

Site G — Mayes County, Camp Garland, 194m elevation. Spring Creek is a third order stream at this site; it is approximately 3-4m wide; substrate consists of gravel; it is partially shaded; and there are backwater areas present.

Site H — Mayes County, Twin Bridges, 183m, elevation. Spring Creek is a third order stream at this site; it is approximately 10m wide; substrate consists of gravel; it has full exposure to sun; and there are backwater areas present.

SIGNIFICANT RECORDS

Ephemerella rotunda Morgan — This species is known from eastern Canada, eastern USA along the Appalachians from Maine to Georgia, but also extending into Florida (Berner 1958, 1977). It has also been reported from Kentucky, Michigan, and Wisconsin (Allen and Edmunds 1965). It has not been known west of Wisconsin and Kentucky. Its presence in the Oklahoma Ozarks represents a considerable range extension westward, but as for so many other Ozark species, it is a common Appalachian species also occurring in Kentucky. The larvae of this species cannot consistently be told from those described as *E. inconstans* Traver. Thus, there remains the possibility that the Oklahoma record of *E. rotunda* is attributable to *E. inconstans*, assuming the latter name is not a junior synonym of the former. *Ephemerella inconstans* has been recorded from Georgia, Kentucky, North Carolina, Tennessee, and Virginia (see Allen and Edmunds 1965, Berner 1977). Larvae of *E. rotunda* were collected on III-14,18-1995 and V-18-1996.

Nixe flowersi McCafferty — The discovery of *N. flowersi* in Oklahoma is significant because the species was previously known only from the type locality in Indiana. The species was described from adults (McCafferty 1982) and reared larvae that had previously been described as the larvae of *Heptagenia persimplex* McDunnough (McCafferty 1977). In Indiana, the species occurs in the far south central unglaciated area of the Ohio River Basin. Several mayflies from this latter area appear to be more typical of other southern unglaciated areas of North America, including the Ozarks and Smoky Mountains. Adults of *N. flowersi* were taken on VI-29-1996.

Paraleptophlebia jeanae Berner — Berner (1955, 1975) reported this species from Alabama, South Carolina, and Virginia. It was recently discovered in far southern Indiana (Randolph and McCafferty 1996) in the unglaciated area of the Ohio River Basin, and therefore may occur in Kentucky. Its presence in the Oklahoma Ozarks reflects a common distributional pattern (i.e., western Ozark-Oauchita and eastern Cumberland Plateau-Appalachian pattern) pointed out by McCafferty and Provonsha (1978) for much of the Ozark-Oauchita mayfly fauna. Harris (1990) considered this species among rare and possibly endangered mayflies in Alabama, as did Kondratieff and Kirchner (1991) for Virginia, and Morse *et al.* (1996) generally. The fact that its larvae were not identifiable prior to the time of the larval description by Randolph and McCafferty (1996) may account in part for its not having been reported from mountainous Arkansas and the fact that it has sometimes been considered rare. At least one species of *Paraleptophlebia, P. calcarita* Robotham and Allen, known from the Ozarks (Robotham and Allen 1988), remains undescribed as larvae. Adults of *P. jeanae* were taken on V-21-1996.

Paraleptophlebia moerens (McDunnough) — This is an eastern and midwestern North American species that has not been previously reported from the Ozarks or any areas adjacent to Oklahoma. Oklahoma represents the westernmost known range of the species. This species apparently fits the second element of the Ozark mayflies identified by McCafferty and Provonsha (1978). That is those that range generally into the Midwest, are widely adapted, and common in the East and states such as Indiana and Illinois. It has been rarely reported from the Southeast (Berner 1975, Harris *et al.* 1996). Larvae of *P. moerens* were taken on I-25-1996 and V-21-1996.

Rhithrogena impersonata (McDunnough) — This species has been reported from northeastern North America and north-central USA, including Michigan and Wisconsin, where it is relatively common in northern counties (see Leonard and Leonard 1962, Flowers and Hilsenhoff 1975, Yanoviak and McCafferty 1996). Its presence in western Oklahoma evidently represents a significant disjunct range extension, as does its previously unreported presence in Kentucky (Randolph and McCafferty, unpublished). It has not been reported from other areas of the Midwest, including adjacent mountainous areas of Missouri and Arkansas. Larvae of *R. impersonata* were taken on V-18-1996.

Rhithrogena jejuna Eaton — The distribution of this species is essentially the same as that of *R. impersonata.* Moreover, Leonard and Leonard (1962) found the two species cohabiting in Michigan. Its presence in western Oklahoma also represents a significant disjunct range extension. It has not been reported from adjacent areas of Missouri and Arkansas. Larvae of *R. jejuna* were taken on III-21-1995.

Stenonema vicarium (Walker) — This is mainly a northeastern and midwestern species in North America (Bednarik and McCafferty 1979), although it has been reported recently from Alabama by Harris *et al.* (1996). Its presence in Oklahoma represents a notable southwestern disjunction, having not been found in Arkansas, or confirmed from Missouri. Larvae of *S. vicarium* were taken on III-13-14, 18, 21-1995, VII-14-15-1995, X-17-1995, and I-16-17-1996.

Table 1. Alphabetical listing of Ephemeroptera collected at Spring Creek sites. Sites are described in the text and shown in Figure 1. Asterisks indicate new Oklahoma records.

SPECIES	COLLECTING SITES								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
*Acentrella turbida	A	B	C	D	E	F	G	H	I
*Acerpenna pygmaea	A	B	C	D	E	F	G	H	I
Baetis flavistriga	A	B	C	D	E		G		I
Baetis intercalaris	A		C	D			G		
*Callibaetis floridanus									I
Caenis anceps	A		C	D				H	
Caenis latipennis	A		C					H	I
*Choroterpes basalis		B			E				I
*Diphetor hageni	A	B		D	E				
Ephemera traverae	A	B	C						
*Ephemerella rotunda			C	D	E	F			
*Eurylophella bicolor		B		D	E	F	G		I
*Eurylophella enoensis									I
*Eurylophella macdunnoughi						F			
Heptagenia sp.		B		D		F	G	H	I
Hexagenia bilineata							G	H	I
Hexagenia limbata								H	I
*Isonychia bicolor								H	
*Isonychia sicca									I
*Leptophlebia nebulosa				D	E			H	I
*Leucrocuta hebe								H	I
*Leucrocuta minerva									I
*Nixe flowersi					E				
*Nixe inconspicua									I
*Nixe perfida					E		G		I
*Paraleptophlebia guttata						F			I
*Paraleptophlebia jeanae				D					
*Paraleptophlebia moerens				D					
*Paraleptophlebia mollis			C		E				I
Paraleptophlebia sp.				D					
*Procloeon rubropictum				D	E	F			I
*Rhithrogena impersonata						F			
*Rhithrogena jejuna									I
*Siphlonurus marshalli				D	E				
Stenacron interpunctatum	A	B			E				I
*Stenonema bednariki									I
Stenonema femoratum				D	E				I
Stenonema luteum		B							
Stenonema m. arwini							G		I
*Stenonema modestum					E				I
Stenonema t. terminatum		B						H	
*Stenonema vicarium				D	E				
Tricorythodes sp.		B			E		G	H	I

ACKNOWLEDGMENTS

We thank members of the Spring Creek Coalition and their president, Jennifer Owens (Peggs, OK), for support and access to study sites. We also thank A. V. Provonsha (Purdue University) for preparation of Figure 1, and R. P. Randolph (Purdue University) for his technical assistance. Boris Kondratieff kindly drew our attention to some of the previous Oklahoma mayfly records. This paper has been published as Purdue University Agricultural Research Program Journal No. 15233.

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SOUTHWARD RANGE EXTENSION OF THE COMMON RINGLET, *COENONYMPHA TULLIA INORNATA* (LEPIDOPTERA: SATYRIDAE)[1]

David C. Iftner[2]

ABSTRACT: The occurrence of *Coenonympha tullia inornata* is recorded in New Jersey for the first time. Its present distribution in the northeast, and its potential for spread in New Jersey are also discussed.

The common ringlet, *Coenonympha tullia inornata* (W. H. Edwards, 1861) is one of many described subspecies that make up the confusing "*tullia*" species complex. Some authors consider many or all of these subspecies to be distinct species (Miller and Brown, 1981; Opler and Malikul, 1992). This species is circumpolar in occurrence, and extremely variable geographically. In North America, this species is found from Alaska to southern California and Arizona in the west, throughout much of lower Canada, and in the eastern United States as far south as the northern parts of Minnesota, Wisconsin and Michigan, and central New England (Opler and Krizak, 1984).

Since its first appearance in New England (Ferris, 1970; Shapiro, 1974), the southward expansion of this species into the northeastern United States has been truly remarkable. In a period of less than twenty five years, this species has moved steadily southward from where it first entered both Maine and New York from Canada to localities as far south as New York City, and Westchester County, New York (Glassberg, 1993).

On 26 June 1994 while conducting survey work for The Nature Conservancy in the Mashipacong Bogs Preserve, Sussex County, New Jersey, I observed a small, unfamiliar orange brown butterfly flying across an old pasture south of the utility buildings. The individual was soon collected, and surprisingly turned out to be a worn female of *C. t. inornata*, a new state record for New Jersey. This specimen is housed in the collection of the author.

It had been speculated that this species would soon be found in New Jersey, with most collectors thinking that it would first be located in the northeastern portion of the state, somewhere adjacent to Westchester County, New York where it was already established. The presence of this butterfly in northwestern New Jersey indicates that the spread of this species has probably already encompassed all of extreme northern New Jersey. Subsequent collecting by James J. Popelka and the author in 1995 supports this notion, yielding eight additional

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[1] Received January 26, 1996. Accepted March 1, 1996.

[2] 8 Alpine Trail, Sparta, New Jersey 07871.

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locality records for this butterfly, including new county records for Passaic and Morris counties. The presence of a second brood was also confirmed.

While it is unknown how far south and east *C. t. inornata* will eventually spread, suitable habitat exists throughout much of the northern half of New Jersey, and northeastern Pennsylvania. Individuals hoping to find this butterfly should search open grassy areas (meadows, pastures, old fields, etc.) that have a profusion of nectar sources during the months of June and August when the two broods are on the wing. Various grasses (Poaceae) serve as hostplants in North America, while sedges (Cyperaceae) are utilized in Eurasia (Scott, 1986).

ACKNOWLEDGMENTS

I kindly thank John V. Calhoun, John W. Peacock, and two anonymous reviewers for critically reviewing the draft of this manuscript. I also wish to thank James J. Popelka for his assistance and companionship in the field.

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(Continued from page 182)

Some Pine Barrens species are no longer found in natural habitats. The Frosted Elfin *(Callophrys irus)* is nearly restricted to railroads, powerlines and airports, where its host, *Baptisia,* still occurs in abundance. Thus, while there may be a large enough protected area of land to permit their survival, present management practices appear to be causing declines of some of the rarer, highly fire-dependent species found in the Pine Barrens.

In news of entomological interest, Dr. Schweitzer reported seeing two Question Marks *(Polygonia interogationis)* on February 19, although he had seen his first moths of the year on January 3 in Cumberland Co, NJ. Ichneumonids have also been seen at light. There was some discussion and speculation on the reasons for low yellowjacket *(Vespula* sp.) numbers the past year. Possible causes included heavy spring rains and increasing implementation of pack-in, pack-out rules for food waste in public parks.

W.J. Cromartie,
Corresponding Secretary

EFFICIENCY OF ARTHROPOD EXTRACTION FROM SOIL CORES[1]

Renate M. Snider[2], Richard J. Snider[2]

ABSTRACT: Soil cores (5 x 15 cm) were heat-extracted in Tullgren-type funnels, then floated three consecutive times in a saturated sugar solution. The organic supernatant was decanted and searched for Collembola and Acari. Heat-extraction efficiency varied greatly between arthropod taxa, years, dates within years, and single samples within sampling dates. Using Onychiuridae as an example, effects of sugar flotation on the accuracy of population density estimates were discussed.

Soon after the beginning of a long-term study whose goals included monitoring of soil faunal dynamics in Michigan forests ("Project ELF", Snider & Snider 1987), we realized that our data could be severely biased by the method used to extract fauna from soil cores. One of the objectives of the study concerned potential effects of Extremely Low Frequency electromagnetic fields on collembolan and acarine populations. An accurate estimate of population densities was of primary importance. We therefore sought to validate the efficiency of standard heat-extraction by post-extraction treatment of samples with saturated sugar solution (sugar flotation). Examples of results are presented below.

METHODS

Soil cores (5 cm diameter, 15 cm depth) were taken in two hardwood forest sites in northern Michigan (Test and Control sites of "Project ELF", described in Snider & Snider 1987). Soils in both sites were well-drained Spodosols (Alfic Haplorthods, coarse-loamy, mixed, frigid), with approximately 60% sand, 23% silt, and 17% clay. Cores were transported in coolers and placed on sieves in Tullgren-type extractors (Tullgren 1918). Large, inverted funnels housing 40 watt light bulbs completely covered those which housed the samples. Heat, controlled by rheostats, was increased gradually over a period of 7 days, or until samples were completely dry. Following heat-extraction of soil fauna into collection jars, the dry core samples were removed, bagged in plastic, and treated as follows: 1) Soil cores were gently crumbled while still in plastic bags, placed into wide-mouth jars (1 liter capacity), moistened with distilled water, and immersed in saturated sugar solution, leaving approximately 3 cm head space. 2) Jars were covered with lids, gently shaken several times, and left standing for 2 hours to allow organic matter to float to the surface. 3) The solution, including

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[1] Received June 12, 1996. Accepted December 9, 1996.

[2] Department of Zoology, Michigan State University, East Lansing, Michigan 48824.

roots and other organic debris, was decanted through a 200 mesh sieve into a large bowl. Care was taken to not include silt which had settled in the bottom of the jar. 4) The sugar solution from the bowl was returned to the jar, and the organic matter was rinsed with water and then washed from the sieve into sample jars with 95% ethyl alcohol. 5) Steps 2 to 4 were repeated two more times and all organic matter from each core was combined in one sample jar. By the third decanting, very little organic matter was recovered. When the method was first developed, we floated and decanted organic supernatant four times, and sorted each "run" separately; results showed that the fourth iteration was not necessary, since it yielded < 1% of the total specimens extracted by flotation.

Most Collembola and mites could be identified with a dissecting microscope. Small specimens, and particularly members of the family Onychiuridae, were mounted on slides after rehydration in an acetic acid/water solution for up to 24 hours. It was also necessary to train personnel in distinguishing exuviae (which were shriveled and twisted, clear to near-opaque, and tended to float in alcohol) from whole animals (which resembled live specimens and usually did not float in alcohol).

RESULTS AND DISCUSSION

From 1986 through 1992, we used sugar flotation for all soil samples taken in Test and Control sites of "Project ELF" (Snider & Snider 1987, 1995). In Table 1, annual extraction efficiency data are summarized for frequently encountered taxa. Several taxa were always poorly extracted by heat (e.g., Onychiuridae in general, and the undescribed mesostigmatid mite "sp. A"). Others were consistently obtained with relatively high efficiency *(Nanorchestes* "sp. A", *Isotoma notabilis* Schaeffer). Species-specific differences were also observed between members of the same family (e.g., Isotomidae: *Isotomiella minor* (Schaeffer) vs. *Isotoma notabilis).*

The most commonly used methods for obtaining microarthropods from soil samples are Tullgren-type heat extractors and flotation procedures. Many variants of these techniques have been devised, compared and reviewed (e.g., Edwards & Fletcher 1971; Peterson 1978; Walter *et al.* 1987; Dunger & Fiedler 1989; Edwards 1991). None of them are 100% efficient for any given taxon. For Collembola, funnel extraction efficiency may range from 16% (Tamura 1976) to >90% (Petersen 1978; Lussenhop 1971). Edwards (1991) suggested that a correction factor should be applied to density estimates obtained by a particular technique in a given site. We had hoped to derive species-specific correction factors from first-year data (eliminating the need to use sugar flotation), but it soon became clear that this would not be possible. Not only did efficiency of heat extraction vary between dates (Table 2), but it also varied greatly between individual samples taken on the same date (Table 3). A *posteriori* correction for extraction efficiency would have to be applied to individual samples, since statistical tests of density differences between dates, sites or

Table 1. Efficiency of heat-extraction for selected arthropods, based on the total number of specimens obtained per year; values are given as percent [(N individuals obtained by heat-extraction) / (N total obtained by heat plus flotation)] x 100; T and C = Test and Control sites.

		PERCENT EXTRACTED BY HEAT						
TAXON	**SITE**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
ACARINA								
Nanorchestes sp. A	T	100.0	80.1	92.3	91.5	94.2	87.2	100.0
	C	94.9	84.4	97.8	98.4	94.1	98.7	100.0
Mesostigmata sp. A	T	36.9	23.9	38.9	27.5	42.1	20.9	18.9
	C	25.6	32.4	40.3	40.6	34.8	27.7	14.4
COLLEMBOLA								
Tullbergia mala Christiansen & Bellinger	T	27.8	25.2	15.1	11.1	27.2	12.2	9.1
	C	23.4	11.9	7.3	10.1	9.1	8.6	7.7
Tullbergia granulata Mills	T	29.2	19.8	20.4	11.1	19.5	16.2	4.8
	C	28.5	12.1	7.5	19.7	12.8	13.9	7.8
Isotoma notabilis Schaeffer	T	92.4	90.4	90.7	84.5	94.6	78.1	72.7
	C	94.2	87.5	90.2	90.1	91.6	93.9	71.1
Isotomiella minor (Schaeffer)	T	43.8	44.3	30.3	34.3	29.7	15.7	2.1
	C	50.7	28.6	22.9	48.3	33.3	29.3	19.6
Total Onychiuridae	T	31.6	24.1	18.1	12.8	20.3	16.5	6.6
	C	24.5	12.1	7.3	12.6	13.1	13.1	4.4
Total Isotomidae	T	77.1	78.3	80.3	70.1	78.7	56.8	51.4
	C	84.8	71.2	68.9	74.1	64.6	66.1	48.9

Table 2. Example of date-specific heat-extraction efficiencies for *Tullbergia mala* (Onychiuridae) from the Control site, dates 1 through 13 (early May to late October), 1986; N = 10 samples / date. N Heat = number of individuals extracted by heat; N Float = number obtained by sugar flotation; % Effic. = percent of total number extracted by heat.

	TOTAL NUMBER OF INDIVIDUALS / DATE												
DATE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
N Heat	78	173	75	212	97	83	35	38	22	138	50	67	23
N Float	254	209	382	336	281	130	410	203	196	241	322	260	331
% Effic.....	23.5	45.3	16.4	38.7	25.7	39.0	7.9	15.8	10.1	36.4	13.4	20.5	6.5

years are based on sample means and associated error estimates. If a general correction factor for heat extraction efficiency were uniformly applied to the data in Table 3, for example, the result would be a severe distortion rather than a correction of data.

Population density estimates and analyses of community structure and composition must depend to some degree on the methods used to obtain specimens. During the first 2 years of the study (1984-1985) we used heat-extraction alone. Species which were then thought to be rare or absent in either site (e.g., *Willemia intermedia* Mills and *W. similis* Mills: Hypogastruridae) were found to be common in both communities once we initiated sugar flotation. Annual density estimates, particularly for Onychiuridae (Table 4), also increased significantly beginning in 1986.

Without doubt, standard procedures of handling, extraction, and subsequent sorting of soil faunal samples harbor numerous sources of error, variable with soil type, operator skills, extraction apparatus and available facilities. In the case of "Project ELF", for instance, lack of temperature-controlled facilities precluded the use of high-gradient methods, which have been shown to increase efficiency (Merchant & Crossley 1970; Edwards & Fletcher 1971; Bieri *et al.* 1986; Crossley & Blair 1991; review in Edwards 1991), and may have contributed to variable extraction efficiencies over seasons or years.

Some arthropods are extracted more efficiently by heat, others by flotation (Edwards & Fletcher 1971; Edwards 1991). We used both methods, and found it necessary to process all samples in this manner, due to the wide variation between individual samples (Table 3). Financial constraints usually preclude labor-intensive procedures such as flotation. We recorded sorting times of 10 to 12 hours for a single sugar-floated forest soil sample, depending on the skill of individuals as well as on the structural complexities of samples (amount of root material or particulate organic matter). However, for any soil biological

Table 3. Examples of sample-specific heat-extraction efficiencies for *Tullbergia mala* (Onychiuridae) from the Control site, May 5 and 19, 1986. Abbreviations as in Table 2.

	TOTAL NUMBER OF INDIVIDUALS / SAMPLE										
SAMPLE NO.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
May 5, 86:											
N Heat	9	0	0	0	7	8	0	1	3	50	78
N Float	15	10	3	6	17	28	16	12	90	57	254
% Effic.	37.5	0.0	0.0	0.0	29.2	22.2	0.0	7.7	3.2	46.7	23.5
May 19, 86:											
N Heat	9	4	34	18	37	19	3	1	34	14	173
N Float	2	0	5	20	3	11	7	5	147	9	209
% Effic.	81.8	100.0	87.2	47.4	92.5	63.3	30.0	16.7	18.8	60.9	45.3

study where the validity of conclusions rests on the accuracy of population estimates, we suggest that investing in a procedure such as the one described here may well be worthwhile.

Table 4. Mean annual density /m2 of Onychiuridae (all species combined) in Test and Control sites, 1984 to 1992.

	DENSITY / M^2								
METHOD	**Heat extraction**		**Heat extraction plus flotation**						
YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992
TEST SITE	2854	3819	8538	13756	11893	12995	8505	10806	10085
CONTROL SITE	7884	6442	25603	43425	28860	31739	28992	15847	21017

ACKNOWLEDGMENTS

We are grateful to Nancy J. Sferra, Frank Calandrino, Tina Schachterle, Thomas Harpstead and Chad Schaedig for their technical support and for training the numerous undergraduates who helped with sample processing. Support for this research was provided by the Naval Electronic Systems Command through a subcontract to IIT Research Institute under contract N00039-81-C-0357.

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SCIENTIFIC NOTE

ANTHICUS UNICOLOR (COLEOPTERA: ANTHICIDAE), A NEW PREDATOR OF *DIURAPHIS NOXIA* (HOMOPTERA: APHIDIDAE) FROM TURKEY[1]

Meryem Elmali[2]

The natural enemies of Russian wheat aphid *[Diuraphis noxia* (Kurdjumov)] are well documented in South Africa (Aalbersberg *et al.* 1988), in USSR (Kovalev *et al.* 1991), in Eurasia (Gruber *et al.* 1991), in California (Bernal *et al.* 1993), in Morocco, Jordan, Syria (Miller *et al.* 1992), and in Turkey (Miller *et al.* 1992, Elmali 1996). Although Anthicidae is commonly referred to as a family containing predator species (McQuillan *et al.* 1982, Smith *et al.* 1987, Frank and Slosser 1991, Elmali 1996), *Anthicus unicolor* Schm. has not been previously reported in the literature as a predator of *D. noxia.* This anthicid was also a first record for Turkish fauna. It was locally seen in only one field infested with *D. noxia* at high density in Konya province. However, after *A. unicolor* adults suddenly appeared in large numbers, *D. noxia* declined rapidly. *A. unicolor* has a large brown egg which it deposits at the top of a short white fiber like a neuropteran egg. Eggs were where *D. noxia* colonies were present. *A. unicolor* was able to prey on *D. noxia in* rolled leaves and other concealed places. Although *Sitobion avenae (*F.), *Rhopalosiphum maidis* Fitch, *R. padi* (L.) (Homoptera: Aphididae), and *Sipha (Rungsia) elegans* Del Guercio (Homoptera: Chaitophoridae) were also prey of *A. unicolor, D. noxia* was preferred.

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(Continued on page 212)

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[1] Received September 16, 1996. Accepted December 10, 1996.

[2] Plant Protection Department, Faculty of Agriculture, Selçuk University, 42031 Konya, Turkey.

A NEW *SPIROPLASMA* (ENTOMOPLASMATALES: SPIROPLASMATACEAE) RECORD FOR GEORGIA AND ATTEMPTED HORIZONTAL TRANSMISSION VIA PREDATION[1]

Jim Wedincamp Jr.[2], Frank E. French[3], Robert F. Whitcomb[4]

ABSTRACT: Firefly larvae, *Photuris lucicrescens* and *P. hebes*, did not become infected with EC-1 or HYOS-1 *Spiroplasma* strains after feeding on injected *Tenebrio molitor* pupae. P. *lucicrescens* and *P. hebes* larvae had natural *Spiroplasma* infections but no mollicutes related to strains EC-1 or HYOS-1 were recovered. Injected *T. molitor* pupae carried both the HYOS-1 (11/13) and EC-1 (10/10) strains for up to five days. Isolations of naturally occurring spiroplasmas from *P. hebes* larvae and adults were identified as group XIX spiroplasmas. These isolations of spiroplasmas from *Photuris* spp. fireflies were the first isolates of group XIX from Georgia.

Spiroplasmas are helical wall-less prokaryotes belonging in the Division Tenericutes, Class Mollicutes and Order Entomoplasmatales (Tully *et al* 1993; Whitcomb and Tully 1982). They are associated with arthropods (Whitcomb, 1981), especially flies (Diptera) and beetles (Coleoptera) (Hackett, 1990). Little is known of the bionomics of *Spiroplasma*. The natural routes by which spiroplasmas colonize tabanids have never been demonstrated and limited sampling suggests that spiroplasmas do not occur or are rare in tabanid larvae (French *et al* 1992). If this is true we must look for alternate hosts that enable tabanid spiroplasmas to overwinter. Fireflies are rich sources of spiroplasmas including the group XIV strain EC-1 (Hackett *et al* 1992) which are also found in tabanids. The EC-1 strain was originally isolated from the gut and hemolymph of *Ellychnia corrusca* firefly beetles collected in Maryland (Hackett *et al* 1992). The HYOS-1 strain was originally isolated from the tabanid, *Hybomitra opaca*, collected in Montana.

Spiroplasmas isolated in other studies from fireflies include: the group XIV strain EC-1 isolated from *Ellychnia corrusca*, group XVI strain isolated from *Photinus pyralis*, group XIX strain PUP-1 isolated from *Photuris lucicrescens*, and group XIX strain PUP-1 isolated from *Photuris* spp. (Hackett *et al* 1992).

To simulate natural acquisition of spiroplasmas via predation, tenebrionid pupae were injected with tabanid spiroplasmas and offered as prey to firefly

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[1] Received October 15, 1996. Accepted October 30, 1996.

[2] 402 Life Sciences Building, Department of Entomology, Louisiana State University, Baton Rouge LA 70803.

[3] Biology Department and Institute of Arthropodology and Parasitology, Georgia Southern University, Statesboro GA 30460.

[4] Vegetable Laboratory, U.S. Department of Agriculture, Beltsville MD 20705.

larvae, which are predaceous and are potential reservoirs for tabanid spiroplasmas. The possibility that spiroplasmas could be acquired in the course of predation has been suggested (Hackett and Clark 1989).

MATERIALS AND METHODS

Spiroplasma were isolated from *Photuris* firefly larvae abdominal viscera after surface sterilization, abdominal snip, removal and mincing of viscera in M1D broth (Whitcomb 1983) and filtration through 0.45µm pores using the techniques of Markham *et al* (1983) with the exception that two drops of Photoflo 200 was added to the hypochlorite solution to ensure wetting of the insect and surface sterilization.

Serological deformation tests (Williamson and Whitcomb 1983) with a final antiserum dilution of 1:1280, were used to confirm the presence of *Spiroplasma* HYOS-1 and EC-1.

Firefly larvae, 45 *Photuris lucicrescens*, were collected September 26-30, 1993, in Mercer County, New Jersey. *Photuris hebes* ($n = 61$) were collected March 30-April 4, 1994, in Evans County, Georgia. The larvae were collected on the surface of the soil by observation of light flashes emitted from the abdomen. Each larva was placed in a 60 mm disposable petri dish lined with 5.5 cm dia. #1 Whatman® filter paper moistened with distilled water and maintained at 16-25° C with a 12/12 hr photoperiod.

Mealworm beetle pupae *(Tenebrio molitor* L., Coleoptera: Tenebrionidae) with lightly colored legs were selected for injection, since pupae with darker pigmented legs tended to develop into adults before the firefly larvae fed. Pupae were randomly assigned to 1 of 3 groups. Group 1 was injected with 5.0 µl of the HYOS-1 *Spiroplasma* strain grown in M1D broth using a 10 µl Osge® syringe. Group 2 was injected with 5.0 µl of the EC-1 *Spiroplasma* strain grown in M1D broth. The titer of injected spiroplasmas, as estimated by serial dilution, was 10^8-10^9 spiroplasmas per ml (strain HYOS-1) and 10^7-10^9 spiroplasmas per ml (strain EC-1). Group 3 was injected with 5.0 µl of M1D broth as controls. Each *T. molitor* pupa was injected 24 to 30 hrs before placement in a 60 mm petri dish with a single firefly larva. A second injected pupa was placed with each firefly larva after evidence of feeding was observed. Feeding was indicated by evisceration or holes in the exoskeleton of the mealworm pupa. Viscera of 88 firefly larvae were cultured four days after feeding on a second mealworm pupa. Viscera of 11 adults reared from *P. hebes* larvae from the same field collection were also cultured for spiroplasmas three days after eclosion.

RESULTS AND DISCUSSION

The firefly larvae used in our test had natural infections of spiroplasmas and

Entomoplasma ellychnia, complicating the isolation of spiroplasmas from gut flora. *P. lucicrescens* larvae had a natural *Spiroplasma* infection rate of 6.7% (3/45), but all spiroplasmas isolated were closely related to the group XIX PUP-1 strain (Whitcomb *et al* 1992). The *P. hebes* larvae had a natural infection rate of 21% (9/43) with *Spiroplasma* group XIX, but no mollicutes related to strains EC-1 or HYOS-1 were recovered. All nine isolates from 43 larvae of *P. hebes* and four isolates from 11 reared adults (same field collection) were identified serologically as group XIX spiroplasmas. Injected *T. molitor* control pupae carried both the HYOS-1 (11/13) and EC-1 (10/10) strains for up to five days.

Firefly larvae, 45 *P. lucicrescens* and 43 *P. hebes,* did not become infected with EC-1 or HYOS-1 *Spiroplasma* strains after feeding on injected *T. molitor* pupae.

The Evans County isolations of spiroplasmas from *Photuris* spp. firefly larvae and adults were the first isolates from Georgia. These isolations of group XIX from *P. hebes* firefly larvae and adults confirms the existence of this group in the southeastern USA. Shaikh *et al* (1987) reported the group XIX *Spiroplasma* from mosquitoes in Alabama. Adult *P. hebes* fireflies either carried the infection through metamorphosis or became infected from the soil within one day after emergence from the pupal stage.

Although our findings suggest that acquisition of spiroplasmas via predation may not occur it should be noted that alternate routes for the transfer of spiroplasmas among fireflies and tabanids do occur. Wedincamp *et al* (1996) revealed evidence that spiroplasmas may be transmitted among adult fireflies and tabanids at shared carbohydrate feeding sites, *ie.* nectaries and honeydew deposits.

ACKNOWLEDGMENTS

We thank Anthony J. LeCroy (Statesboro, Georgia) for laboratory assistance and field collections of fireflies; Jonathan Copeland (Georgia Southern University, Statesboro, Georgia) for technical advice; Paul S. Johnson (Princeton, New Jersey) for obtaining firefly larvae and Frederic V. Vencl (State University of New York at Stony Brook, New York) for identification of fireflies.

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SCIENTIFIC NOTE

FEMALE *PHENGODES* FEEDING AND AN ASSOCIATED RISK (COLEOPTERA:PHENGODIDAE)[1]

Richard Stuart Miller[2]

Phengodes Illiger are remarkable beetles. Known females are difficult to distinguish externally from larvae, except by their larger size and their ovipositional behavior. Although there are scattered notes published about *Phengodes* luminescence and the female's resemblance to larvae, their biology remains comparatively unknown. No thorough study, such as that of *Zarhipis* LeConte by Tiemann (1967), has been published. This is surprising, given the interest that phengodids generate among amateur and professional entomologists alike. Several biological observations of *Phengodes* sp., which differ from published accounts of phengodid biology, are discussed here.

In May 1986 two female *Phengodes* were discovered under the bark of a fallen hardwood tree 6-7 km west of Cloverdale, Putnam County, Indiana. The tree was supported above the ground by another tree, except at the roots. Its bark was loose, but the wood was still solid. Based on distribution (Wittmer 1975), these *Phengodes* were most likely one of three species - *P. fusciceps intermedia* Wittmer, *P. plumosa* Olivier, or *P. laticollis* LeConte. One was feeding on *Narceus* sp. (Diplopoda: Spirobolidae) about a meter distant from the other feeding on *Polydesmis* sp. (Diplopoda: Polydesmidae). Phengodids are known millipede specialists (Riley 1887, Balduf 1935) and these observations corroborate Tiemann's (1967) observations that prey selection is not species-specific.

I brought both phengodids with additional living *Narceus* back to the lab and placed each phengodid separately in petri dishes with moist Whatman #1 filter paper. Since the *Narceus* prey in the field was approximately the same size as the phengodid female predator, I placed a similar-sized millipede sequentially in each petri dish. The following observations were made with the aid of a M5 dissecting microscope.

Both phengodids attacked the millipedes immediately after coming into contact with them. They encircled their prey, drawing them off the substrate while holding the millipedes' anterior legs directed dorsally. The phengodids then reached around the millipedes in attempts to bite their ventral cervical membranes. The first female was successful and held the millipede for several minutes in this fashion, while leaving her mandibles embedded within the millipede, until the latter was quiescent. The phengodid then used her mandibles to remove the head from the rest of the body. She fed on the head first, and then inserted her head into the thorax and began to feed. Later, I noted that she had crawled further into the body as she continued to feed. This behavioral sequence was similar to that of larval *Zarhipis integripennis* (LeConte) reported by Tiemann (1967). The next morning the millipede was merely an empty exoskeleton with no observable liquid or soft contents.

The second female did not seem able to keep herself free of the millipede's legs. The constant motion of those legs ultimately exposed the phengodid's cervical membranous region to the *Narceus* mandibles. Although the millipede did not pierce the membrane, it evidently crushed

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[1] Received November 2, 1996. Accepted December 28, 1996.

[2] 618 South 15th Ave., Bozeman, MT 59715.

the subesophageal ganglion, since the phengodid immediately ceased attacking the millipede and her entire body began to quiver. The millipede moved away and ignored the beetle thereafter. Later, the phengodid lay quiescent on her side. The next morning she was able to right herself slightly, but she never regained mobility. Tiemann (1967) suggested that millipede defense from larval *Zarhipis* predation is limited to wriggling free and outrunning it. The results of the second encounter suggest that this is not the case, at least for *Narceus*. This may also explain Tiemann's (1967) observation that *Zarhipis* invert their cervical membrane away from millipede mandibles to protect it when biting its prey.

The first phengodid layed 2 eggs shortly after feeding on the millipede, but the second never oviposited in the lab. Barber (1906) reported 53 eggs from a single *Phengodes* female. Therefore, the first female either died before additional oviposition or she had previously oviposited. Alternatively, egg number is extremely variable in *Phengodes*. Both females died within days of the first's oviposition. Soon thereafter, 2 first instar *Phengodes* eclosed. Tiemann (1967) hypothesized that female *Zarhipis integripennis* do not feed as adults, because they ignored several live millipedes offered as food. However, adult female *Phengodes* do feed after mating as exemplified in both the field and laboratory.

ACKNOWLEDGMENT

Thanks to Charles Withrow for determination of the millipedes and to Kevin O'Neil and Richard Hurley, two anonymous reviewers and the editor for manuscript review.

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A PRELIMINARY LIST OF THE BRUCHIDAE (COLEOPTERA) OF CUBA[1]

Dania Alvarez Marin[2], John M. Kingsolver[3]

ABSTRACT: A preliminary list of 36 known species of Cuban bruchids with their synonyms is assembled as a basis for a faunal study of the island. Known distribution and plant host genera are provided.

Thirty-six species of Bruchidae are herein recorded for the island of Cuba. *Bruchus centrimaculatus* Allard was listed by Blackwelder (1946) but it is a European species undoubtedly misidentified and should be stricken from the list. Both Suffrian (1870) and Gundlach (1891) listed *Bruchus cinerifer* Fahraeus as occurring in Cuba but this species, now in *Mimosestes,* has so far been found only in southeastern Mexico. Only a critical examination of the specimen in the Gundlach Collection will determine its correct assignment. We omit it from this list.

Recent surveys of specimens in the Instituto de Ecologia y Sistemática, Havana, the Florida State Collection of Arthropods, Gainesville, and the Stewart B. Peck private collection, Ottawa, Ontario, have added seven species to the faunal list for the island. Each is designated in the list as NEW RECORD.

Three species names in the list *(Bruchus quadratus, Bruchus pantherinus,* and *Bruchus livens)* were proposed by Suffrian in 1870, and although the types recently became available, no bruchid specialist has yet critically studied them.

Faunal lists for other West Indian islands have not been compiled but 14 species are known from the Dominican Republic, 12 from Jamaica, and 13 from Puerto Rico. Florida now lists 48 species.

Generic name(s) following each specific name indicate previous assignments of that name. Full bibliographic citations are given for valid names. Refer to the catalog by Udayagiri and Wadhi (1989) for citations for synonyms.

PACHYMERINAE

Caryobruchus gleditsiae (Johansson and Linné, 1767) (*Dermestes, Bruchus, Pachymerus*)
= *Bruchus fuscus* Goeze 1777
= *Bruchus arthriticus* Fabricius 1801
Distribution: Bahamas, Bermuda, Cuba, Dominica, Dominican Republic, El Salvador, Guatemala, Honduras. Jamaica, Mexico, Panama, USA
Host: *Chamaedorea, Coccothrinax, Copernica, Hemithrinax,* Livistona, Phoenix, Sabal, *Serenoa, Thrinax, Washingtonia*

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[1] Received May 15, 1996. Accepted November 7, 1996.

[2] Jefe, Departamento de Entomologia, Instituto de Ecologia y Sistematica, Academia de Ciencias de Cuba, Habana, Cuba.

[3] Research Associate, Florida State Collection of Arthropods, P.O. Box 147100, Gainesville, FL 32614-7100 USA.

ENT. NEWS 108(3): 215-221, May & June, 1997

Caryobruchus marieae Nilsson and Johnson, 1990
Distribution: Cuba
Host: *Sabal palmetto* (Walt.) Lodd., *Chamaeodorea elegans* Mart.

AMBLYCERINAE

Amblycerini

Amblycerus baracoensis Kingsolver, 1970 (emended from *baracoenis*)
Distribution: Costa Rica, Cuba, Mexico, Paraguay
Host: *Cordia gerascanthus* L.
Amblycerus cistelinus (Gyllenhal, 1833) (*Spermophagus*)
= *Spermophagus centralis* Sharp, 1885
Distribution: Belize, Brazil, Costa Rica, Cuba, Guatemala, Mexico, Nicaragua, Panama
Host: *Guazuma ulmifolia* Lam.
Amblycerus eustrophoides (Schaeffer, 1904) (*Spermophagus*)
Distribution: Cuba, Costa Rica, Florida, Mexico
Host: *Drypetes laterifolia* (Sw.) Krug & Urban
Amblycerus pygidialis (Suffrian 1870) (*Spermophagus*)
= *Amblycerus chapini* Kingsolver 1970
Distribution: Cuba, Jamaica
Host: *Cordia gerascanthus* L.
Amblycerus sallei (Jekel, 1855) (*Spermophagus*), NEW RECORD
= *Amblycerus martorelli* Bridwell 1944
Distribution: Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico, Venezuela
Host: *Prosopis juliflora* (Sw.) DC.
Amblycerus schwarzi Kingsolver, 1970, NEW RECORD
Distribution: Cuba, Curaçao, Dominican Republic, Grand Cayman, Jamaica, Puerto Rico, St. Croix, Virgin Is., Florida.
Host: *Hippomane mancinella* L., *Tectona grandis* L., *Ricinis communis* L., *Randia aculeata* L. (flowers)
Amblycerus simulator Jacquelin-Duval, 1857) (*Spermophagus*)
Distribution: Costa Rica, Cuba
Host: *Luehea speciosa* Willd.
Amblycerus taeniatus (Suffrian, 1870) (*Spermophagus*)
Distribution: Cuba
Host: *Caesalpinia bijuga* Swarz

Spermophagini

Zabrotes subfasciatus (Boheman, 1833) (*Spermophagus*)
Spermophagus musculus Boheman 1833
Spermophagus semifasciatus Boheman 1839
Bruchus cingulatus Kunze in Suffrian 1870
Bruchus leucogaster Kunze in Sharp 1885
Spermophagus pectoralis Sharp 1885
Spermophagus (Zabrotes) semicinctus Horn 1894
Spermophagus basicornis Pic 1928
Spermophagus minusculus Pic 1943 (misspelling for *musculus* Boheman)
Distribution: Nearly worldwide, especially in tropical and subtropical regions
Host: Many leguminous genera *Cajanus, Cicer, Dolichos, Glycine, Phaseolus, Pisum, Vicia, Vigna*

BRUCHINAE
Bruchini

Bruchus pisorum (Linné, 1758)
= *Laria salicis* Scopoli 1763
= *Bruchus cruciger* Geoffroy 1785
= *Bruchus sparsus* Fabricius 1801
= *Bruchus intermedius* Motschulsky 1854
= *Bruchus fabae* Brulle 1864
= *Bruchus lunarius* Rey 1893
= *Bruchus unifasciatus* Rey 1893
Distribution: Cosmopolitan
Host: Prefers *Pisum* sp. but also reported in *Cassia, Cytisus, Lathyrus, Phaseolus, Vicia*

Bruchus rufimanus (Boheman, 1833)
= *Bruchus fabae* Motschulsky 1854
= *Bruchus granarius* Marsham 1802
Distribution: Cosmopolitan
Host: Prefers *Vicia* but also reported in *Cicer, Lathyrus, Lens, Lupinus, Phaseolus, Pisum, Vigna*

Bruchidiini

Callosobruchus chinensis (Linné,1758) *(Curculio, Mylabris, Bruchus, Pachymerus)*
= *Bruchus pecticornis* Fabricius 1775
= *Bruchus rufus* De Geer 1775
= *Bruchus scutellaris* Fabricius 1792
= *Bruchus barbicornis* Fabricius 1801
= *Bruchus bistriatus* Fabricius 1801
= *Bruchus biguttatus* Fabricius 1801
= *Bruchus rufobrunneus* Wollaston 1870
= *Bruchus elegans* Sturm in Gemminger & Harold 1873
Distribution: Cosmopolitan, mostly tropical and subtropical, major stored product pest
Host: Many leguminous genera including *Arachis, Cajanus, Cassia, Cicer, Cyamopsis, Dolichos, Glycine, Lathyrus, Lens, Phaseolus, Pisum, Vicia, Vigna. Nelumbo* (Nelumbonaceae)

Callosobruchus maculatus (Fabricius, 1775)
= *Bruchus ornatus* Boheman 1829
= *Bruchus vicinus* Gyllenhal 1833
= *Bruchus ambiguus* Gyllenhal 1839
= *Bruchus sinuatus* Fahraeus 1839
Distribution: Cosmopolitan, major stored product pest
Host: Many leguminous genera including *Acacia, Arachis, Cajanus, Cicer, Dolichos, Glycine, Lathyrus, Medicago, Phaseolus, Pisum, Vicia, Vigna*

Megacerini

Megacerus ferruginosus Teran and Kingsolver, 1977
Distribution: Cuba
Host: Unknown

Megacerus flabelliger (Fahraeus, 1839) *(Bruchus)*, NEW RECORD
= *Bruchus luculentus* Boheman 1859
= *Kytorhinus pygidialis* Motschulsky 1874
= *Pachybruchus verticalis* Pierce 1915
Distribution: Argentina, Brazil, Costa Rica, Cuba, Ecuador, Mexico, Nicaragua, Venezuela
Host: Species of *Ipomoea* and *Merremia* (Convolvulaceae)

Megacerus porosus (Sharp) 1885 *(Bruchus)*
= *Bruchus obliquefasciatus* Pic 1932
= *Bruchus notaticollis* Pic 1932
Distribution: Colombia, Cuba, Brazil, Mexico, Puerto Rico
Host: *Merremia aegyptia* Dennst.

Megacerus tricolor (Suffrian, 1870) *(Bruchus, Acanthoscelides)*
Distribution: Cuba, Dominican Republic, Nicaragua
Host: *Ipomoea alba* L. (= *I. bonanox* L.)

Acanthoscelidini

Acanthoscelides flavescens (Fahraeus, 1839) *(Bruchus)*, NEW RECORD
= *Bruchus ochraceous* Schaeffer 1907 (not Baudi 1886)
= *Bruchus ochraceicolor* Pic 1913
Distribution: Costa Rica, Cuba, Dominican Republic, Guatemala, Honduras, Nicaragua, Mexico, Panamá, Puerto Rico, St. Vincent, USA
Host: *Eriosema, Galactia, Rhynchosia, Tephrosia*

Acanthoscelides livens (Suffrian, 1870) *(Bruchus)*. Transferred by Blackwelder (1946) but correct generic placement depends on critical examination of the type in the Gundlach Collection.
Distribution: Cuba
Host: Unknown

Acanthoscelides obtectus (Say, 1831) *(Bruchus)*
= *Acanthoscelides obsoletus* of authors (misident.)
= *Bruchus irresectus* Fahraeus 1839
= *Bruchus pallidipes* Fahraeus 1839
= *Bruchus tetricus* Gyllenhal 1839
= *Bruchus subellipticus* Wollaston 1854
= *Bruchus incretus* Walker 1859
= *Bruchus fabae* Riley 1871
= *Bruchus varicornis* Motschulsky 1874
Distribution: Cosmopolitan, major stored product pest
Host: Many leguminous genera including *Cajanus, Cicer, Lathyrus, Lens, Phaseolus, Pisum, Sesbania, Vicia, Vigna*

Acanthoscelides pantherinus (Suffrian, 1870) *(Bruchus)*. Transferred by Blackwelder (1946) but correct generic placement depends on critical examination of the type in the Gundlach Collection.
Distribution: Cuba
Host: Unknown

Acanthoscelides quadratus (Suffrian, 1870) *(Bruchus)*. Transferred by Blackwelder (1946) but correct generic placement depends on critical examination of type in the Gundlach Collection.
Distribution: Cuba
Host: Unknown

Acanthoscelides quadridentatus (Schaeffer, 1907) *(Bruchus)*, NEW RECORD
  Distribution: Cuba, Mexico through Central America to Brazil, USA
  Host: Varieties of *Mimosa pigra* L., *M. strigillosa* Torr. & Gray, *M. pigra* var. *berlandieri* (Gray) Turner
Ctenocolum podagricus (Fabricius, 1801) (*Bruchus, Pseudopachymerus, Acanthoscelides, Caryedes*), NEW RECORD
  = *Bruchus crotonae* Fahraeus 1839
  = *Bruchus pictifemur Sharp* 1885
  Distribution: Brazil, Costa Rica, Cuba, Ecuador, El Salvador, Guyana, Mexico, Tobago, Venezuela
  Host: *Lonchocarpus, Piscidia*
Meibomeus relictus (Suffrian, 1870) *(Bruchus)*
  Distribution: Cuba
  Host: unknown for Cuba; other species in genus attack seeds of *Adesmia, Desmodium, Poiretia,* and *Zornia*
Merobruchus lysilomae Kingsolver, 1988
  Distribution: Bahamas, Cuba, Dominican Republic, Florida, Haiti
  Host: *Acacia, Albizia, Lysiloma*
Mimosestes insularis Kingsolver and Johnson, 1978
  Distribution: Cuba, Dominican Republic, Puerto Rico, Hawaii
  Host: *Acacia farnesiana* (L.) Willd., *Prosopis*
Mimosestes mimosae (Fabricius, 1781) (*Bruchus)*
  = *Bruchus dominicanus* Jekel 1855
  = *Bruchus breweri* Crotch 1867
  = *Bruchus inornatus* Horn 1873
  = *Bruchus subrufus* Motschulsky 1874
  = *Bruchus strigatus* Motschulsky 1874
  = *Bruchus immunis* Sharp 1885
  = *Bruchus innotatus* Pic 1912
  Distribution: Brazil, Colombia, Costa Rica, Cuba, Curaçao, Dominican Republic, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Netherlands West Indies, Nicaragua, Puerto Rico, Trinidad, Venezuela
  Host: *Acacia, Caesalpinia, Ceratonia, Parkinsonia*
Mimosestes nubigens (Motschulsky, 1874) *(Bruchus, Acanthoscelides)*
  = *Bruchus sallaei* Sharp 1885
  Distribution: Brazil, Costa Rica, Cuba, El Salvador, Guatemala, Hawaii, Honduras, Mexico, New Caledonia, Nicaragua, Panamá, Philippines, Puerto Rico, USA
  Host: *Acacia, Prosopis (*occasionally)
Sennius fallax (Boheman; 1839) *(Bruchus, Acanthoscelides)*
  = *Bruchus californicus* Boheman 1859
  = *Bruchus xanthopus* Suffrian, 1870
  = *Bruchus probus* Sharp 1885
  Distribution: Costa Rica, Cuba, Guatemala, Jamaica, Mexico, Panama, Puerto Rico, USA
  Host: *Cassia*
Sennius morosus (Sharp, 1885) *(Bruchus, Acanthoscelides)*, NEW RECORD
  Distribution: Costa Rica, Cuba, El Salvador, Guatemala, Honduran, Mexico, Nicaragua, Panamá, USA
  Host: *Cassia*
Sennius rufomaculatus (Motschulsky,1874) *(Bruchus, Acanthoscelides)*
  = *Bruchus instabilis* Sharp 1885
  = *Bruchus ricanus* Pic 1929

= *Bruchus turrialbanus* Pic 1930
Distribution: Colombia, Costa Rica, Cuba, El Salvador, Grenada, Guadeloupe, Guatemala, Hispaniola, Honduras, Jamaica, Mexico, Nicaragua, Panamá, Puerto Rico, St. Vincent, Tobago, Trinidad
Host: *Cassia*

Stator bottimeri Kingsolver, 1972
Distribution: Bahamas, Cuba, USA
Host: *Acacia farnesiana* (L.) Willd., *Acacia pinetorum* Hermann

Stator rugulosus Kingsolver, 1972
Distribution: Cuba
Host: *Pithecellobium discolor* Britton

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NAME THAT INSECT. A GUIDE TO THE INSECTS OF SOUTHEASTERN AUSTRALIA. 1997. T.R. New. Oxford University Press. 194 pp. Cloth $22.95. Also ppbk., price not shown.

An introductory guide to the Orders and major families of insects in the region, with selected examples of species to illustrate their diversity and biology.

THE BIOLOGY OF INSECT OVERWINTERING. 1993. Ppbk. 1995. S.R. Leather, K.F.A. Walters, and J. S. Bale. Cambridge University Press. 253 pp. Hardbk. $89.95. Ppbk. $29.95.

Although most insects in temperate climates spend a large proportion of their life in an overwintering stage, the study of insect overwintering has been surprisingly neglected. Yet, the study of overwintering can offer an insight into the development of insects. This book provides a comprehensive account of the various forms of insect overwintering that highlights important areas of economic interest.

MEDICAL ENTOMOLOGY FOR STUDENTS. 1996. M.W. Service. Chapman and Hall. 278 pp., Ppbk.

This book is aimed at students, whether they be physicians, nurses, health officials and workers, or students working on a masters' degree in parasitology or medical entomology. Groups considered include mosquitoes, blackflies, sandflies, biting midges, horseflies, tsetse-flies, house and stable-flies, fleas, lice, bedbugs, cockroaches, ticks and mites. For each group there is provided text on external morphology, life cycle, ecology, behavior and habits, medical importance, and control.

CERCOPOIDEA TYPES OF SPECIES DESCRIBED BY EDMUND SCHMIDT IN THE U.S. NATIONAL MUSEUM OF NATURAL HISTORY, WITH LECTOTYPE DESIGNATIONS (HOMOPTERA: CERCOPOIDEA)[1]

Ai-Ping Liang[2]

ABSTRACT: Syntypes and "cotypes" of 35 Cercopoidea species and subspecies described by E. Schmidt and recently found in the U.S. National Museum of Natural History are documented. Seventeen lectotypes are newly designated. *Colsa krügeri* (Schmidt) is emended as *C. kruegeri* and synonymized with *C. cavata* Walker. The following new combinations are established: *Liorhina affinis* (Schmidt), *L. flaviscutellata* (Schmidt), *L. pulchra* (Schmidt), *L. similis* (Schmidt), and *L. taeniaticollis* (Schmidt); all are transferred from *Clovia*.

Between 1906 and 1932, Edmund Schmidt described many new species and genera of Cercopoidea. The great majority of Schmidt's type specimens were formerly kept in the Stettiner Museum, but were removed in 1945, after the devastation of Stettiner during World War Two. They are now located in the Institute of Zoology of the Polish Academy of Sciences (IZPAS), in Warsaw.

Part of the type series of 32 species and subspecies described by Schmidt were recently found and examined in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. The depositories of these syntypes were never mentioned in Schmidt's original descriptions.

The USNM collection contains authentic Schmidt specimens as evidenced by Schmidt's handwritten determination and type labels. Their authenticity as syntypes was verified by comparing the label data on the specimens with the original descriptions.

The deposition of the Schmidt material in Washington might be the result of the acquisition of the C.F. Baker collection by the USNM. While he was a professor at the University of the Philippines, Baker sent specimens he collected in Singapore, Borneo, and the Philippines to Schmidt for identification. Part of the material was later returned to Baker, together with syntypes of species for which Schmidt had duplicate examples. Baker later donated all of his personal collection to the National Museum of Natural History. At present, one specimen among the series for each species or subspecies bears the species name handwritten on a large black-bordered red label. I attribute this labeling to C.F. Baker, as evidenced by the label format and handwriting.

The purpose of the present paper is to document fully the existing type

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[1] Received July 29, 1996. Accepted September 18, 1996.

[2] Department of Entomology, Institute of Zoology, Academia Sinica, 19 Zhongguancun Lu, Beijing 100080, PR China.

ENT. NEWS 108(3): 222-228, May & June, 1997

material. Lectotype and paralectotype designations are made where appropriate. One incorrect original specific spelling is emended. Also, one new specific synonymy and four new species combinations are reported. Most species of Cercopoidea can be identified accurately only by using diagnostic characters in the males, particularly the structures of the male genitalia. Therefore, in most cases the male was designated as the lectotype when syntypes existed. The female was designated as the lectotype when no male was present among the known syntypes. Lectotype and paralectotype designations were not made for the female syntypes of 15 species and subspecies at this time because the male syntypes of these species and subspecies exist in the Institute of Zoology, Polish Academy of Sciences, Warsaw.

The list of types is arranged alphabetically by species name. Each name is followed by the original generic combination, author, date, page reference, and subsequent synonymy or different generic name combination. To document the historical status of the syntypes, information from each was recorded exactly as given on labels, with (1), (2), (3), and so forth, indicating the sequence of labels on the pin from top to bottom. Lastly, my hand printed red lectotype or yellow paralectotype label is attached to each specimen so designated.

affinis, Clovia, Schmidt, 1922a: 9. Here transferred to *Liorhina* Stål, **New Combination.**

Lectotype ♂ – (1) ISOLE BATU 1896-97 H. Raa p. (2) (pink label) Typus; (3) E. Schmidt (4) *Clovia affinis* Schmidt ♂ Edm. Schmidt determ. 1921 (5) (black-bordered red label) *Clovia affinis* Schm.

apicalis, Simeliria, Schmidt, 1909c: 290.

1 ♀ Syntype – (1) Goenoeng Sitoli, Nias, H. Rolle Berlin SW 11 (2) (pink label) Type (3) *Simeliria apicalis* Schmidt ♀ Edm. Schmidt determ. 1908 (4) (black-bordered red label) *Simeliria apicalis* Schm.

The male syntype of this species is in the IZPAS.

borneensis, Leptataspis, Schmidt, 1911: 90.

Lectotype ♂ - (1) Nord-Borneo Waterstradt (2) (pink label) Type (3) *Leptataspis borneensis* Schmidt ♀ Edm. Schmidt determ. 1910 (4) (black-bordered red label) *Leptataspis borneensis* Schm.

breddini, Trichoscarta, Schmidt, 1910: 85.

Lectotype ♀ - (1) Soekaranda, Januar 1894 Dohrn (2) (pink label) Type (3) *Trichoscarta Breddini* [sic] Schmidt ♀ Edm. Schmidt determ. 1910 (4) (black-bordered red label) *Trichoscarta breddini* Schm.

camerunensis, Clovia, Schmidt, 1922b: 176.

1 ♀ Syntype - (1) Kamerun Barombi Conradt (2) (pink label) Typus (3) *Clovia camerunensis* Schmidt ♀ Edm. Schmidt determ. 1921 (4) (black-bordered red label) *Clovia camerunensis* Schm.

The male syntypes of this species are in the IZPAS.

cochleatum, Ectemnonotum, Schmidt, 1909c: 318.

1 ♀ Syntype - (1) Sumatra, Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *Ectemnonotum cochleatum* Schmidt ♀ Edm. Schmidt determ. 1909 (4) (black-bordered red label) *Ectemnonotum cochleatum* Schm.

The male syntypes of this species are in the IZPAS.

dohrni, Ectemnonotum, Schmidt, 1909c: 304.

Lectotype ♂ - (1) Soekaranda Januar 1894 Dohrn (2) (pink label) Type (3) *Ectemnonotum dohrni* Schmidt ♂ Edm. Schmidt 1909 (4) (black-bordered red label) *Ectemnonotum dohrni* Schm.

excellens, Ectemnonotum, Schmidt, 1909c: 311.

1 ♀ Syntype - (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *Ectemnonotum exellus* [sic] Schmidt ♀ Edm. Schmidt determ. 1909 (4) (black-bordered red label) *Ectemnonotum excellens* Schm.

The male syntypes of this species are in the IZPAS.

flavipes, Eoscarta, Schmidt, 1925b: 40.

Lectotype ♂ - (1) Sandakan Borneo Baker (2) (pink label) Cotypus (3) *Eoscarta flavipes* Schmidt ♂ Edm. Schmidt determ. 1923 (4) (black-bordered red label) *Eoscarta flavipes* Schm.

Paralectotype ♂ - (1) Sandakan Borneo Baker (2) 17884 (3) (pink label) Cotypus (4) *Eoscarta flavipes* Schmidt ♂ Edm. Schmidt determ. 1923.

flaviscutellata, Clovia, Schmidt, 1922a: 4. Here transferred to *Liorhina* Stål, **New Combination.**

Lectotype ♀ - (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Typus (3) *Clovia flaviscutellata* Schmidt ♀ Edm. Schmidt determ. 1921 (4) (black-bordered red label) *Clovia flaviscutellata* Schm.

formosula, Leptataspis, Schmidt, 1911: 98.

Lectotype ♂ - (1) Soekaranda Januar 1894 Dohrn (2) (pink label) Type (3) *Leptataspis formosula* Schmidt ♂ Edm. Schmidt determ. 1910 (4) (black-bordered red label) *Leptataspis formosula* Schm.

fornax, Leptataspis, Schmidt, 1911: 96.

Lectotype ♂ – (1) New Guinea (2) (pink label) Type (3) *Leptataspis fornax* Schmidt ♂ Edm. Schmidt determ. 1910 (4) (black-bordered red label) *Leptataspis fornax* Schm.

fruhstorferi, Leptataspis, Schmidt, 1927: 10.

1 ♀ Syntype – (1) Tonkin, Than-Moi, Juni-Juli, H. Fruhstorfer (2) (pink label) Typus (3) *Leptataspis fruhstorferi* Schmidt ♀ Edm. Schmidt determ. 1923 (4) (black-bordered red label) *Leptataspis fruhstorferi* Schm.

The male syntypes of this species are in the IZPAS.

haglundi, Literna, Schmidt, 1920: 107.

1 ♀ Syntype – (1) Kamerun Barombi Conradt (2) (pink label) Type (3) *Literna haglundi* Schmidt ♀ Edm. Schmidt determ. 1920 (4) (black-bordered red label) *Literna haglundi* Schm.

The male syntypes of this species are in the IZPAS.

krügeri, Sialoscarta, Schmidt, 1906: 279; *Colsa krügeri,* Lallemand, 1949: 91, pl. iv, fig. 8. A junior synonym of *Colsa cavata* Walker, 1858: 343, **New Synonymy.**

Lectotype ♂ – (1) Dohrn Sumatra Soekaranda (2) (pink label) Type (3) *Sialoscarta krügeri* Schmidt ♂ Edm. Schmidt determ. 1906 (4) (black-bordered red label) *Sialoscarta krügeri* Schm.

Schmidt's (1906) original spelling *krügeri* is here emended to *kruegeri* (ICZN, Art. 32c), **Emendation.**

This species was erroneously synonymized with *Colsa concinna* (Jacobi) by Lallemand (1912: 121).

lutea, Mioscarta, Schmidt, 1925a: 36.

Lectotype ♀ – (1) Mt Makiling Luzon Baker (2) 21179 (3) (pink label) Cotypus (4)

Mioscarta lutea Schmidt ♀ Edm. Schmidt determ. 1923 (5) (black-bordered red label) *Mioscarta lutea* Schm.

marginalis, Plinia, Schmidt, 1919: 381.

1 ♀ Syntype – (1) Sumatra, Soekaranda, Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Plinia marginalis* Schmidt ♀ Edm. Schmidt determ. 1919 (4) (black-bordered red label) *Plinia marginalis* Schm.

1 ♀ Syntype – (1) Sumatra, Soekaranda, Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Plinia marginalis* Schmidt ♀ Edm. Schmidt determ. 1919.

The male syntypes of this species are in the IZPAS.

marquardti, Clovia, Schmidt, 1924: 289.

1 ♀ Syntype – (1) Cambodja (Friedrich) (2) (pink label) Typus (3) *Clovia marquardti* Schmidt ♀ Edm. Schmidt determ. 1924.

The male syntypes of this species are in the IZPAS. Lallemand (1940: 146) synonymized this species with *Lallemandia navigans* (Jacobi).

nox, Clovia, Schmidt, 1922a: 1.

Lectotype ♂ – (1) Sumatra Soekaranda Dr. H. Dohrn. S. (2) (pink label) Typus (3) *Clovia nox* Schmidt ♂ Edm. Schmidt determ. 1921 (4) (black-bordered red label) *Clovia nox* Schm.

penskyi, Clovia, Schmidt, 1922a: 5.

1 ♀ Syntype – (1) Sumatra Soekaranda Dr. H. Dohrn. S. (2) (pink label) Typus (3) *Clovia penskyi* Schmidt ♀ Edm. Schmidt determ. 1921 (4) (black-bordered red label) *Clovia penskyi* Schm.

The male syntypes of this species are in the IZPAS.

pulchra, Clovia, Schmidt, 1922a: 3. Here transferred to *Liorhina* Stål, **New Combination.**

Lectotype ♂ – (1) SUMATRA SI-RAMBE XII.90-III.91 E. MODIGLIANI (2) (pink label) Typus (3) *Clovia pulchra* Schmidt ♂ Edm. Schmidt determ. 1921 (4) (black-bordered red label) *Clovia pulchra* Schm.

punctipennis, Plinia, Schmidt, 1919: 380.

Lectotype ♂ – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Typus (3) *Plinia punctipennis* ♂ Schmidt Edm. Schmidt determ. 1919 (4) (black-bordered red label) *Plinia punctipennis* Schm.

pygmaea, Eoscarta, Schmidt, 1909b: 240.

Lectotype ♀ – (1) Java (2) (pink label) Type (3) *Eoscarta pygmaea* Schmidt ♀ Edm. Schmidt determ. 1908 (4) (black-bordered red label) *Eoscarta pygmaea* Schm.

roseinervis, Eoscarta, Schmidt, 1925b: 39.

Lectotype ♀ – (1) Singapore, Coll. Baker (2) (pink label) Cotypus (3) *Eoscarta roseinervis* Schmidt Edm. Schmidt determ. 1923.

Paralectotype ♀ – (1) Singapore Coll. Baker (2) 17885 (3) (pink label) Cotypus (4) *Eoscarta roseinervis* Schmidt ♀ Edm. Schmidt determ. 1923.

rugosum, Ectemnonotum, Schmidt, 1909c: 313.

1 ♀ Syntype – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *Ectemnonotum rugosum* Schmidt ♀ Edm. Schmidt determ. 1909 (4) (black-bordered red label) *Ectemnonotum rugosum* Schm.

The male syntypes of this species are in the IZPAS.

similis, Clovia, Schmidt, 1922a: 12. Here transferred to *Liorhina* Stål, **New Combination.**

1 ♀ Syntype – (1) Java K. Fruhstorfer S. (2) (pink label) Typus (3) *Clovia similis* Schmidt ♀ Edm. Schmidt determ. 1921 (4) (black-bordered red label) *Clovia similis* Schm.

The male syntypes of this species are in the IZPAS.

taeniaticollis, Clovia, Schmidt, 1922a: 13. Here transferred to *Liorhina* Stål, **New Combination.**

Lectotype ♀ – (1) Balabac (2) E. Schmidt (3) (pink label) Typus (4) *Clovia taeniaticollis* Schmidt ♀ Edm. Schmidt determ. 1921 (4) (black-bordered red label) *Clovia taeniaticollis* Schm.

taeniatifrons, Clovia, Schmidt, 1922b: 178.

1 ♀ Syntype – (1) IS. S. THOME Agua-Ize XII.1900, 400-600 m. L. Fea (2) E. Schmidt (3) (pink label) Typus (4) *Clovia taeniatifrons* Schmidt ♀ Edm. Schmidt determ. 1921 (5) (black-bordered red label) *Clovia taeniatifrons* Schm.

The male syntypes of this species are in the IZPAS.

testaceicollis, Leptataspis, Schmidt, 1911: 88.

1 ♀ Syntype – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *Leptataspis testaceicollis* Schmidt ♀ Edm. Schmidt determ. 1910 (4) (black-bordered red label) *Leptataspis testaceicollis* Schm.

The male syntypes of this species are in the IZPAS.

tricolor borneensis, Suracarta, Schmidt, 1909a: 182.

1 ♀ Syntype – (1) Nord-Borneo, Waterstradt (2) (pink label) Type (3) *S. Tricolor* [sic] subsp. *borneensis* Schmidt ♀ Edm. Schmidt determ. 1907 (4) (black-bordered red label) *Suracarta tricolor* subsp. *borneensis* Schm.

The male syntypes of this species are in the IZPAS.

tricolor rubroplagiata, Suracarta, Schmidt, 1909a: 177.

Lectotype ♂ – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *S. tricolor* subsp. *rubroplagiata* Schmidt ♂ Edm. Schmidt determ. 1907.

Paralectotype ♀ – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *S. tricolor* subsp. *rubroplagiata* Schmidt ♀ Edm. Schmidt determ. 1907 (4) (black-bordered red label) *Suracarta tricolor rubroplagiata* Schm.

Paralectotype ♀ – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *S. tri. rubroplagiata* var. *punctata* Schmidt ♀ Edm. Schmidt determ. 1907.

Paralectotype ♀ – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *S. tri. rubroplagiata* var. 2 *punctata* ♀ Edm. Schmidt determ. 1907.

Paralectotype ♀ – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *S. tri. rubroplagiata* var. 3 *punctata* ♀ Edm. Schmidt determ. 1907.

trimaculata, Considia, Schmidt, 1909b: 239.

1 ♀ Syntype – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Type (3) *Considia trimaculata* Schmidt ♀ Edm. Schmidt determ. 1908 (4) (black-bordered red label) *Considia trimaculata* Schm.

The male syntypes of this species are in the IZPAS.

The following six specimens (representing three Schmidt species) labeled "cotypus" in the USNM are not designated as part of the type series, because the 1923 date on their determination labels suggests that Schmidt did not have these specimens when he described these species in 1911.

costalis, Leptataspis, Schmidt, 1911: 91.

1 ♂ "Cotype" – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Leptataspis costalis* Schmidt ♂ Edm. Schmidt determ. 1923 (4) (black-bordered red label) *Leptataspis costalis* Schm.

1 ♀ "Cotype" – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Leptataspis costalis* Schmidt ♀ Edm. Schmidt determ. 1923.

similis, Leptataspis, Schmidt, 1911: 87.

1 ♂ "Cotype" – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Leptataspis similis* Schmidt ♂ Edm. Schmidt determ. 1923 (4) (black-bordered red label) *Leptataspis similis* Schm.

1 ♀ "Cotype" – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Leptataspis similis* Schmidt ♀ Edm. Schmidt determ. 1923.

sumatrana, Leptataspis, Schmidt, 1911: 85.

1 ♂ "Cotype" – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Leptataspis sumatrensis* [sic] Schmidt ♂ Edm. Schmidt determ. 1923 (4) (black-bordered red label) *Leptataspis sumatrensis* [sic] Schm.

1 ♀ "Cotype" – (1) Sumatra Soekaranda Dr. H. Dohrn S. (2) (pink label) Cotypus (3) *Leptataspis sumatrensis* [sic] Schmidt ♀ Edm. Schmidt determ. 1923.

ACKNOWLEDGMENTS

I am grateful to Richard C. Froeschner and Thomas J. Henry for their kind assistance during my visit to the National Museum of Natural History, Washington, D.C. I thank Lee Herman and Randall T. Schuh of the Department of Entomology, American Museum of Natural History, New York, for several useful discussions during the preparation of this work. I also thank Howard P. Boyd, Lewis L. Deitz, Richard C. Froeschner, Lee Herman and M. W. Nielson for reading the manuscript and for their valuable comments in improving the contents of the paper. Support for this research was provided by a President Research Fellowship from the Academia Sinica. My travel to the USNM was funded by the Theodore Roosevelt Memorial Fund, Postdoctoral Fellowship Program, American Museum of Natural History, New York.

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DROSOPHILA CELLS IN CULTURE. 1997. G. Echalier. Academic Press. 702 pp. Hard $135.00.

This volume summarizes some thirty years of experience in the handling of *in vitro* cultured cells of *Drosophila* cells. Its main emphasis is on gene transfer methodology, cell responses to heat shock, hormonal regulation of genes, and on the expression and mobility of transposable elements.

THE EVOLUTION OF SOCIAL BEHAVIOR IN INSECTS AND ARACHNIDS. 1997. J.C. Choe & B.J. Crespi. eds. Cambridge University Press. 541 pp. Hard $105.00, Ppbk. $47.95.

The purpose of this book is to explore the causes of the diversity of animal social systems from the viewpoint of behavioral ecology as well as the causes of the transitions between cooperation and competition, commensalism, or parasitism. In a series of twenty-four discourses, the many contributors seek to explain under what conditions such behavior as parental care, alloparental care, and other forms of altruism among adults have evolved from the individually selfish life histories so common in animals, and how such behavior, once evolved, can be lost.

AMBLYCERUS SCHWARZI (COLEOPTERA: BRUCHIDAE) ATTACKING THE SEEDS OF THE TROPICAL-ALMOND TERMINALIA (COMBRETACEAE) IN CUBA

Julio Genaro[1], John M. Kingsolver[2]

ABSTRACT: A bruchid beetle, *Amblycerus schwarzi,* described in 1970 from the West Indies, is recorded for the first time in *Terminalia catappa,* a new host and host family for the species.

The tropical-almond terminalia, *Terminalia catappa* L. (almendro de la India) (Combretaceae), is indigenous to the Old World tropics and is cultivated as an ornamental in Cuba (Sauget and Liogier, 1953). The fruit is edible and the seed contains a valuable oil, not unlike that of the true almond, *Prunus dulcis* (Miller) Webb. The bruchid, *Amblycerus schwarzi* Kingsolver, has a wide distribution in the West Indies (Kingsolver, 1970). Bruner *et al.* (1975) listed insects that affect the plant in Cuba but do not mention any that feed upon the fruits. Martorell (1964) listed only a scolytid beetle infesting seeds of tropical-almond in Puerto Rico. Kingsolver (1970) listed for *A. schwarzi* three host plants. These belong to two plant families: *Hippomane mancinella* L. and *Ricinis communis* L. (Euphorbiaceae) and *Tectona grandis* L. (Verbenaceae).

The purpose of this paper is to cite a new host plant record for *A. schwarzi* and to illustrate the damage to fruits of *T. catappa* caused by the larvae of the beetle.

Observations were made in June of 1994, June and December of 1995, and January of 1996 on 37 trees of tropical-almond terminalia at Brisas del Mar and La Veneciana, Guanabo, at the north coast of Havana City, Cuba. Dry fruits were gathered from beneath the trees and placed in bags for transport and later study. Diameters of beetle emergence holes were measured, and dry fruits without signs of infestation were kept to await adult emergence. Beetles were identified by the junior author (JMK).

Beetles affected the dry fruits. The larvae feed in the seed without completely consuming it, then cut a hole in the seed wall. Larvae pupate inside the seed and adults emerge through the hole. Emergence holes of beetles in dry fruits (Fig. 1) that remained on the ground provided entry of other invertebrate species (i.e. Dermaptera, Coleoptera, Araneae) that used the cavities as refugia or as feeding places. From 1 to 5 beetles ($x = 1.8$, $SD = 1.0$, $N = 70$) emerged

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[1] Museo Nacional de Historia Natural, Obispo #61, esquina officios, Plaza de Armas, Habana Vieja 10100, Cuba.

[2] Florida State Collection of Arthropods, P.O. Box 147100, Gainesville, FL 32614-7100 USA.

ENT. NEWS 108(3): 229-230, May & June, 1997

from each fruit. Average diameter of emergence holes was 2.6 mm (SD-0.4, range: 2.0-3.5 mm, N = 44).

A microlepidopteran *Blastobasis* (probably a new species) (Blastobasidae), identified by David Adamski (Smithsonian Institution, Washington, D.C., also emerged from the fruits after the larva had partly consumed the seed. Its cocoon was spun inside the cavity. Martorell (1964) cited moths of the families Olethreutidae and Pyralidae feeding in the fruits of *T. catappa* in Puerto Rico.

Voucher specimens are deposited in the Museo Nacional de Historia Natural de Cuba, Florida State Collection of Arthropods, Gainesville (beetles), and the Smithsonian Institution (moths).

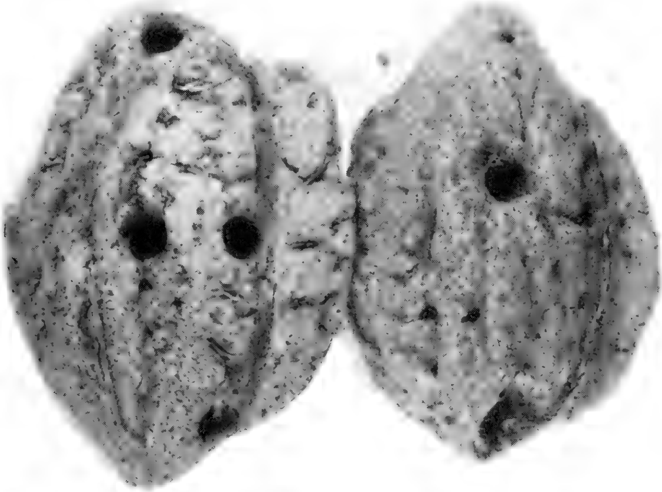

Fig. 1. Dry fruits of tropical-almond terminalia showing the emergence holes of *Amblycerus schwarzi.*

ACKNOWLEDGMENTS

The first author thanks the RARE Center for Tropical Conservation, Philadelphia, Pennsylvania for generously providing financial support during a visit to several museums in the United States.

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SEASONAL DISTRIBUTION OF EMBOLEMIDAE (HYMENOPTERA) IN CENTRAL AND NORTHERN ARKANSAS[1]

C. N. Lewis, J. B. Whitfield[2]

ABSTRACT: The seasonal distribution of the two eastern U. S. species of embolemid wasps *(Ampulicomorpha confusa* and *Embolemus nearcticus)* in the Ouachita Mountains and Ozark Plateau of central and northern Arkansas is estimated from Malaise trap collections at 12 sites. In this limited study *A. confusa* appeared early in the season, whereas *E. nearcticus* was active during most of the summer season. Discontinuous morphological variation among the sampled male individuals of *Embolemus* was evident, possibly indicating the presence of undiagnosed species.

Wasps of the family Embolemidae are seldom encountered by collectors despite their widespread distribution in North America and many other parts of the world. About 10 species are known in 2 genera (Finnamore and Brothers, 1993); in eastern North America two species are currently recorded, *Ampulicomorpha confusa* Ashmead and *Embolemus nearcticus* (Brues) (Krombein, 1979). Although little is known of the biology of embolemids, the species in both genera possibly are external parasitoids of homopterans. *Ampulicomorpha confusa* has been reared from fulgoroid nymphs living under bark in North America (Bridwell, 1958; Krombein, 1979; Wharton, 1989). Otherwise, the only available information is that wingless females of other species have been reported to have been recovered from ant nests (Donisthorpe, 1927) and mammal burrows (Heim de Balsac, 1935) in Europe.

Malaise trap surveys for braconid wasp diversity in the pine-hardwood forests of the Ouachita Highlands (Ouachita National Forest) by C. N. Lewis (CNL), Malaise collecting in the same areas to test trapping efficiencies by C. E. Carlton (CEC; LSU, Baton Rouge, LA), and Malaise trapping to monitor parasitoids in the oak-hickory woodlands of the southern Ozark Plateau by J. B. Whitfield (JBW) incidentally yielded 81 embolemid wasps spanning a variety of localities and dates. Below we summarize observations we made on species identity and seasonal distributions in the two sampled mountain regions.

MATERIALS AND METHODS

In 1993, CEC ran 8 Malaise traps in 4 locations in the Ouachita Highlands

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[1] Received July 29, 1996, Accepted January 31, 1997.

[2] Department of Entomology, University of Arkansas, Fayetteville, AR 72701.

Figure 1. Two individuals of *Embolemus nearcticus* from a single trap sample, showing a large male and a moderately small one (the smallest were about half the size of the smaller one shown here).

of west central Arkansas as part of a testing program for arthropod sampling techniques. During the same year, JBW ran one Malaise trap in a mostly second-growth oak-hickory forest in the Ozark Plateau near the summit of Mt. Sequoyah on the east side of Fayetteville, Washington County, Arkansas, as a part of a sampling regime for oak herbivores and their parasitoids. The following year, CNL collected insects with Malaise traps in 9 locations (7 of which yielded embolemids) in the Ouachita National Forest as part of a braconid diversity assessment of mixed pine-hardwood forests that have been managed with several different timber harvest strategies by the U. S. Forest Service. The embolemids that were incidentally collected in these studies provide us with some seasonal and distributional information on the genera.

Collection sites. ARKANSAS: Montgomery Co., a pooled sample of locations near Mt. Ida (CEC collector). **Montgomery Co.,** (1) Womble 1658, NW Mt. Ida; (2) Womble 1651, 9 km SW Mt. Ida; (3) Caddo 23, Walsh off FS 471; (4) Oden 1119, Hwy 270 at CR 527; in **Scott Co.,** (5) Poteau 1284, S. Parks off CR 19; and in **Yell Co.,** (6) Jessieville 605, 3 km NE Aly off W 36900 and (7) Cold Springs 284, 6 km NE Blue Ball off FR 3070 (CNL collector). **Washington Co.,** Mt. Sequoyah, E. Fayetteville (JBW collector).

Townes style (Townes, 1972) Malaise traps manufactured by Golden Owl Publishers, Lexington Park, MD, were used in all 3 studies. JBW and CEC harvested their traps at weekly intervals, while CNL harvested her 9 traps for one synchronized week each month from late May to late August 1994. All samples were collected in 95% ethanol; no attractants were used in the traps.

Trap samples were brought to the laboratory and identified initially to hymenopteran family. Embolemids were determined by referring to the keys and descriptions of Ashmead (1893), Finnamore and Brothers (1993), Reid (1941), Richards (1939) and Wharton (1989).

RESULTS

A total of 81 male embolemids were sampled in the trapping regimes outlined above. No females were collected; in many species, females are wingless and not often sampled in Malaise traps. One specimen, collected the week of 5 May 1993 at Mt. Sequoyah, Washington County (the Ozark site) was *Ampulicomorpha confusa* Ashmead; all others apparently were *Embolemus nearcticus* (Brues) although they showed marked size differences (see below). Table 1 summarizes the catches by month through the trapping season. The single individual of *A. confusa* appeared earlier in the season than any sampled

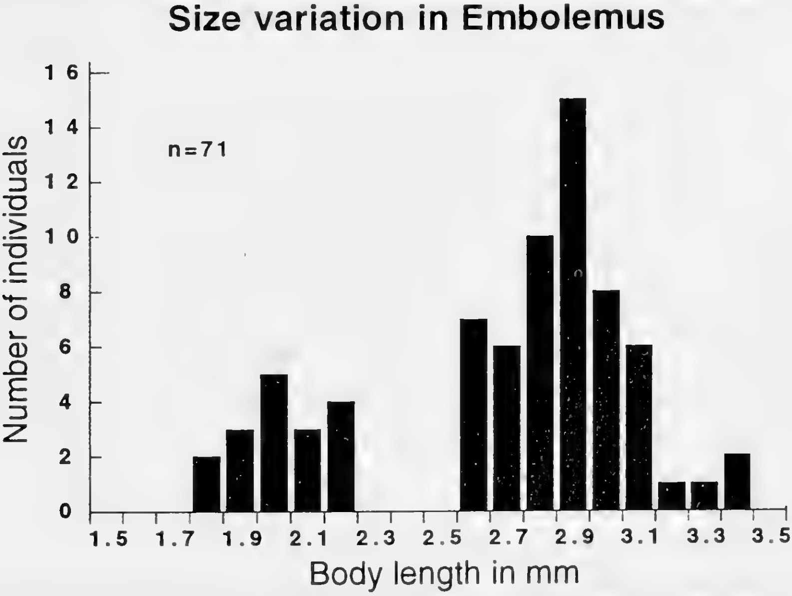

Figure 2. Bimodal distribution of body size in *Embolemus* males collected in the traps. The larger "morph" also showed discontinuous variation in antennal form and eye size (see test).

specimens of *E. nearcticus.* In addition, the more southerly Ouachita Highlands traps recovered *E. nearcticus* earlier in the season than the Ozark site. The observed abrupt end to the apparent flight season of *E. nearcticus* at the Ouachita sites is likely an artifact of the late-August final sampling period for the more numerous CNL traps; however, the earlier appearance of this species at those sites is not likely an artifact because all traps at all sites were set up early enough to sample the beginning of the flight season.

Our *Embolemus* (putatively *nearcticus)* collections displayed a diversity of body sizes, color patterns and head morphologies (see Fig. 1 for an example of the size variation). The more easily quantifiable patterns we observed are the following. The distribution of body lengths (range 1.8 to 3.4 mm) among the wasps appears bimodal, suggesting the existence of two "morphs" (Fig. 2). Within the larger "morph," two forms appear to be present: the first with the first flagellomere 1.4 to 1.5x as long as the scape, and with the eye approximately 0.45 to 0.5x the (dorsoventral) height of the head, and the second with the first flagellomere 0.9 to 1.1x as long as the scape, and the eye 0.55 to 0.6x the height of the head. Whether these variants represent the presence of more than one species or represent phenotypic effects due to different hosts is not possible to say at this point. Clearly more host data would be of considerable aid in understanding these wasps.

Table 1. Embolemid collection dates and locations. Seasonal distribution of *Embolemus nearcticus* (Brues) in Arkansas. The Ouachita Highlands totals are pooled from 11 localities; the Ozark totals are from a single locality (see Materials and Methods for localities). All collected individuals were males.

		Location			**Date**			
Collector		**Arkansas**	5-11	6-14	7-14	8-17	9-24	10-2
JBW	(1993)	**Wash. Co.**	1		2		2	1
CEC	(1993)	**Mont. Co.**	14[1]					
CNL	(1994)	**Mont. Co.**						
		(1) Wom 1658		2	2	1		
		(2) Wom 1651		5	3	15		
		(3) Caddo 23		1				
		(4) Oden 1119			1			
		Scott Co.						
		(5) Poteau 1284		1	1			
		Yell Co.						
		(6) Jessieville 605		2	4	17		
		(7) Cold Sprs 284		1	4	3		

[1] Collection represents a pooled sample of 4 locations.

DISCUSSION

No definite host records have been reported for *E. nearcticus*. Since previous records of embolemids are from homopterans living under bark of pines and oaks or from ant nests or mammal burrows, it may be that the hosts of *E. nearcticus* are similarly cryptically located.

Embolemus appeared in our samples later in the season than the *Ampulicomorpha* individual. Since only a single specimen of *A. confusa* was collected, the temporal disparity may not be significant. Wharton (1989), however, stated that he has collected *A. confusa* from April through June in central Texas, whereas in the same traps *Embolemus* appeared from May to October; thus, a later but overlapping flight season for *Embolemus* seems best supported by the available evidence.

ACKNOWLEDGMENTS

We would like to thank C. E. Carlton, Louisiana State University, Baton Rouge, LA for allowing us to use insects he collected while evaluating arthropod sampling techniques. We very much appreciate site maps of the Ouachita/Ozark National Forest provided by the USDA Forest Service, Southern Forest Experiment Station, Monticello, AR, with special thanks to James B. Baker. T. J. Kring and D. C. Steinkraus, as well as two anonymous reviewers, provided useful comments on an earlier draft of this manuscript. This study was funded by the Department of Entomology of the University of Arkansas at Fayetteville.

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ERGATANDROMORPHISM IN *ODONTOMACHUS CLARUS* (HYMENOPTERA: FORMICIDAE)[1]

Juan A. Rodriguez-Garza[2]

ABSTRACT: An ergatandromorph of *Odontomachus clarus* was collected in Villa de Arriaga, San Luis Potosi, Mexico. The specimen is predominantly that of a worker, but the head is noticeably male on the right half, worker on the left half. Abnormal coloration in abdomen is present.

In ants, as in many other Hymenoptera, all the fertilized eggs become females (both queens and workers) while the unfertilized eggs become males. Gynandromorphism is a phenomenon of genetic origin. Combinations of male and female characteristics may occur laterally & dorso-ventrally, arteroposteriorly or in patches (mosaics). In social insects, the presence of castes provides a terminology based on male and female combinations: a queen-male combination is called a gynandromorph, a soldier-male combination is a dinergatandromorph and a worker-male combination is an ergatandromorph (Donisthorpe 1929, Wheeler 1937); Berndt and Kremer (1982) postulated heat shock as a possible cause of ergatandromorphism.

Aberrant forms of *Odontomachus chelifer* (Latreille) and *O. bauri* Emery {under the name *O. haematodus*) are mentioned by Wheeler (1928) but in both cases their abnormalities were caused by parasites. Therefore, the ergatandromorph briefly described in the next paragraphs is interesting because it is the first example of ergatandromorphism in the genus *Odontomachus*.

The description of the ergatandromorph is based on Brown's diagnosis of the genus (1976) with special emphasis on cranial relief. The queen and workers are superficially similar, 7 mm long, but the queen has the mesosoma larger, thus is easily differentiated. In both castes, the gaster is black and the rest of the body orange reddish without the constriction in the gaster that occurs in most other ponerines.

The sexes differ greatly in head shape. The workers and the queen have a pear-shaped head and large mandibles. The male has weak, small mandibles and the head is more or less rounded. Also, the eyes and antenna are very different in both sexes, principally in the relative length of the scape and in the number of flagellar segments

The specimen described was collected by me in Villa de Arriaga, San Luis Potosi, Mexico, on November 4th, 1984, and stored in 70% ethyl alcohol for

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[1] Received September 28, 1994. Accepted January 13, 1997.

[2] Division de Ciencias e Ingenieria, Universidad de Quintana Roo, 77000, Chetumal, Q. Roo, Mexico.

ENT. NEWS 108(3): 236-238, May & June, 1997

six years. The mouthparts are damaged. It is deposited in the entomological collection of the Colegio de Postgraduados, Montecillos, Mexico.

The specimen is predominantly a worker, with a morphological abnormality in the right half of the head and abnormal coloration in propodeum, petiole and gaster (Fig. 1, B). The head is distorted by the diminution of the right side (Fig. 1, A). Despite this reduction, the specimen still shows the characteristic cranial relief of a worker. The right temporal prominence is well defined, but neither the antennal fossa nor the extraocular depression are well defined, therefore the ocular prominence is not defined. The eye is that of a male and in the ventral part of the ocular area the coloration is black. The antenna is as in males (i.e. it has a short scape, pedicel and an 11-segmented flagellum). The mandible is as in normal males; weak and short, its reduced size allowing us to see the

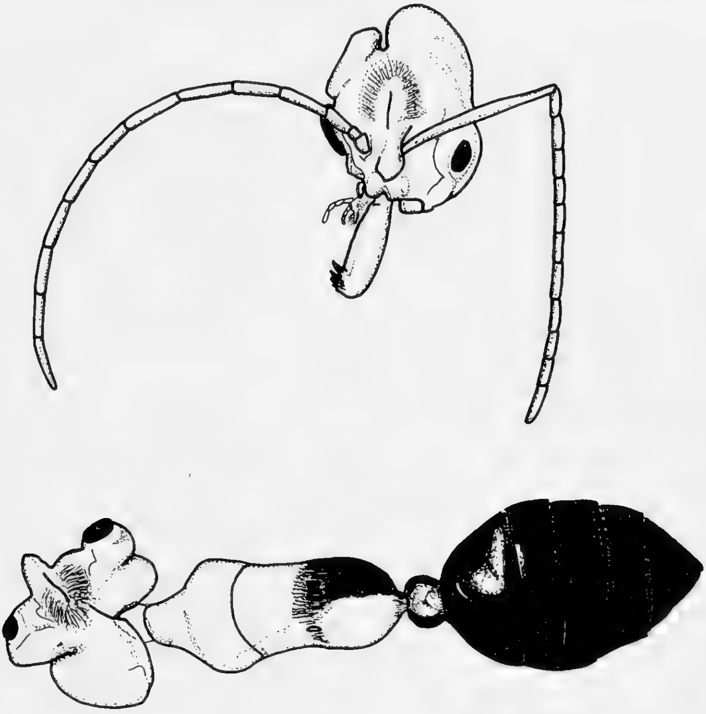

Fig. 1. *Odontomachus clarus*. A – Frontal view of the ergatandromorph head. B – Dorsal view of the ergatandromorph, without appendages.

hypopharaux and right maxilla. On the left side, the eye, antenna and mandible are fairly normal, and the cranial relief is typical of workers of this species.

I did not observe any escape behavior at the moment it was collected, only erratic and slow movements.

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THE BUTTERFLIES OF COSTA RICA AND THEIR NATURAL HISTORY, Vol. II: Riodinidae. 1997. P.J. deVries. Princeton University Press. 288 pp., 25 plates, 59 figs. Cloth $90.00. Ppbk. $29.95.

This 6 x 9" field guide provides the first detailed treatment of over 250 species of Costa Rican butterflies in the family Riodinidae. The taxonomy, distribution, and natural history of each taxon is discussed in detail, plus sections on ecology, evolution, behavior, symbioses with ants, caterpillar acoustical calls, systematics, collecting and preserving, host-plant relationships, and the comparative diversity of riodinid butterfly faunas.

OLFACTION IN MOSQUITO-HOT INTERACTIONS. 1996. Ciba Foundation. John Wiley & Sons. 331 pp. Cloth $84.95.

A compilation of sixteen papers presented at the Symposium on Olfaction in mosquito-host interactions in collaboration with the World Health Organization at the Ciba Foundation, London, 31 Oct. - 2 Nov. 1995.

THE THERMAL WARRIORS. STRATEGIES OF INSECT SURVIVAL. 1996. B. Heinrich. Harvard University Press. 221 pp. Hard $27.00.

For insects, the struggle to keep their body temperatures in a range suitable for activity is a matter of life and death. The ingenious survival strategies that have evolved to control their temperatures is the focus of this book. Heinrich tells of bees that shiver to keep their flight motors warmed up for the next takeoff, grasshoppers that pant, cicadas that "sweat", and numerous other insects with astonishing strategies for survival. Written in the same engaging prose as earlier Heinrich offerings.

ABUNDANCE AND SEASONAL ACTIVITY OF CANTHARIDAE, LAMPYRIDAE AND LYCIDAE (COLEOPTERA) IN A RASPBERRY PLANTATION AND ADJACENT SITES IN SOUTHERN QUÉBEC (CANADA)[1]

Claire Levesque, Gilles-Yvon Levesque[2]

ABSTRACT: A total of 185 Cantharidae (four taxa), 403 Lampyridae (eight species) and only 18 Lycidae (four species) adults were collected with pitfall traps and flight intercept traps during 1987-1989 in a raspberry plantation and adjacent sites in southern Québec. The most common species at the soil surface of the raspberry plantation was *Cantharis rufa*, an adventive species in North America. The most abundant species in flight traps in open sites near raspberry plants were *Cantharis rufa* and *Pyropyga decipiens*. *Ellychnia corrusca* was the most abundant species captured by both methods at the woods-field boundary and in a pine woods. *Cantharis rufa* activity occurred mainly in June during the period of raspberry flowering, and this species probably overwintered as larvae. Adults of *Ellychnia corrusca* were active from May to October. mainly in May-June, and adult overwintering was probable.

Hill (1952) recorded 137 species of insects on cultivated raspberries *(Rubus idaeus* L.) in Scotland, including four Cantharidae species, particularly *Cantharis nigricans* Müller and *Malthinus flaveolus* Paykull. In spite of their abundance, they do not appear to play an important part in the ecology of the plantation. Recently, Gordon and Woodford (1994) reported the first record of damage to raspberry plants by Cantharidae: in May 1991, the stems of expanding fruiting laterals of red raspberry plantations in Scotland were extensively chewed by adults of *Cantharis obscura* L. Adults of *C. obscura* can also damage young tree shoots of *Pinus silvestris* L. in Poland (Chobotow 1993). Nevertheless, adults of many Cantharidae species feed on nectar and pollen, and some *Cantharis* L. and *Podabrus* Westwood species also feed on insect larvae (Andow 1982, Wheeler 1977).

Little is known about the biology of adult Cantharidae, Lampyridae and Lycidae within raspberry plantations and other small fruit crops in North America. Over a three-year period (1987-1989), we collected these three families in a raspberry plantation and adjacent sites in southern Québec. We now present results on the abundance and seasonal activity of adult Cantharidae, Lampyridae and Lycidae.

MATERIALS AND METHODS

The beetles were collected from early May through late October during a

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[1] Received September 3, 1996. Accepted December 3, 1996.

[2] 291 rue des Diamants, Fleurimont, Québec, Canada J1G 4A1.

three-year period, in a monocultural raspberry farm at Johnville (45°26'N, 71°41'W, about 240 m a.s.l.), near Sherbrooke, in southern Québec, Canada. We sampled from the Boyne cultivar in this conventionally cultivated plantation (about 7 ha, on sandy soil). Levesque and Levesque (1992) presented detailed information about the study sites, including a sketch-map of the raspberry farm.

The ground surface-active beetles were caught with pitfall traps in the following sites: (1) a raspberry row planted in 1978 (old plants), (2) a raspberry row planted in 1985 (young plants), (3) a woods-field boundary (boundary), and (4) an adjacent wooded site dominated by eastern white pine, *Pinus strobus* L. (pine woods). Pitfall traps consisted of glass jam jars (450 ml, 6.5 cm diameter at the top) partially filled with 100 ml of 4% formalin. In the plantation (sites 1 and 2), traps were inserted into the soil beneath the canopy as close to the cane of raspberry plants as possible. A plywood cover (20 by 20 cm) was placed 2.5 cm above the trap to avoid flooding the trap, prevent excessive formalin evaporation and capture of flying beetles. In each site, 20 traps were set in a row (5 m apart) and were emptied weekly.

In addition, we studied beetles flying close to the ground with flight intercept traps at four sites: (A) an open site near the center of the plantation, about 20 m from old plants; (B) an open site near a pond, about 5 m from young raspberry plants; (C) a woods-field boundary; and (D) a pine woods. These traps were not located between rows of raspberry plants because of grower's activities and public access during harvest. Flight traps were modified from the large-area "window" trap design promoted by Peck and Davies (1980). Each consisted of a gray 1.5 mm mesh window screen (1.22 m height, 1.52 m width, about 1.85 m^2 of surface) fastened to a wooden frame. The frame itself was suspended by two lateral triangular wooden supports (1.83 m at the base, 1.25 m height), 2-4 cm over a set of two galvanized metal pans (25 by 61 cm at the top, 7.5 cm deep) which were placed directly on the ground. The insects were caught in the pans partially filled with 2% formalin solution into which a few drops of detergent were added. We installed one flight trap in each site; the pine woods trap (D) was only operated in 1988 and 1989. Samples were collected twice a week and were pooled weekly.

In all traps, formalin was used as a killing and preserving agent as well as to prevent escape and predation, in spite of its potential selective effect as repellent or attractant to some beetle species (Adis, 1979).

RESULTS AND DISCUSSION

Abundance of Cantharidae, Lampyridae and Lycidae. We collected a total of 185 Cantharidae (four taxa), 403 Lampyridae (eight species) and 18 Lycidae (four species). Only one captured taxon is known to be an adventive species in North America, *Cantharis rufa* L. (McNamara 1991).

Pitfall trapping resulted in the collection of 63 Cantharidae (two taxa), 140 Lampyridae (four species) and 6 Lycidae (two species) (Table 1). The most common species at the soil surface were *C. rufa* in the raspberry plantation, and *Ellychnia corrusca* (L.) at the woods-field boundary and in the pine woods (Table 1).

Table 1. Total catches of adults in pitfall traps (1987-1989) at Johnville, Québec.

Family and taxon	Old plants	Young plants	Boundary	Pine woods	Total
Cantharidae					
Cantharis rufa L.	13	26	2	0	41
Podabrus spp.	0	0	13	9	22
Lampyridae					
Ellychnia corrusca (L.)	4	1	62	66	133
Pyropyga decipiens (Harris)	0	3	0	0	3
Lucidota atra (Oliv.)	0	1	1	0	2
Photuris pennsylvanica (DeGeer)	0	0	2	0	2
Lycidae					
Celetes basalis LeC.	0	0	1	3	4
Dictyopterus aurora (Herbst)	0	0	0	2	2

Total catches of beetles in flight intercept traps comprised 122 Cantharidae (four taxa), 263 Lampyridae (seven species) and 12 Lycidae (four species) (Table 2). Adults of *C. rufa* and *Pyropyga decipiens* (Harris) flew almost exclusively in the two open sites A and B near raspberry plants, while *E. corrusca* flew mainly at the boundary and in the pine woods.

For the most frequent Cantharidae in Finland meadows, a vegetation with grasses or a small woods bordering at grass-covered surfaces represent the most preferential habitats (Wrede 1963). It is apparently also true for many Cantharidae captured at Johnville.

Ellychnia corrusca is a common woodland species, usually found in shady locations in Ohio and in Ontario (Chénier and Philogène 1989; Marvin 1965), whereas *P. decipiens* is collected in open grassland fields near small streams or ponds in Ohio (Marvin 1965). Our observations on habitat of these two species at Johnville agreed with previous ones.

Adults of Lycidae from Johnville occurred almost exclusively at the boundary and in the pine woods (Tables 1 and 2). *Dictyopterus aurora* (Herbst) was captured only in spring (from May to mid-June).

Chénier and Philogène (1989), capturing beetles in Ontario with traps of three designs, believed that Lampyridae use tree trunks as rest or display sites. In this study, we collected by pitfall traps many adults of two diurnal species,

Table 2. Total catches of adults in flight intercept traps (1987-1989) at Johnville, Québec.

Family and taxon	Open site near center (A)	Open site near pond (B)	Boundary (C)	Pine woods[a] (D)	Total
Cantharidae					
Cantharis rufa L.	56	40	3	0	99
Cantharis spp.	1	5	0	2	8
Podabrus spp.	4	0	6	1	11
Chauliognathus pennsylvanicus (DeGeer)	1	3	0	0	4
Lampyridae					
Ellychnia corrusca (L.)	3	13	131	83	230
Pyropypa decipiens (Harris)	17	7	0	0	24
Lucidota atra (Oliv.)	0	2	1	1	4
Pyractonema linearis LeC.	1	1	0	0	2
Pyractonema angulata (Say)	0	0	1	0	1
Pyractonema borealis (Randall)	0	1	0	0	1
Photinus obscurellus LeC.	0	1	0	0	1
Lycidae					
Dictyopterus aurora (Herbst)	0	0	2	4	6
Celetes basalis LeC.	0	0	1	2	3
Plateros lictor (Newm.)	0	0	1	1	2
Calopteron terminale (Say)	0	1	0	0	1

[a] not sampled in 1987.

C. rufa and *E. corrusca;* both species probably searched for a protective site under the plywood cover placed 2.5 cm above the trap.

Seasonal Activity of Three Abundant Species. Adults of *Cantharis rufa* were caught by pitfall traps from May until July during the three-year study, but mainly in June (Fig. 1). They flew in June-July only and particularly in June. The period of raspberry flowering occurred in June and we observed adults on raspberry flowers in the plantation sporadically. We suggest that, during their mating period, adults of *C. rufa* could play a minor role in raspberry pollinization. The sex ratio for trapped adults of this cantharid varied with the method: 1♀ : 2.2 ♂ in flight traps and 2.4♀ : 1♂ in pitfall traps. We suspect that the epigeal activity of females was linked to an oviposition behavior ensuring an egg shelter against dessication and predators. This species probably overwintered as larvae, such as observed in other cantharids (Aitchison 1979).

We collected adults of *Ellychnia corrusca* in pitfall and flight traps from May through October in the three years (Fig. 1). The first capture peak oc-

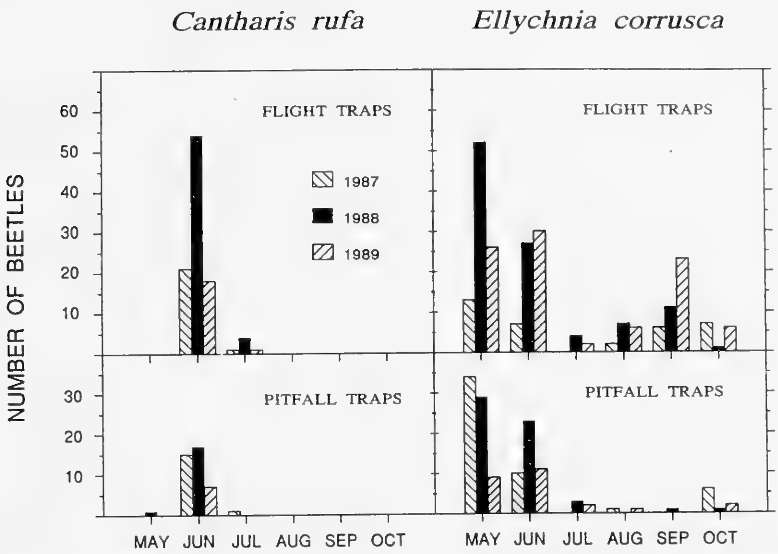

Fig. 1. Seasonal abundance of *Cantharis rufa* and *Ellychnia corrusca* adults in pitfall and flight traps at Johnville, Québec.

curred in May-June and is possibly linked to the activity of overwintering beetles during their mating period. An autumnal second flight activity peak has been observed in September 1989, possibly associated with the new generation dispersal. Females and males were active during the same period and the sex ratio of adults collected by both methods was generally close to one. This species is most abundant in early spring and fall in Ohio (Marvin 1965), and *E. corrusca* adults occur on trunks of trees from April until November in Québec (Chagnon and Robert 1962). Our results agreed with previous observations.

We collected three adults of *Pyropyga decipiens* at the soil surface in the raspberry plantation during July 1988. Adults from Johnville flew from June to August, but mainly in July (18 of 24 catches in flight traps). This lampyrid species was collected from 20 June to 1 August in Ohio (Marvin 1965). This species probably overwintered as larvae.

ACKNOWLEDGMENTS

We appreciate the help of J. McNamara (Centre for Land and Biological Resources Research, Agriculture Canada, Ottawa, Ontario) for identifications and confirmations of species collected in this study. We are grateful to two anonymous reviewers for their comments improving the manuscript. We thank Michel Couture and Lucie Labrecque, owners of "La Framboisière de l'Estrie, enr." at Johnville (Québec). This study was partially supported by the Fonds F. C. A. R. (Québec).

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108 SEPTEMBER & OCTOBER, 1997 U.S. ISSN 0013-872X NO. 4

ENTOMOLOGICAL NEWS

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(Continued on inside of back cover)

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A NEW SPECIES OF *XENOS* FROM ARIZONA, WITH DISCUSSION OF OTHER NORTH AMERICAN SPECIES (STREPSIPTERA: STYLOPIDAE)[1]

Jerry L. Cook[2], Blaine Mathison[3]

ABSTRACT: *Xenos kifunei*, a new species of Strepsiptera in the family Stylopidae, is described from Arizona. During its developmental stages *Xenos kifunei* is a parasite of *Polistes comanchus navajoe*. This becomes the sixth recognized *Xenos* species from North America, all parasites of *Polistes* species. The status of other North American *Xenos* is discussed.

The genus *Xenos* was described by Rossius (1793) and is distinguished from other genera of Stylopidae by several key characters. *Xenos* males have four antennal segments, the last two are flattened and much longer than the first two, and the first radial wing vein is either continuous, or, if broken, with the apical segment in line with the proximal. All North American species have maxillary palps that are shorter than the mandibles. Female *Xenos* have four, or rarely five, genital openings, compared to five in other Stylopidae. Although not a distinguishing character, *Xenos* species have thus far been found only in hosts from the family Vespidae. Prior to this description, there were 37 recognized species, most parasitic on species of *Polistes*. All North American species are parasites of *Polistes*. Valid North American species include *Xenos peckii* Kirby 1813; *Xenos nigrescens* Brues 1903; *Xenos pallidus* Brues 1903; *Xenos hunteri* (Pierce 1909); and *Xenos rubiginosi* (Pierce 1909).

The North American species of *Xenos* were last reviewed by Bohart (1941). In this revision, Bohart synonymized ten species with either *X. pallidus* or *X. peckii* and recognized only these two species as being valid and distinct. Bohart did not comment on three other named species (*X. nigrescens, X. hunteri,* and *X. rubiginosi),* but instead left their status as questionable. Since Bohart's revision, no new North American species of *Xenos* have been described, nor has any taxonomic work been carried out on this group.

All specimens of the new species of *Xenos* described below were recovered from *Polistes comanchus navajoe* Cresson, collected in Arizona, USA. We examined three females and five males and found them to have characters sufficiently different from other species of *Xenos* to warrant this description. Measurements in this description are presented as a range from these specimens.

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[1] Received March 3, 1997. Accepted March 22, 1997.

[2] Department of Entomology, Texas A & M University, College Station, TX 77843-2475, USA.

[3] Department of Entomology, University of Arizona, Tucson, AZ 85721, USA.

ENT. NEWS 108(4): 245-252, September & October, 1997

Xenos kifunei, Cook and Mathison, NEW SPECIES

(Figures 1 A-C, 2, & 3 A-H)

(all measurements in mm)

Female Description. Cephalothorax dark brown posteriorly. Anterior areas orange-tan (Fig. 1B). First abdominal segment dark brown and tan. Remaining abdominal segments tan with a somewhat darker dorsal region (Fig. 1A). There is some variation in coloration between specimens, some are much darker than others but the pattern of coloration is consistent in all specimens. Total body length 6.38 to 7.40. Greatest body width, measured across the abdomen, 1.90 to 2.13. Cephalothorax length 1.22 to 1.24; its greatest width (behind the first abdominal spiracles) 1.35 to 1.43. Width at first abdominal spiracles 1.24 to 1.32. First abdominal spiracle lateral and somewhat ventral. Distance between mandibles 0.23 to 0.24. Mandibles shaped as in figure 1C.

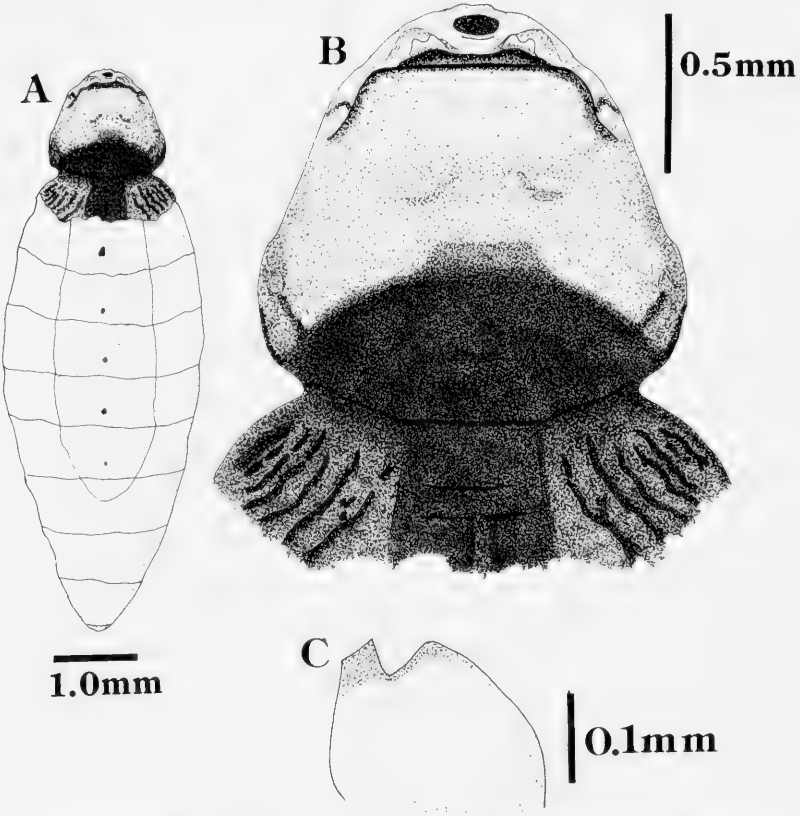

Fig. 1A-C. *Xenos kifunei*, NEW SPECIES, adult female. A. dorsal habitus. B. dorsal cephalothorax and part of first abdominal segment. C. Right mandible.

Abdomen with one genital opening on each of segments II-V, and one specimen has a very small genital opening on abdominal segment VI.

Male description. Body coloration brown, ranging from almost black to light tan or yellow. Total body length 3.14 to 3.53. Head somewhat dumb bell-shaped, with large, dark eyes (Fig. 2). Antennae (Fig. 3A) typical of *Xenos;* third and fourth segments approximately the same size and covered with numerous sensory cups, the latter absent from segments I and II. Antennal segment lengths; I = 0.10, II = 0.06, III = 0.87, and IV = 0.83. Vertex of head pointed, triangular. Mandibles and maxillae shaped as in Fig. 3F. Mandibles crossing in front of mouth, yellow, clear, length 0.26 to 0.30. Maxillae and palps yellow to light brown, combined length 0.21 to 0.25. Legs yellow ventrally, light brown dorsally. Tarsal segment I on prothoracic leg with one large sensory cup on its ventral surface. Femur of metatarsal leg somewhat bowed. Shapes of leg segments as in Fig. 3B, 3C, and 3D. Prothoracic leg measurements; coxa = 0.33 0.34, trochantofemur = 0.40-0.44, tibia = 0.43-0.47, tarsi: I = 0.22-0.23, II = 0.17-0.19, III = 0.11-0.14, IV = 0.15-0.21. Mesothoracic leg measurements; coxa = 0.39. trochantofemur = 0.56-0.58, tibia = 0.48-0.52, tarsi: I = 0.18-0.19, II = 0.12-0.14, III = 0.10, IV = 0.14-0.17. Metathoracic leg measurements; trochanter = 0.21-0.25, femur = 0.52-0.55, tibia = 0.41-0.47, tarsi I = 0.17-0.19, II = 0.1-0.16, III = 0.11-0.14, IV 0.14-0.19. Fore wing club-shaped with one vein (R) to half its length, total wing length 0.33-0.55. Hind wing (Fig. 3E) clear, except for shaded area between Sc

Fig. 2. *Xenos kifunei,* NEW SPECIES, male habitus.

and R veins. Sc vein heavy, reaching half-way to wing margin; R_1 and R_2 divided by gap half as long as R_1; R_1 and R_2 appear to be in line, R_1 is proximal, R_2 is distal; R_2 three times length of R_1; R_3 slightly longer than R_2; R_4 five times as long as R_5; MA = CuA_1 = CuA_2; CuP heavy; no veins reach wing margin. Thoracic segments as in Fig. 2. Abdomen brown, slender. Abdominal segment X dark brown, triangular in dorsal view (Fig. 2). Dorsal abdominal segment IX triangular (Fig. 2), prescutum shape distinctive, shaped as in Fig. 2. Aedeagus (Fig. 3G) clear-yellow, bowed with sharp dorsal projection, no ventral projection or basal hump, thickest in middle of shaft, length 0.25-0.28. One male cephalotheca of puparium was observed (Fig. 3H). Cephalotheca dark brown, total size = 1.23 *X.* 0.56, distance between maxillae = 0.12, distance between mandibles = 0.20, distance between antennae = 0.51.

Triungulin larvae. unknown.

Holotype. Female, in alcohol; Catalina Mountains, Pima County, Arizona; June 11 1965; collected by F. Werner, the host is *Polistes comanchus navajoe* Cresson. Deposited in the United States National Museum.

Allotype. Male, in alcohol, Sycamore Canyon, T 105, R 13, Pima Co., Arizona, June 24, 1961, collected for the Arizona Survey, the host is *Polistes comanchus navajoe.* Deposited in the United States National Museum.

Paratypes. Host of all paratypes is *Polistes comanchus navajoe.* One female, pinned; Molino Canyon in the Catalina Mountains, Pima County, Arizona, October 16, 1994, collected by Blaine Mathison, deposited in the University of Arizona Insect Collection (UAIC). One male, in alcohol, Sycamore Canyon, T 105, R 13, Pima Co., Arizona, June 24, 1961, collected for the Arizona Survey, deposited in UAIC. One male, in alcohol, Catalina Mountains, Pima Co., Arizona, Oct. 7, 1984, collected by Olson, in the collection of the senior author (JLC).

Host voucher. A host, *Polistes comanchus navajoe,* is deposited as a voucher specimen at UAIC.

Etymology. This species is named in honor of Teiji Kifune, for his contribution to the study of Strepsiptera, including the descriptions of several species of *Xenos.*

Diagnosis. *Xenos kifunei* most closely resembles the other five North American species. It is distinct from all *Xenos* in the shape of the prescutum (Fig. 2). It differs from all other North American species in having no basal hump on the shaft of the aedeagus (Fig. 3 G).

Xenos kifunei most closely resembles *Xenos peckii.* Females differ in the pigmentation pattern of the cephalothorax. *Xenos kifunei* has a pigmented area that extends slightly anteriorly in the center (Fig. 1). The pigmented area is strongly emarginate in the middle in *X. peckii.* The teeth of the mandible are of about equal length in *X. kifunei,* but the inner tooth of the mandible of *X. peckii* is much longer than the outer tooth. The cephalothorax of *X. kifunei* is more narrowed anteriorly, giving it a somewhat triangular appearance compared to a round-shaped cephalothorax in *X. peckii.* In male *X. kifunei,* the R5 wing vein is much shorter than R4 while *X. peckii* have R4 and R5 veins almost equal in length. Male mandibles of *X. kifunei* are completely clear yellow but they are black at the base in *X. peckii.*

Xenos kifunei differs from *Xenos pallidus* in several characters. Male *X.*

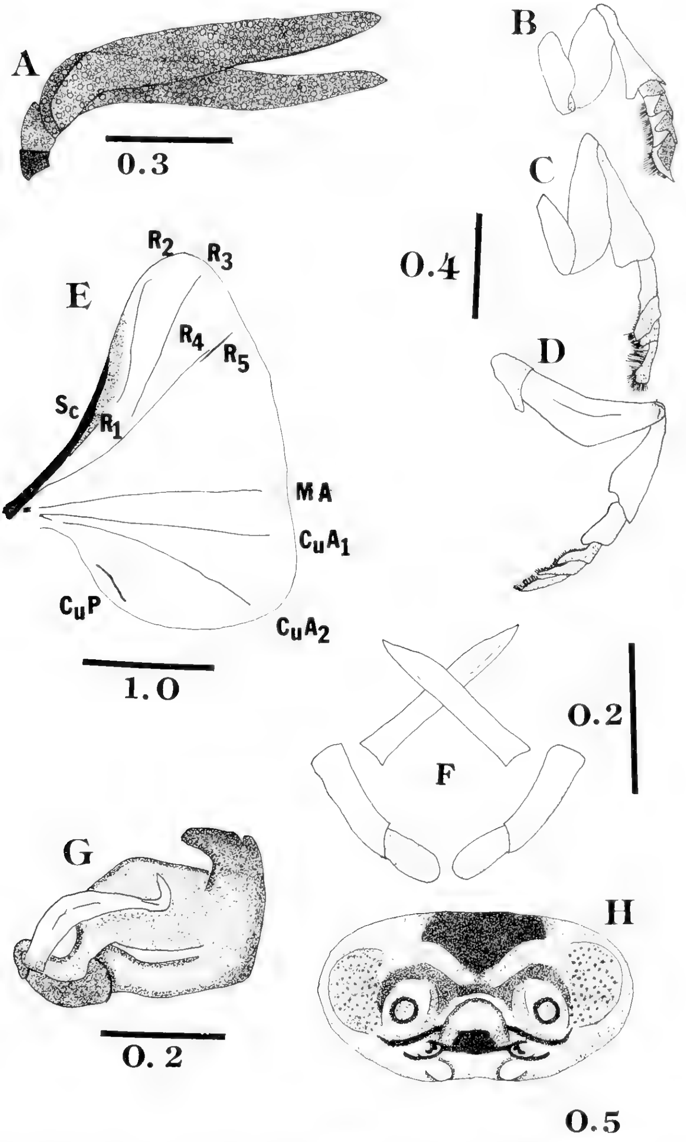

Fig. 3A-M. *Xenos kifunei*, NEW SPECIES, male characters. A. Right antennae. B. Right prothoracic leg. C. Right mesothoracic leg. D. Right metathoracic leg. E. Right hind wing with veins labeled (following designation by Kinzelbach 1972). F. Mandibles, crossing, and maxillae with palps. G. Genital capsule showing aedeagus. H. Cephalotheca of male puparium.

kifunei have a total length of 3.14 to 3.53 mm. compared to 2.25 to 2.75 mm in *X. pallidus.* Lengths of Strepsiptera are quite variable but there is a significant difference between these two species. Hind wing veins are heavy and pigmented in *X. kifunei* but not so in *X. pallidus.* There is a distinct gap in R1 and R2 wing veins in *X. kifunei* but the two appear almost as one vein in *X. pallidus. Xenos kifunei* has a CuP vein about equal to R1 in length, while CuP is much shorter (nearly absent) in *X. pallidus.* The females of these species have minor differences, but no easily recognizable characters to separate them.

Xenos kifunei males are significantly smaller than is recorded for *Xenos nigrescens* (3.14 - 3.53 vs. 4.5 mm) and have clear yellow mandibles compared to those of nigrescens, which are black at the base. Wings of *X. kifunei* have heavy, dark wing veins compared to pale veins with posterior veins obsolete in *X. nigrescens.* Females of *X. kifunei* have a pigmented area that covers less than the posterior half of the cephalothorax and mandibles with both teeth nearly equal in length. *Xenos nigrescens* has a pigmented area covering at least 2/3 of the cephalothorax and the inner tooth of the mandible is much larger than the outer.

In males of *X. kifunei* the palps equal the maxillae in width and the mandibles are nearly straight. In *X. hunteri,* the palps are about half as wide as the maxillae and the mandibles are strongly curved. The cephalothorax of female *X. kifunei is* about as wide as long, with less than the posterior half pigmented. The female cephalothorax of *X. hunteri* is longer than wide, with the posterior 3/4 pigmented.

Only the female of *Xenos rubiginosi* is known. *Xenos kifunei* has a cephalothorax about as wide as long, spiracles lateral and somewhat ventral, and pigmentation covering less than the posterior half. The cephalothorax of *X. rubiginosi* is much longer than wide, has dorsal first abdominal spiracles, and pigmentation covering the posterior 2/3 of the cephalothorax.

DISCUSSION

Xenos kifunei becomes the 38th valid species in this genus and the sixth recognized species in North America. The number of North American species in this genus is likely to change, however. The validity of half the recognized species, *Xenos nigrescens, Xenos hunteri,* and *Xenos rubiginosi,* is in question (Bohart 1941). It is also possible that one or more synonymized species may be valid.

The validity of *X. nigrescens* is uncertain and no type specimens were designated by Brues (1903). Brues gave *Polistes rubiginosus* Lepeletier as the host of *X. nigrescens. Polistes rubiginosus* has since been synonymized with *Polistes carolina* (Linnaeus), which is the host of *Xenos peckii.* The character that best distinguishes between *X. nigrescens* and *X. peckii* is the nature of the wing veins. The wing veins of *X. peckii* are very stout and distinctly darkened, whereas the veins of *X. nigrescens* are weak and barely visible. The female of *X. peckii* has a black pigmented posterior cephalothorax with a strong, square emargination in the center dorsally, while in *X. nigrescens* this pigmented boundary forms a straight line. We have examined three females and one male strepsipteran from *P. carolina* hosts, collected in central Texas, and found them all to closely match the description given by Brues of *X. nigrescens* (type locality, Austin Texas). The specimens we examined were from different locations within the same geographical region as the type locality and we found characters to be consistent among the collections. Our specimens were also collected several years apart. The question remains whether these Texas specimens are a distinct species or a local variation of *X. peckii.* The total number of specimens examined combined with those from Brues' description amounts to five males and four females. Thus, too few are known to make meaningful decisions with such minor differences. However, there is almost no variation in those we have examined.

Xenos hunteri is represented by a female type (USNM cat. no. 10115) and a male description given by Pierce (1909), but has not been reported since. This species was described from an undetermined species of *Polistes,* reported by Pierce to be "near *Polistes minor* Palisot de Beauvois". The type locality was Victoria, Texas. The actual *Polistes* host species that Pierce made this description from is uncertain, but is likely either *Polistes dorsalis dorsalis* (Fabricius) or *Polistes exclamens exclamens* Viereck. The reason for this assumption is that Bequaert (1940) stated that wasps frequently called *P. minor* in the United States are usually *P. fuscatus hunteri* Bequaert (later synonymized with *P. dorsalis dorsalis)* or *P. exclamens.* Both of these species are reported from the type locality of *X. hunteri.* The female type of *X. hunteri* does appear to have characters distinctive from other species of *Xenos,* but with only one specimen available variation is unknown. The male reputedly has characters that differ somewhat from other species of *Xenos,* but reference specimens are unavailable for comparison. There seems to be enough character differences with other *Xenos* to maintain *X. hunteri* as a separate species at this time. Of significant difference are the male mouthparts of *X. hunteri,* whose palp is half as thick as the maxillae, a character found in no other North American *Xenos.*

The status of *X. rubiginosi* is in some doubt. Pierce (1909) listed the host of *X. rubiginosi* as *P. rubiginosus* which has since been synonymized with *P. carolina,* the host of *X. peckii.* However, the description of the shape of the *X. rubiginosi* female cephalothorax appears to be outside the range of *X. peckii.* The uncertainty of species validity occurs because *X. rubiginosi* is known only from the type female (USNM cat. no. 10119). No males have been reported. With both species described from *P. carolina* and only a single specimen of *X. rubiginosi* suggests that this might be an aberrant specimen of either *X. peckii* or *X. nigrescens.* More specimens from *P. carolina* need to be surveyed to determine the status of *X. rubiginosi.*

Another aspect of *Xenos* taxonomy that is in need of review is the synonyms created by Bohart (1941). In some of the synonymized species, Bohart was forced to make decisions using small numbers of specimens. Some of these synonymies are clearly correct, but for some of the species to be synonyms, there would have to be vast character variation within *X. peckii* and *X. pallidus.* There is, without doubt, some range in the characters of these species. With more specimens collected from reported hosts of the synonymized species such as *Polistes apachus* Saussure and *Polistes metricus* Say, one or more of these synonyms may be reinstated as valid species.

ACKNOWLEDGMENTS

We thank David Maddison and Carl Olson, both of the University of Arizona, for allowing us access to these specimens. We thank Roger Gold for providing facilities and support for our study. We thank Teiji Kifune of Fukuoka University, Japan and Robert Wharton of Texas A&M University for their reviews and helpful suggestions in preparing this manuscript. We also thank two anonymous reviewers for their aid in bringing this manuscript to its final form.

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SOCIETY MEETING OF MARCH 2, 1997

Dr. Owain Edwards

USDA-ARS Beneficial Insects Introduction Research Lab, Newark, Delaware

IS ADAPTATION AFTER RELEASE NECESSARY FOR SUCCESSFUL CLASSICAL BIOLOGICAL CONTROL?

Dr. Edwards began by pointing out that, historically, biological control researchers have assumed that natural enemies must adapt after introduction into novel environments. In fact, lack of adaptation is often presented as the reason for failed establishment. If parasitoid populations from diverse environments differ with respect to fitness traits, this would suggest that adaptation would likely be important after release into a novel environment.

(Continued on page 258)

DESCRIPTION OF THE PUPA OF *CYRNELLUS FRATERNUS* (TRICHOPTERA: POLYCENTROPODIDAE), WITH NOTES ON VARIATION IN PUPAL CASE CONSTRUCTION[1]

Zane B. Johnson, James H. Kennedy[2]

ABSTRACT: The pupa of *Cyrnellus fraternus* is described for the first time, from the Elm Fork of the Trinity River, Texas. Study of this species in the Elm Fork has shown two distinct pupal case morphologies. These cases are described from field-collected and reared material.

Banks (1905) originally described *Cyrnellus fraternus* from a single female collected at Plummer's Island, Maryland. *Nyctiophylax marginalis* Banks and *Cyrnellus zernyi* Mosely are considered junior synonyms of this species (Ross 1944; Flint 1964). Complete bibliographic citations for *C. fraternus* can be found in Flint (1971) and Nimmo (1986).

Based on associated material, Ross (1959) included the larva of *Cyrnellus* in his generic key, but no published description of the larva was available until provided by Flint (1964). The pupa and pupal case of *C. fraternus* have remained undescribed.

Cyrnellus fraternus is widespread in the United States, recorded from Nebraska and Texas, east to Florida and New York, and north to Minnesota. It has been recorded from Mexico and the Amazon River Basin in South America (Nimmo 1986). Wiggins and Mackay (1978) categorized *Cyrnellus* as collector-filterers of warm, lotic waters of eastern deciduous forest biomes. Larvae of *C. fraternus,* although usually occurring in large rivers, also live in smaller streams, lakes and reservoirs (Ross 1944; Flint 1964; Wiggins 1996). Sublette (1957) reported collections of the larvae (as *C. marginalis)* from the gravel and sand benthos of Lake Texoma in Oklahoma and Texas. Selwyn Roback observed the larvae inhabiting both rivers and lakes, living on wood and rock and tolerating current regimes from standing to rapidly flowing (Flint 1964). Information on the range of stream orders, stream widths, substratum types and flow permanency of the habitats of *C. fraternus* in the Interior Highlands of North America was provided by Moulton and Stewart (1996).

In this paper we describe the pupa of *C. fraternus* and the variation in structure of the pupal case. Morphological terminology for the pupal description follows that of Resh (1976). Specimens used for descriptions are from field-preserved samples and material reared in 37.85 l aquaria. Material exam-

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[1] Received January 30, 1997. Accepted March 21, 1997.

[2] Department of Biological Sciences, University of North Texas, Denton, Texas 76203.

ined is deposited in the collection of the University of North Texas, and preserved in 70% ethanol.

Cyrnellus fraternus (Banks)

Pupal Description. Length 5-6 mm. Labrum with 2 groups of long anterolateral setae, each with 3 setae (Fig. 1); 2 groups of posterolateral setae, each with 2 long, 1 short setae. Mandibles thin, sickle-shaped, bases stout with 2 short lateral setae (Fig. 2). Paired presegmental plates on III each with 5-6 denticles; IV each with 5-7 denticles; V each with 7 denticles; VI each with 12-13 denticles; VII each with 5-8 denticles; VIII each with 4-6 denticles. Paired postsegmental plates on V each with 10 denticles (Fig. 3). Lateral gills on abdominal segments II-VII; single on II, bifid on III-V, single on VI-VII. Anal rods short and rounded, each with 10-11 setae (Fig. 4).

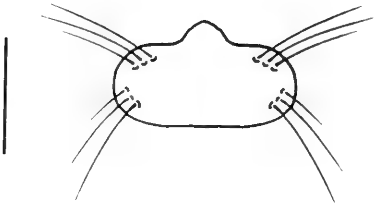
Pupal Case. Length 7.5-9 mm. Cylindrical to ovoid in shape, constructed of sand grains and various-sized detrital particles attached to a silk interior (Figs. 5-6).

Material Examined. U.S.A., Texas, Denton Co., Elm Fork of Trinity River 1 km upstream of bridges at FM 428, ca. 4 mi E Aubrey, 13-vii-1995, Z. B. Johnson and R. E. Cook, 1 pharate male, 2 pupae; same but 10-ix-1995, Z. B. Johnson and J. D. Csekitz, 1 pupa; same but 08-x-1995, Z. B. Johnson and B. T. Hall, 1 pupal case; same but 21-xii-1995, Z. B. Johnson and J. D. Csekitz, 2 cases from reared specimens; same but 26-i-1996, Z. B. Johnson and R. E. Cook, 1 pharate male, reared; same but 31-i-1996, 1 pharate female, reared.

DISCUSSION

Moulton and Stewart (1996) reported *C. fraternus* immatures inhabiting a variety of mineral substrata, ranging from sand/mud to cobbles. In the Elm Fork, *C. fraternus* larvae and pupae were collected from submerged wood, or submerged snags, in an 8 km study area bordered by bottomland hardwood forest and pasture land. Larvae of *C. fraternus* were commonly found on snags with water flow ranging from standing to 0.2 m/s. Larvae were found in their greatest densities on wood covered with dense silt and/or filamentous algae. Roback (in Flint 1964) observed *C. fraternus* larvae on rocks, living under "an amorphous silk mat usually silt covered." Our observations from the Elm Fork support Roback's observations.

Of 7 pupal cases examined from the Elm Fork, 2 basic types with some variation (Figs. 5-7) were constructed by *C. fraternus*. The most common case structure (Fig. 5) consisted of sand and small detrital particles attached to a silken interior. Other materials included fine particulate wood debris and sclerites of other aquatic insect larvae. A variant case that included rock fragments as well as sand, 1 Hydropsychidae lateral head capsule sclerite, 4 pronotal sclerites and additional sclerites from appendages was also observed (Fig. 6). A second case type (Fig. 7) is known from a single field-collected pupa and from cases produced by terminal instar larvae on Elm Fork submerged wood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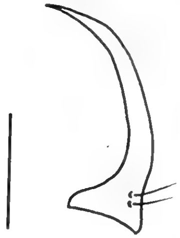
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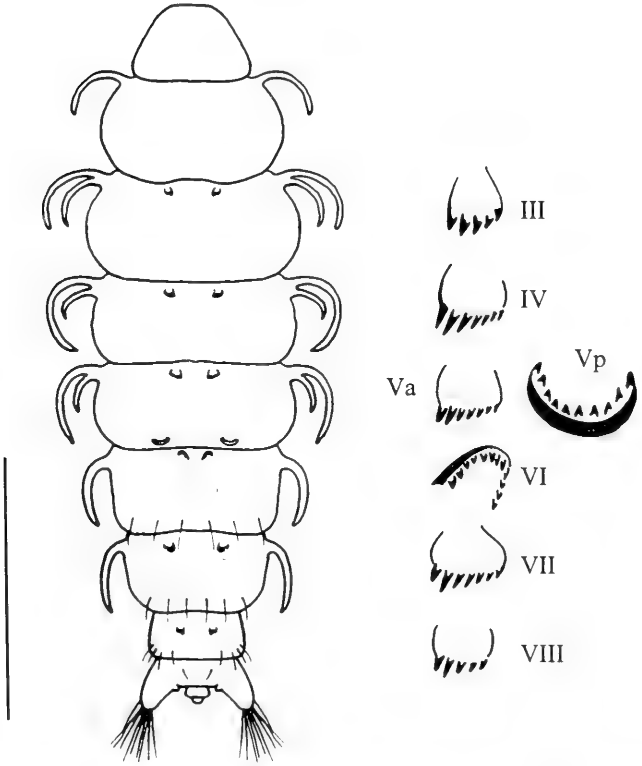

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Figs. 1-3. *Cyrnellus fraternus* pupa. 1. Labrum, dorsal view. Scale bar= 300 µm. 2. Right mandible, dorsal view. Scale bar = 300 µm. 3. Abdomen, dorsal view with inset showing segmental plates with denticles. Scale bar = 1 mm.

in laboratory rearing tanks. This case type had some sand and many various-sized wood particles attached to a silken interior. Wood particles tended to be irregularly placed, except for some elongate twigs located laterally. Cases collected from the sides of rearing aquaria are considered to have been produced under artificial conditions, but the field-collected specimen confirms the diversity of cases constructed by *C. fraternus* under natural conditions. None of the cases studied resemble the silken retreats (illustrated in Wiggins 1996) constructed by the larvae. It is not known if the larval retreat is used in the construction of the pupal case.

Field collections of *Cyrnellus fraternus* pupae were relatively rare in the Elm Fork, even in samples containing numerous 5th instar larvae. One pharate male and 3 pupae were found in preserved submerged wood samples. Surveys of Elm Fork habitats have shown that *C. fraternus* does not inhabit the sand-based benthos (Z. B. Johnson, unpublished data). However, we speculate that the terminal instar larvae leave the snags to pupate. Sand is a main material in pupal case construction, but is not found consistently on submerged wood. Observed variation in case morphology is attributed to availability of building materials.

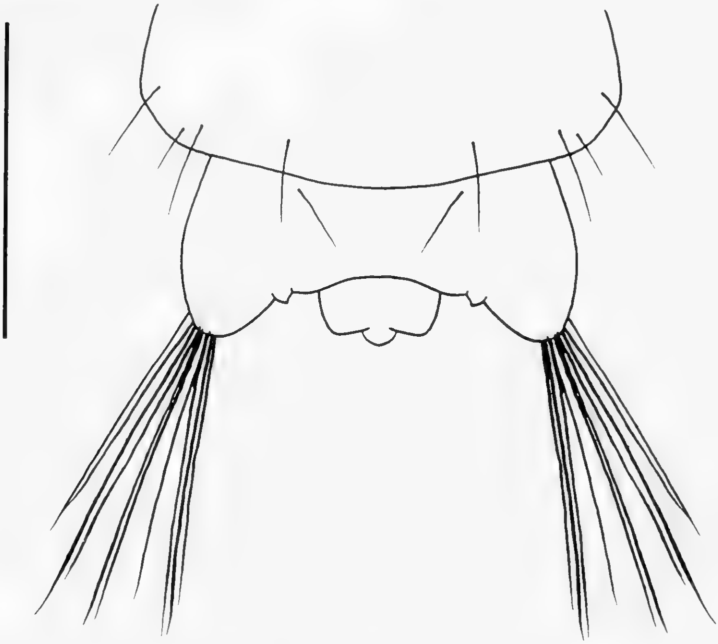

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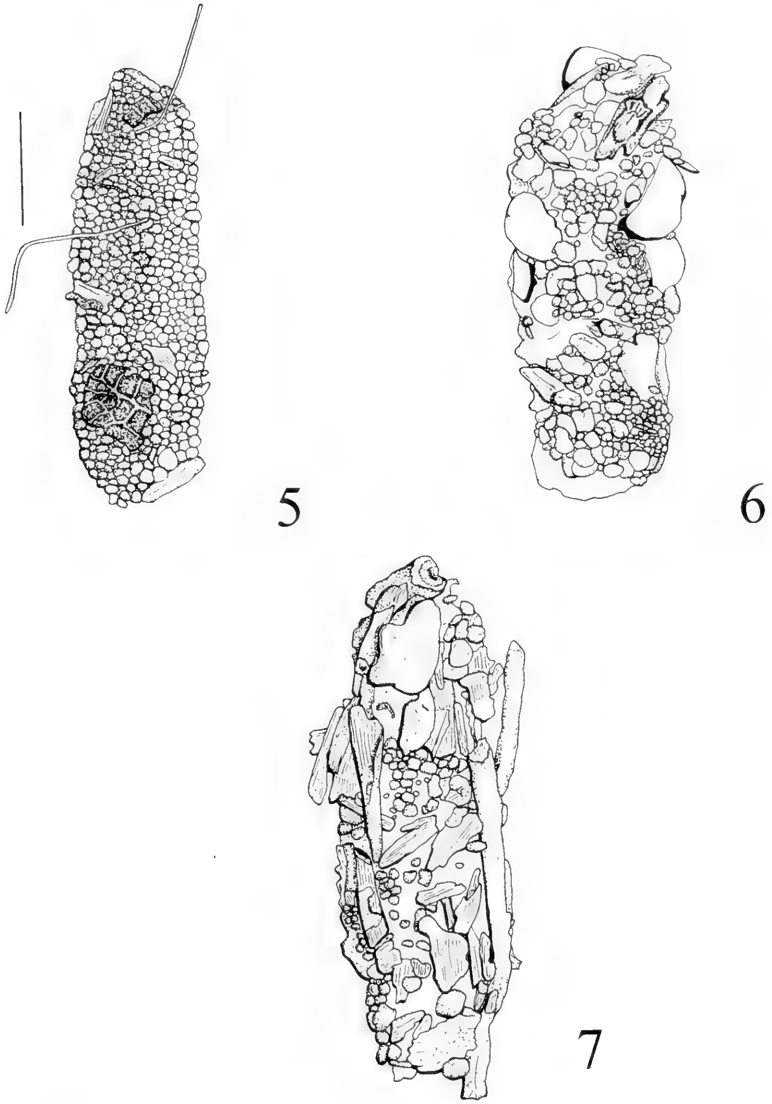
Fig. 4. *Cyrnellus fraternus* pupa anal rods, dorsal view. Scale bar = 300 µm.



Figs. 5-7. *Cyrnellus fraternus* pupal cases. 5. Typical case comprised of sand grains and detritus attached to a silken tube. 6. Case that includes larval sclerites. 7. Variant case predominantly comprised of irregularly-arranged wood particles. Scale bar = 2 mm.

ACKNOWLEDGMENTS

We thank Luciana Nurman for assistance in producing the illustrations used in this paper. We thank Stephen R. Moulton, II and Boris C. Kondratieff for reviewing this manuscript. Suggestions from John C. Abbott and David Houghton improved an early draft of the manuscript. The comments of 2 anonymous reviewers were appreciated.

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(Continued from page 252)

He then described two studies which tested these notions. In the first, populations of the Russian wheat aphid parasitoid *Aphelinus asychis* (Hymenoptera: Aphelinidae) were collected from Antibes and Montpellier in France, Spain, Morocco, Kazakstan, China and Greece. Crosses of these samples indicated that though there were significant levels of variation in fitness within populations, there was not significant variation between populations. This suggests that any of these populations could be introduced to another location without need for adaptation.

The second study concerned the European corn borer parasitoid *Macrocentrus grandii* (Hymenoptera: Braconidae), which was introduced into North America from both France and Korea. Current evidence suggests that the Korean introduction established. An analysis of the environments of Korea and Delaware, which was in the center of the original release area, suggests that the greatest need for adaptation would have been due to climatic differences. Adult *M. grandii* in Delaware would experience extreme temperatures (32-38°C) significantly more often than those in Korea, suggesting that adaptation to high temperatures may have been necessary after release. Laboratory experiments have shown that adult *M. grandii* from Delaware have significantly greater survivorship at 36°C and 38°C than do those from Korea. This suggests that adaptation after release has occurred.

(Continued on page 304)

DESCRIPTION OF MATURE LARVAE OF *MICRODYNERUS EXILIS* AND *M. TIMIDUS* (HYMENOPTERA: VESPIDAE)[1, 2]

J. Tormos, J.D. Asís, S.F. Gayubo, F. Torres[3]

ABSTRACT: The mature larvae (prepupae) of *Microdynerus exilis* and *M. timidus* are described. The number and arrangement of the sensilla and setae on the labrum and the sensilla on the epipharynx are the characters which best provide differentiation of these species from the other previously described from this genus: *M. nugdunensis*.

Current knowledge of the preimaginal states of Eumeninae is very fragmentary. Although the subfamily includes more than 2,500 species (Yamane 1990), the mature larvae of only 39 have been described (important references: Enslin 1921; Janvier 1930; Micheli 1930, 1934; Maneval 1939; Reid 1942; Grandi 1961; Evans 1977; and Kojima 1991). In this paper we describe the prepupae of two species of *Microdynerus* Thomson, obtained in 1992 and 1993, during a study of the fauna of rubicolous species in the northern subplateau of the Iberian Peninsula: *Microdynerus exilis* (Herrich-Schaeffer) and *M. timidus* (Saussure). The mature larva of only one species has been described from this genus: *M. nugdunensis* (Saussure) (Giordani Soika 1934; Grandi 1961).

The method employed to prepare the specimens was similar to that used by Asís et al. (1994). The terminology of larval morphology follows Evans (1987).

In the measurement of certain structures we use the following abbreviations: d = diameter, h = height, l = length, w = width.

RESULTS

The nest of *Microdynerus exilis* (l = 68 mm; d = 2 mm) was located in a cane stem at Salduero (Soria). It had a vestibular cell, initial and final plugs, and 4 brood cells ($\bar{x}$ = 10 mm; range = 9.5-10.5 mm) separated by mud septa, all with a cocoon. The prepupa of cell 1 was preserved for study (voucher number 93070101). Two females emerged from cells 2 and 4 in March 1994. The pupa in cell 3 was dead.

A nest of *Microdynerus timidus* (l = 78 mm; d = 2.5 mm) was obtained

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[1] Received December 2, 1996. Accepted February 23, 1997.

[2] A grant from the DGICYT (PB91-0351-C02-02) supported the study.

[3] Unidad de Zoología, Facultad de Biología, Universidad de Salamanca, 37071-Salamanca, Spain.

from a cane stem at Boniches (Cuenca). The nest had a vestibular cell, initial and final plugs (l = 4 mm), and 6 brood cells ($\overline{x}$ = 12.5; range = 8-18.5 mm) separated by mud plugs. All cells had a cocoon. The cocoon did not completely enclose the prepupa, and excrement was present in its interior basal zone. The prepupa of cell 6 was preserved for study (voucher number 92030101). Four females emerged from cells 2 to 5 and one male from cell 1, in March, 1993.

Descriptions of prepupae

Microdynerus exilis (Herrich-Schaeffer)

General aspect (Fig. 1). Body fusiform (l = 7.0 mm, w = 2.0 mm), with dorsum of the thoracic and first 8 abdominal segments divided into two annulets by a transverse crease. Anus a transverse slit. Pleural lobes weakly developed. Integument with scanty and scattered minute setae (l = 10 µm).

Spiracles (Fig. 2) with walls of atrium smooth; opening into subatrium unarmed; subatrium (d = 40 µm) narrower than atrium (d = 65 µm).

Cranium (Fig. 3) (w = 0.96 mm, h = 0.89 mm), with scattered setae (l = 5 µm) and setigerous punctures. Coronal suture ill-defined; parietal bands absent. Antennal orbits circular (d = 90 µm), with 3 small sensilla. Clypeus with scanty punctures (d = 10 µm). Labrum (Fig. 3a) (w = 450 µm) bilobed, with 21 short conical sensilla (w = 5 µm) on each side. Epipharynx (Fig. 3b) with few small spinules medioventrally (w = 5 µm) and 3 sensilla on each side.

Mouthparts. Mandibles (l = 320 µm, w = 240 µm) weakly tridentate, brown pigmented, upper tooth truncate apically. Maxillae with few setae (l = 15 µm) on external surface; maxillary palpi (l = 65 µm; w = 50 µm) with 4 apical sensilla; galeae (l = 80 µm; w = 30 µm), sharply narrowing at apex. Labium (l = 190 µm, w = 230 µm), with short palpi (l = 30 µm, w = 35 µm), blunt apically and with 4 apical sensilla; prementum with setae (l = 10 µm) ventral to the palpi; spinneret a transverse slit (l = 140 µm) with strongly raised lips.

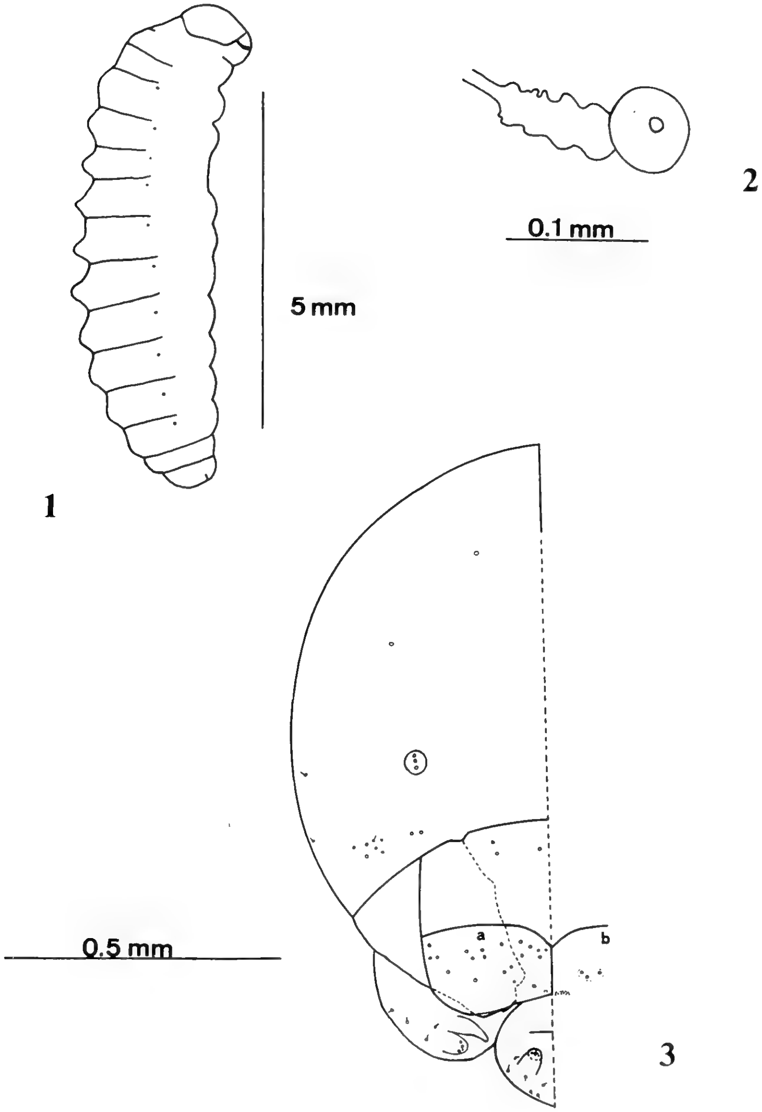
Microdynerus timidus (Saussure)

General aspect (Fig. 4). Body fusiform (l = 7.0 mm, w = 1.9 mm), similar to *M. exilis*.

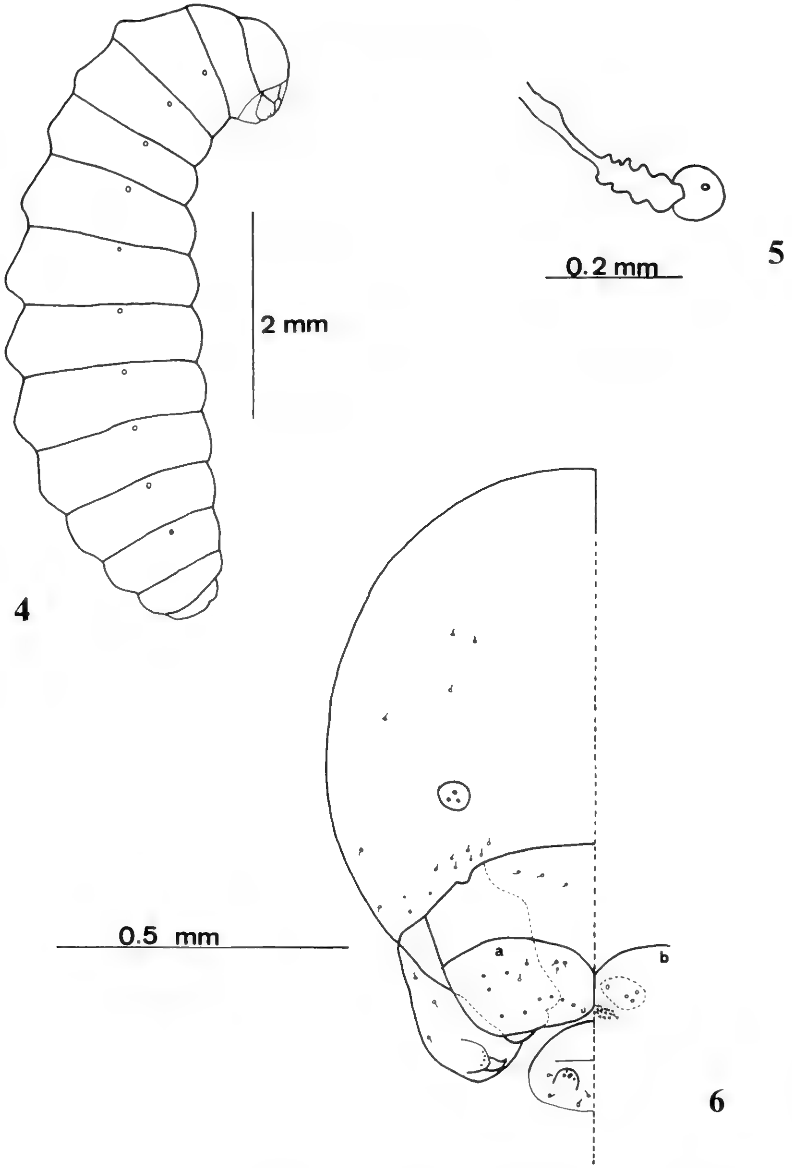
Spiracles (Fig. 5) with walls of atrium smooth; opening into subatrium unarmed; subatrium (d = 30 µm) narrower than atrium (d = 40 µm).

Cranium (Fig. 6) (w = 0.9 mm, h = 0.75 mm), with scattered setae (l = 10 µm) and punctures. Coronal suture not very distinct; parietal bands absent. Antennal orbits circular (d = 50 µm), with 3 small sensilla. Clypeus with a few setae (l = 10 µm). Labrum (Fig. 6a) (w = 450 µm) bilobed, with 10 short conical sensilla (w = 5 µm) and 5 setae (l = 10 µm) on each side. Epipharynx (Fig. 6b) with small spinules medioventrally, and 4 sensilla (w = 5 µm) on each side.

Mouthparts. Mandibles (l = 270 µm, w = 200 µm) and maxillae as described for *M. exilis*; maxillary palpi (l = 50 µm; w = 35 µm) with 4 apical sensilla; galeae (l = 105 µm; w = 25 µm) long, pointed at apex. Labium (l = 180 µm, w = 260 µm) as in the species previously described.



FIGURES 1-3.- Mature larva (prepupa) of *Microdynerus exilis* (Herrich-Schaeffer): 1, Profile; 2, Anterior thoracic spiracle (atrium, subatrium and tracheal trunk); 3, Cranium in frontal view (Labrum [a], Epipharynx[b]).



FIGURES 4-6.- Mature larva (prepupa) of *Microdynerus timidus* Saussure: 4, General aspect; 5, Anterior thoracic spiracle (atrium, subatrium and tracheal trunk); 6, Cranium in frontal view (Labrum (a), Epipharynx (b)).

DISCUSSION

Reid (1942) and Grandi (1961) established several characters to differentiate eumenine larvae from those of the rest of the Vespidae: labrum almost as wide as the clypeus; distance from the antennae to the bases of the mandibles less than that from the center of the anterior edge of the labrum to the center of a line joining the bases of mandibles; and deeply bilobed labrum. All of these characters are well defined in the two species studied in this paper. Moreover, the genus *Microdynerus* could be characterized among eumenine wasps by the presence of very long galeae, narrowing towards the apex.

Although a certain morphological uniformity is noted when comparing the larva of the species described previously (*M. nugdunensis*) with those described in this article, differences do exist (Table I). The most important ones are morphology, number and arrangement of the sensilla on the labrum; the number of sensilla on the epipharynx; and the presence/absence of setae between labial palpi. Additional differences are found in: the number of the setae on the external margin of the maxillae; in the morphology of the mandibles; and in the presence/absence of a circle of spines in the opening to the subatrium.

Each of the three species are differentiated as follows:

- ***M. exilis*:** by having the labrum without setae, only with short conical sensilla (Fig. 3a) [setae are present in *M. nugdunens*is and *M. timidus* (Fig. 6a) (Table I)].
- ***M. nugdunensis*:** a) maxillae with numerous setae on external side [few setae are present in *M. exilis* (Fig. 3) and *M. timidus* (Fig. 6) (Table I)]; b) opening into subatrium with spines [in *M. exilis* (Fig. 2) and *M. timidus* (Fig. 5) the spiracular atrium has no collar-like processes (Table I)]; and c) setae between

Table I.- Characters used to differentiate mature larvae of *Microdynerus* (present: x; absent: -): (1) Labrum with setae; (2) Epipharynx with two sensorial areas, each one with 3 sensilla; (3) Maxillae with few setae on external surface; (4) Galeae long, sharply narrowing at apex; (5) Labium with setae between the labial palpi; (6) Spiracular atrium with collar-like processes.

Species	**1**	**2**	**3**	**4**	**5**	**6**
M. exilis	_	x	x	x	_	_
M. nugdunensis	x	x	_	x	x	x
M. timidus	x	–	x	x	–	–

the labial palpi [no setae in *M. exilis* (Fig. 3) and *M. timidus* (Fig. 6) (Table I)]. - ***M. timidus:*** by having 4 sensilla in each of the sensorial areas of the epipharynx (Fig. 6a) [*M. exilis* (Fig. 3) and *M. nugdunensis* (Fig. 6) have two sensorial areas, each one with 3 sensilla (Table I)].

ACKNOWLEDGMENTS

We are indebted to H.E. Evans (Colorado State University, U.S.A.), J.M. Carpenter (American Museum of Natural History, U.S.A.), J. Kojima (Ibaraki University, Japan) and Sk. Yamane (Kagoshima University, Japan) for their comments on the manuscript.

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LINNAEAN SPECIES OF *CONOPS* (DIPTERA: CONOPIDAE, MUSCIDAE, SCIOMYZIDAE, SYRPHIDAE, & TACHINIDAE), WITH DESIGNATIONS OF LECTOTYPES[1]

F. Christian Thompson[2]

ABSTRACT: Linnaeus described 13 species in the genus *Conops*, which are now placed in the families Conopidae, Muscidae, Sciomyzidae, Syrphidae and Tachinidae. A study is presented of the types and other material of these species in his collection. Lectotypes are designated for 10 names (*C. vesicularis* Linnaeus 1761, *C. macrocephala* Linnaeus 1758, *C. aculeata* Linnaeus 1761, *C. flavipes* Linnaeus 1758, *C. ferruginea* Linnaeus 1761, *C. petiolata* Linnaeus 1761, *C. atomaria* Linnaeus 1767, *C. testacea* Linnaeus 1767, *C. buccata* Linnaeus 1758 & *C. subcoleoptrata* Linnaeus 1758). Three new synonyms (*C. macrocephala = Physocephala niara* De Geer, *C. petiolata = Physocephala rufipes* Fabricius, *C. testacea = Myopa extricata* Collin) and one new combination (*C. atomaria = Euthycera atomaria*) are proposed.

Names are the keys to knowledge as they serve as short tags for complex objects. In biology, scientific names are tags for species as well as groups of species. These names mean that all organisms that have the same name share at least some characteristics in common. The scientific naming system in biology began with Linnaeus who perfected his system through a series of books that attempted to classify all living things into one natural system. He entitled these works *Systema Naturae*, the system of nature. Subsequent biologists have followed the system established by Linnaeus. So, as our current system of scientific names is derived from Linnaeus, the need exists to re-examine the initial state of the system. This paper does that as that system relates to a small group of flies.

Linnaeus recognized 10 groups (genera) of flies. One of these groups was *Conops*, based on flies that had elongate mouthparts. In his final edition (12th, 1767) of his system of nature, Linnaeus included 13 species in the genus *Conops*. Common farm pests, such as the stable and horn flies, as well as parasites of bees and wasps, scavengers in cow dung, etc., were included in *Conops*. As there is a need to fix the identity of *Conops testacea* Linnaeus (see Camras 1994), all the species that Linnaeus included in *Conops* are reviewed. Fortunately, the actual specimens on which Linnaeus based his species are preserved in London (For details on the Linnaean Collection, its curation and history, see Day & Fitton 1978; on Linnaean insect pins, see Mikkola 1983).

Two Linnaean *Conops* species are currently considered *nomina dubia* (Chvála & Smith 1988). Their identities are here resolved. Linnaeus defined another two *Conops* species broadly, the definitions of these are here restricted

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[1] Received August 22, 1996. Accepted March 22, 1997.

[2] Systematic Entomology Laboratory, USDA, NHB-168 Smithsonian Institution, Washington, D.C. 20560.

by lectotype designation. I have designated lectotypes for what are today unique specimens following the recommendation (73F) of the *International Code of Zoological Nomenclature*. Each species included in *Conops* is listed, in the order that it appears in the 12th edition, along with its current status (family, valid name) and an indication of the voucher material available in the Linnaean Collection. For Conopidae, I have followed the species concepts used by Smith (1969) and Chvála (1961, 1963 & 1965).

1) ***rostrata*** Linnaeus 1758: 604. Syrphidae, *Rhingia rostrata* (Linnaeus). A ♀ and 2 ♂♂. Both ♂♂ are Smith specimens. See Thompson, et alii 1982: 159.

2) ***calcitrans*** Linnaeus 1758: 604. Muscidae, *Stomoxys calcitrans* (Linnaeus). Lectotype ♂, paralectotypes ♀. See Pont (1981: 168) for designation and full information.

3) ***irritans*** Linnaeus 1758: 604. Muscidae, *Haematobia irritans* (Linnaeus). Lectotype ♀, paralectotype ♀. See Pont (1981: 169) for designation and full information.

4) ***vesicularis*** Linnaeus 1761: 468. Conopidae, *Conops vesicularis* Linnaeus. A single ♂, here designated as lectotype. This specimen corresponds to the current concept of the name.

5) ***macrocephala*** Linnaeus 1758: 604. Conopidae, *Physocephala nigra* (De Geer). A single ♀, which is here designated lectotype. In the most recent catalog (Chvála & Smith 1988: 252), this name is stated to be ''probably a senior synonym of *Conops vesicularis* Linnaeus." Much paper was wasted on whether Moses Harris' misidentification (Harris 1776) of this species was an independent proposal, and, hence, a valid name for the species now known as *Rhingia campestris* Meigen 1822 (Collin 1946, 1947, 1948; Goffe 1946, 1947, 1948, 1949). Given the confusion over this epithet, *macrocephala* is best left as a forgotten name and current usage of *nigra* be continued.

6) ***aculeata*** Linnaeus 1761: 468. Conopidae, *Dalmannia aculeata* (Linnaeus). A single ♂ here designated as lectotype. This specimen corresponds to the current concept of the name.

7) ***flavipes*** Linnaeus 1758: 604. Conopidae, *Conops flavipes* Linnaeus. A single ♂ with no head is here designated as lectotype. This specimen corresponds to the current concept of the name.

8) ***ferruginea*** Linnaeus 1761: 468. Conopidae, *Sicus ferrugineus* (Linnaeus). A single ♀ here designated as lectotype. This specimen corresponds to the current concept of the name.

9) ***petiolata*** Linnaeus 1767: 1005. Conopidae, *Physocephala rufipes* (Fabricius). Three ♂♂, one of these is clearly a specimen subsequently added by Smith as

it is labelled as from "Angl.", another probably also a Smith specimen as it is on a different and non-Linnaean pin. The third ♂ here designated as lectotype.

In 1761, Poda (1761: 118) described *Empis petiolata*, a species that is clearly a conopid. Unfortunately, whether this name applies to a *Conops* or *Physocephala* cannot be determined from the original description and, unfortunately, the types are lost (Thompson & Pont 1994: 37). For pragmatic reasons, I consider Poda's species to belong to the current concept of *Physocephala*. Hence, the Poda name becomes the senior homonym of the Linnaean name. Thus, *Conops rufipes* Fabricius 1781 may remain the valid name for the species first described by Linnaeus as *petiolata*.

Chvála & Smith (1988: 256) list a *Conops petiolata* Donovan (1808: pl. 451) as an available name and a synonym of *rufipes* Fabricius. However, Donovan clearly and correctly identified the Linnaean species giving the appropriate citation to the name in the then most recent edition of the *Systema Naturae* (13th; Gmelin 1790). If subsequent workers had been as careful as Donovan then today I would not have been forced to twist my interpretation of the literature to suppress the Linnaean name and preserve current usage!

10) ***atomaria*** Linnaeus 1767: 1005. Sciomyzidae, *Euthycera atomaria*, probably a senior synonym for *Euthycera chaerophylli* (Fabricius). A single ♀ remains, but it is in poor condition. The specimen was identified as *Euthycera* by Cogan when the collection was recurated in 1974. As a modern revision of *Euthycera* is needed (Rozkošný 1984), the nomenclatural implication of the identity of this Linnaean name is left for future workers.

11) ***testacea*** Linnaeus 1767: 1006. Conopidae, *Myopa testacea* (Linnaeus). A single ♀ here designated as lectotype. The specimen agrees with the current concept of *Myopa testacea* of Chvála (1965), but seems to run in Collin (1959) either to *extricata* Collin or *testacea* Linnaeus as the specimen has a mixture of the characteristics used by Collin to distinguish those species. The specimen is clearly reddish anterior to the scutellum and has sparse, inconspicuous black facial pile. The palps are yellow. Unfortunately, David Clements (personal communication), who is revising the genus *Myopa*, has confirmed the specimen to be a pale representative of *extricata* Collin.

The real question of what *testacea* Linnaeus is goes beyond what the syntype in the Linnaean Collection is. Linnaeus also included in his concept of *testacea*, *Sicus ferrugineus* Scopoli and the then unnamed species (potential type of) *Stomoxoides* Schaeffer. When the species *Sicus ferrugineus* Scopoli was included in *Conops*, the epithet was identical to that of Linnaeus' *ferrugineus*. Hence, Linnaeus was forced to rename the species. Thus, specimens of either of the two different species could be designated as the type of the name *Conops testacea* Linnaeus and then the species represented by that type would become the first included species in the genus *Stomoxoides* (and thus becoming the type species of *Stomoxoides* by subsequent monotypy as was recognized by

Coquillett (1910: 609). To maintain current usage, I select the specimen in the Linnaean Collection to be lectotype. This action preserves the current interpretation of *Sicus ferrugineus* Scopoli. The genus group name, *Stomoxoides*, which some authors believe is an available (and valid) name, would become the senior synonym of *Myopa* Fabricius (1775) except as noted below.

There is no basis for the assumption that *Stomoxoides* Schaeffer (Schaeffer 1766b: pl. 120) is an available name. Schaeffer rejected the binominal system of Linnaeus. His work *Elementa Entomologia* is best considered binary[3] **as that was the nomenclatural system he followed in his other works** (for example, his *Icones* [Schaeffer 1766a-1779]). *Elementa* includes no references to species, only orders and genera. The use of *Stomoxoides* in the *Icones* is clearly binary. These species taxa of the *Icones* only received available binominal names from Panzer (1804), but Panzer used *Myopa*, not *Stomoxoides*. One could make a tedious and pedantic argument that since the *Elementa* does not deal with the species category, there is no evidence within the *Elementa* itself as to whether Schaeffer's nomenclature would be consistent with the Principle of Binominal Nomenclature or not, hence new genus-group names are available from it under Article llc(i). But why do so? The historical record is clear, Schaeffer used a binary system of nomenclature and regardless of whether *Stomoxoides* is available or not, the name will remain a synonym, either an objective junior synonym of *Sicus* or suppressed subjective senior synonym of *Myopa* (see below).

Collin (1959) was undoubtedly correct in identifying the species figured by Schaeffer as *Sicus ferrugineus* Scopoli.

12) ***buccata*** Linnaeus 1758: 605. Conopidae, *Myopa buccata* (Linnaeus). Three specimens (1 ♂ 2 ♀) are associated with this name, one is apparently a Smith addition, the other two are undoubtedly Linnaean specimens. The one male, associated with the Linnaean name label, is *Myopa fasciata* Meigen. The females are *buccata* of current authors. The female without antennae (one of the Linnaean specimens) is here designated as lectotype and has been so labelled.

13) ***subcoleoptrata*** Linnaeus 1767: 1006. Tachinidae, *Phasia subcoleoptrata* (Linnaeus). A single ♂ is present and is clearly a syntype because it is on a Linnaean pin. The specimen belongs to *Phasia* and appears to agree with the current concept.

There are 2 additional specimens in box 23 that are labelled as from old boxes 196 and 197.

The Linnaean species of *Conops* were re-evaluated as there is a question of the status of the genus-group name *Myopa* (Camras 1994). Unfortunately, this

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[3] Binary nomenclature is the system of using a uninominal name for the genus and a *polynominal* name for the species.

proposal to the International Commission on Zoological Nomenclature was riddled with errors, many of which have already been noted (Sabrosky 1994, Wheeler 1994). Unfortunately, no one in their rush to resolve an old problem bothered to carefully review what earlier workers had done. Linnaeus always attempted to synthesize all previous work in his *Systema Naturae*. His treatment (fig. 2) of *Sicus*, *Sicus ferrugineus* Scopoli and *Stomoxoides* Schaeffer was reasonable within the context of his times. Had subsequent workers followed Linnaeus, this current work as well as the application (Camras 1994) to the Commission would have been unnecessary.

Beyond the errors noted by Sabrosky and by Wheeler, the following should also be corrected.

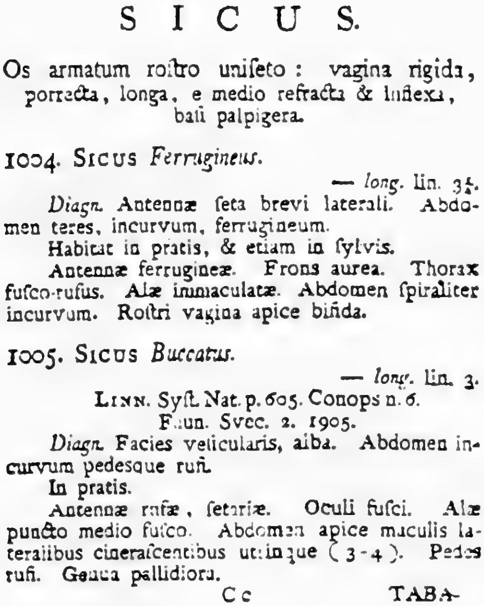
Camras and others want to interpret history to be convenient: *Sicus ferrugineus* Scopoli is clearly an independent and new proposal, which has nothing to do with the previously described species, *Conops ferrugineus* Linnaeus. Like all systematists, Scopoli gave citations to earlier use when he cited available names (see for example, under *Sicus buccatus*; fig. 1).

Camras (1994) stated that Fabricius included *Sicus* in the synonymy of *Myopa* when he established *Myopa*, which is a rather generous interpretation of the facts. Fabricius gave no synonymy for genus-group names, but he did equate, in his species synonymy, *Conops ferruginea* Linnaeus with *Sicus ferrugineus* Scopoli. That is, in retrospect, a correct species synonymy, and, thereby, the genus-group names [given the subsequent type-species designation of *Sicus*] are synonyms. However, as noted above, Linnaeus had previously considered his *ferruginea* distinct from Scopoli's.

The statement (Camras 1994) that the genus-group name *Stomoxoides* Schaeffer "was subsequently only" used by Schaeffer is clearly wrong as Linnaeus and Coquillett treated the name as indicated above.

Unless the plenary powers are invoked, the invalid designation of Coquillett (1910: 605) of a non-originally included species (*Conops ferruginea* Linnaeus 1761) as the type species of *Sicus* Scopoli 1763 remains invalid. As there has never been a valid type designation for *Sicus*, I hereby designate the second originally included species, *Sicus ferrugineus* Scopoli 1763, as the type species. This type species is currently recognized by the name *Sicus ferrugineus* (Linnaeus 1761).

If one considers *Stomoxoides* Schaeffer to be an available name (I do not as it appears only in works that are not binominal), then the question remains as to what is its type species. Under the current rules of nomenclature, because the genus name was published without any included species in the sense of named species, the first subsequently included species become the original included species (ICZN, Art. 69a(i)1). By including *Stomoxoides* in the species synonymy of *Conops testacea*, Linnaeus was the first worker to define *Stomoxoides* by subsequent monotypy. As the Linnaean species *testacea* was



SICUS.

Os armatum roſtro uniſeto: vagina rigida, porrecta, longa, e medio refracta & inflexa, baſi palpigera.

1004. Sicus *Ferrugineus.*

— *long.* lin. 3¼.

Diagn. Antennæ ſeta brevi laterali. Abdomen teres, incurvum, ferrugineum.

Habitat in pratis, & etiam in ſylvis.

Antennæ ferrugineæ. Frons aurea. Thorax fuſco-rufus. Alæ immaculatæ. Abdomen ſpiraliter incurvum. Roſtri vagina apice bifida.

1005. Sicus *Buccatus.*

— *long.* lin. 3.

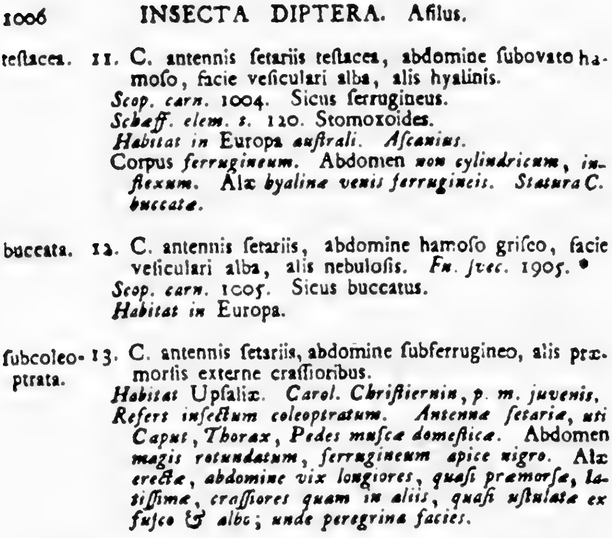
Linn. Syſt. Nat. p. 605. Conops n. 6.
Faun. Svec. 2. 1905.

Diagn. Facies veſicularis, alba. Abdomen incurvum pedesque rufi.

In pratis.

Antennæ rufæ, ſetariæ. Oculi fuſci. Alæ puncto medio fuſco. Abdomen apice maculis lateralibus cineraſcentibus utrinque (3-4). Pedes rufi. Genua pallidiora.

Cc TABA-



1006 INSECTA DIPTERA. Aſilus.

teſtacea. 11. C. antennis ſetariis teſtacea, abdomine ſubovato hamoſo, facie veſiculari alba, alis hyalinis.
Scop. carn. 1004. Sicus ferrugineus.
Schæff. elem. t. 120. Stomoxoides.
Habitat in Europa *auſtrali. Aſcanius.*
Corpus *ferrugineum.* Abdomen *non cylindricum, inflexum.* Alæ *hyalinæ venis ferrugineis. Statura C. buccatæ.*

buccata. 12. C. antennis ſetariis, abdomine hamoſo griſeo, facie veſiculari alba, alis nebuloſis. *Fn. ſvec.* 1905. •
Scop. carn. 1005. Sicus buccatus.
Habitat in Europa.

ſubcoleoptrata. 13. C. antennis ſetariis, abdomine ſubferrugineo, alis præmorſis externe craſſioribus.
Habitat Upſaliæ. *Carol. Chriſtiernin, p. m. juvenis.*
Refert inſectum coleoptratum. Antennæ ſetariæ, uti Caput, Thorax, Pedes muſcæ domeſticæ. Abdomen *magis rotundatum, ferrugineum apice nigro.* Alæ *erectæ, abdomine vix longiores, quaſi præmorſæ, latiſſimæ, craſſiores quam in aliis, quaſi uſtulatæ ex fuſco & albo; unde peregrina facies.*

Figs. 1-2. Taxonomic descriptions. 1. Page from Scopoli (1763) treating *Sicus* and its included species. 2. Page from Linnaeus (1767) treating *Conops testacea* Linnaeus.

clearly a composite of at least two species, which was not resolved until the present lectotype designation, the appropriate type species of *Stomoxoides* remains unresolved. As the illustration provided by Schaeffer is clearly of *ferrugineus* Linnaeus 1761 and the first included species is here restricted to *testacea* Linnaeus (*sensu* its lectotype), there is the problem of misidentification of the type species. The International Commission on Zoological Nomenclature needs (under Art. 70b) to rule whether the type is *Sicus ferrugineus* Linnaeus or *Conops testacea* Linnaeus, of which I would recommend the former.

ACKNOWLEDGMENTS

I thank Brian Pitkin, the Natural History Museum (formerly the British Museum [Natural History]), London (BMNH) and Michael Fitton, the Linnaean Collection, London (LSL); for permission to study material in their care.

Without the advice of various specialists on conopid flies, this paper would not have been possible, so I am indebted to: Sidney Camras, Field Museum of Natural History, Chicago; David Clements, Cardiff, Wales; Milan Chvala, Charles University, Prague; and Kenneth G. V. Smith, retired from the British Museum (Natural History) [=The Natural History Museum], London.

I also thank Neal L. Evenhuis, Bishop Museum, Honolulu; James Pakaluk, Richard E. White, Curtis W. Sabrosky, and Manya B. Stoetzel of the Systematic Entomology Laboratory, USDA, Washington; and Wayne N. Mathis of the Smithsonian Institution (USNM), Washington, for their critical review of the manuscript.

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STUDIES ON SOME MOTH FLIES (DIPTERA: PSYCHODIDAE), WITH THE FIRST RECORD OF *CLOGMIA ALBIPUNCTATA* IN CENTRAL EUROPE[1]

Doreen Werner[2]

ABSTRACT: In the course of an ecological study of waste disposal facilities, the psychodid fauna of terrestrial habitats on refuse or garbage was investigated. Species of this family are important components of the edaphic insect fauna of these biotopes. The fauna was sampled at five sites by means of emergence traps, and material was reared under natural conditions. Ecological notes are given. Six species of Psychodidae were found and one of these, *Clogmia albipunctata,* is recorded for the first time from Germany. The most abundant species was *Psychoda parthenogenetica.* with 88.8% of the individuals sampled. No moth flies were reared at two of the five sites.

Because of their anthropogenic characteristics, rubbish tips and dumps have featured regularly as a field of interest for zoologists and have also been the subject of faunistic and ecological studies. However, they are still relatively under-researched biotopes, and many basic questions remain unanswered. It has only recently been accepted that these sites consititute a complex ecosystem, with conditions that vary greatly within very short periods of time and which exist only for a short time because of continuous interference and modification. The insects that inhabit these biotopes have frequently been the subject of ecological examinations but have not been as intensively researched as other groups of soil animals. In the following paper the results are given of a study of Psychodidae that live on dumps. In general, the larvae of the Psychodidae and their ecology are better known than those of other Diptera, but they have not been examined in detail. The preimaginal stages of Psychodidae are generally found in terrestrial, aquatic and dendro-limnic habitats.

STUDY AREA

This investigation was carried out in the Berlin area at several waste disposal facilities which employ different methods of waste management. The dumps at site 1, Schwanebeck, and site 2, Wernsdorf, manage refuse from Berlin and use a method of dense packing. These are so-called "Class II sites". Approximately 70% of the waste is household waste, 20% household-related

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[1] Received July 29, 1996. Accepted December 28, 1996.

[2] D. Werner, Museum für Naturkunde, Institut für Systematische Zoologie, Invalidenstraße 43, 10115 Berlin, Germany.

rubbish, and 10% is estimated to be communal waste. Following the windrow method, the refuse is immediately crushed and is then stacked as densely as possible so as to avoid empty spaces between the layers. After this treatment, the surface is covered usually with clay- or sandy soil to prevent rubbish being blown away and/or the air being polluted by dust or odors. Samples were collected from waste that was approximately 4-6 weeks old.

The tip at site 3, Eggersdorf, is an unmanaged tip onto which not only household waste, building rubble, faeces and sewage are dumped but also industrial waste. The survey for Diptera was carried out on deposits that were 3 years old.

At site 4, Falkenberg facility, biological waste from fruit growers and market gardeners (i.e. horticultural and agricultural waste) is composted. The organic substances are treated in a manner that guarantees high biological degradability. The refuse is shredded and broken down, and is then stacked in windrows. The specific treatment of these windrows, with careful temperature and moisture control, ensures a constant process of decay. The traps for the Diptera survey were set on a new windrow.

Since the dumps and tips discussed so far differ both in their components and their size, and thus in the overall conditions they provide for decomposition, the investigation was extended to include a heap which contained the kitchen and garden waste from a private household. This was in an isolated position in Waldsieversdorf (site 5) in the Markische Schweiz region, about 45m above sea level, and was about two years old when the survey was carried out. The heap remained undisturbed during the period of the investigation, with neither chalk nor other soil constituents added.

SAMPLING METHODS

The use of pyramid-shaped traps (photoeclectors) for the compilation of species inventories has proved very effective (Funke 1971). They have been used for ecological studies with increasing frequency in recent years. This method was used to collect the Diptera emerging from the soil. Most of the emerging Diptera behaved with positive phototaxis and flew into the transparent plastic box filled with ethylene-glycol. Supplementary samples were collected using Barber traps (pitfall traps), colored dishes, or baited traps. The sampling period was from March 1993 to April 1994. The traps were used in a three-week cycle in which they were emptied at the end of the first week, removed, and then set up again after two weeks in order to avoid any effect from large climatic variations (Grimm et al. 1975). Furthermore the photoeclectors were made of a material with a special fiber to reflect light and avoid overheating.

RESULTS

Adult Psychodidae are small Diptera of compact or stocky, slightly hunchbacked build. They are characterized by their dense vestiture of hairs or scales. These features are responsible for their restricted and short flight ability, and also explain why they are found mainly in the immediate vicinity of their breeding sites. Predominantly *Psychoda* species hold their wings roof-shaped over the abdomen, a tactic to hide in small crevices. Climatic factors, for example temperature or dampness of the substrate, have a strong influence on the occurrence of Psychodidae. Three of the study sites presented almost ideal conditions for Psychodidae. These were the dumps in Schwanebeck and Wernsdorf and the compost heap in Waldsieversdorf.

On the dumps, the heterogeneous structure of the various components of rubbish, garden waste, and household waste offered protection from unfavorable climatic conditions, for example from wind and rain, as the flies matured. Furthermore, there is a special microclimate in the windrows, characterized by an atmospheric humidity of 95-100% and a high soil temperature, caused mainly by energy released through fermentation and by the effect of the sun.

When any sort of decaying organic material is added to these already favorable conditions, flies can breed in huge numbers. Adults move over their feeding or breeding substrates by running or hopping or in short bursts of flight. They were only rarely collected in direct sunlight. Moth flies are crepuscular creatures, with only a short phase of activity in the morning, whereas they can be observed for several hours in the evening when they may even fly to a height of almost 1.5 metres. However, the moth flies observed during this project always remained close to their breeding medium.

Psychodid larvae can be arranged into different ecological groups: they are found in stagnant or flowing, clean or dirty, fresh or salt water, mud, mosses, sap or soil (Vaillant 1971). In addition to larvae with a mydobiontic mode of life (particularly the genera *Pericoma, Telmatoscous* and *Clytocerus),* the larvae of many species, and in particular those of the genus *Psychoda* which has a saprobiontic mode of life, are found in and on rotten plant material in manure pits, sewage, cesspits and dumps. In general the larvae need a firm substrate, damp rotten organic material, and permanent access to atmospheric oxygen.

This investigation produced a total of 3033 moth flies, which belong to a relatively small number of species: 6 species in 4 genera, all in the subfamily Psychodinae. Breeding populations of all these species were found at the sites listed above. 2262 specimens were caught in traps, and 771 using bait. The following species were found (nomenclature follows Wagner 1990):

Satchelliella trivialis (Eaton 1893), *Tinearia alternata (*Say 1824), *Psychoda albipennis* (Zetterstedt 1850), *Psychoda cinerea* (Banks 1894), *Psychoda parthenogenetica* (Tonnoir 1940), and *Clogmia albipunctata* (Williston 1893).

The dominant species was the cosmopolitan *Psychoda parthenogenetica.* Its life-cycle depends mainly on the available food supply, temperature and humidity. The time from egg-laying until adult eclosion is in the region of 22 to 30 days at a temperature of 20-22°C.

Psychoda parthenogenetica also breeds in baits. It has bred and hatched particularly successfully in damp rabbit droppings, rotting potatoes, cabbage, manure and carrots. A few specimens also have bred in rotten celeriac, soggy bread, ground coffee dregs and agar culture mixed with cow's blood. When several substrates are available, it prefers dung as its basic food and breeding medium. This range of food substances is more extensive than has previously been mentioned in the literature on this species. Vaillant (1971) refers to the remarkably euryoecious mode of life of Psychodinae larvae.

Although adults of *Psychoda parthenogenetica* visit liver and excrement, no egg-laying on these media took place either on the baits at the dumps or in the laboratory.

As a rule, larvae were found on the preferred baits in dark and shady slits and cracks, with the tube-like siphon projecting out of the soft development medium.

The pupae are light brown, and are found in large numbers on the surface and at the edges of the substrates. Unlike other families of Nematocera, they are not connected to the last larval skin. The pupal stage lasts 3 to 5 days at 20-22°C.

At all stages this relatively short life-cycle is subject to strong natural influences, mainly climatic variations. Delays are therefore possible in each of the individual developmental stages. A reduction in humidity and temperatures below 10°C greatly delayed or even held up the development of the preimaginal stages. Despite this, however, *Psychoda parthenogenetica* is able to develop and emerge even at low temperatures. In mild winters the first adults emerge as early as January, and only temperatures below 0°C stop their growth completely (R. Wagner pers. comm.). The larvae and pupae of *Psychoda parthenogenetica* are illustrated in Fig. 1.

Adult moth flies were frequently infested by mites, 6 to 8 parasites being commonly found on a single moth fly, but they seem to have no influence on adult activity. Infestations are rarely found on those individuals which develop in or close to streams.

The seasonal occurrence of *Psychoda parthenogenetica* at the various study sites is shown in Figs 2a-c. Only the moth flies collected in photoeclector soil traps and in the Barber traps placed beneath the eclectors are included in these figures. *Psychoda parthenogenetica* was found constantly throughout the period of the investigation. From the figures it can be seen that moth fly activity began in March. Several generations developed in the biotopes under study, with the generations overlapping continuously throughout the season. A maximum in the intervals between generations was noted in late summer and autumn. Wagner (1979) also reported that this species has a continuous seasonal distribution, reaching a maximum in autumn at the Breitenbach stream.

The species collected at the various study areas are listed in Table 1.

Compared with *Psychoda parthenogenetica, Psychoda albipennis* was rare although greater numbers had been expected. This species is usually found wherever there is decaying organic matter, for example alongside streams and brooks, silage, and mushroom farms. The larvae live in the faeces of various vertebrates (Wagner 1977). Whereas Satchell (1947) observed *Psychoda albipennis* on decaying substances and reaching a maximum in October, the species was only found in the course of this investigation to develop in the spring at the Waldsieversdorf compost heap. It is a bisexual species, and so it may not be possible for it to reach the high population densities that *Psychoda parthenogenetica* reaches (R. Wagner pers. comm.). *Psychoda albipennis* was

Fig. 1: Larvae and pupae of *Psychoda parthenogenetica.*

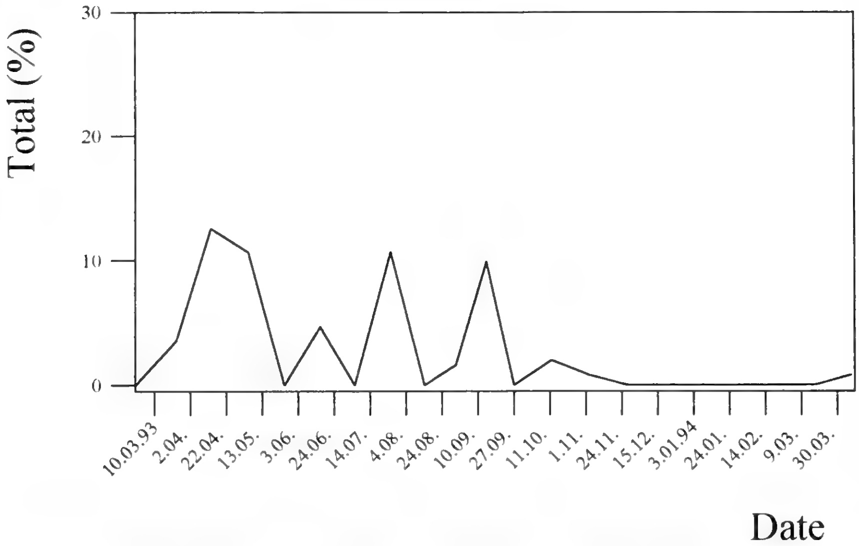

Fig. 2a: Seasonal distribution of *Psychoda parthenogenetica* at the Schwanebeck tip

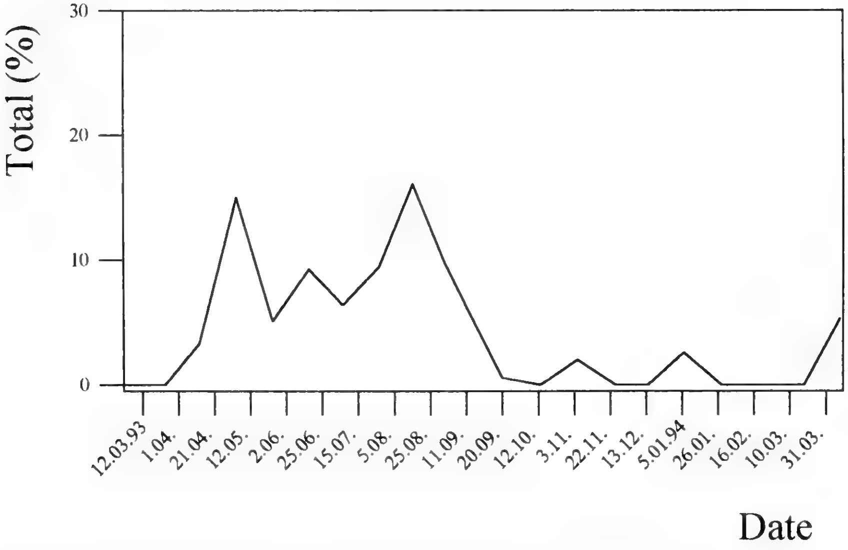

Fig 2b: Seasonal distribution of *Psychoda parthenogenetica* at the Wernsdorf tip.

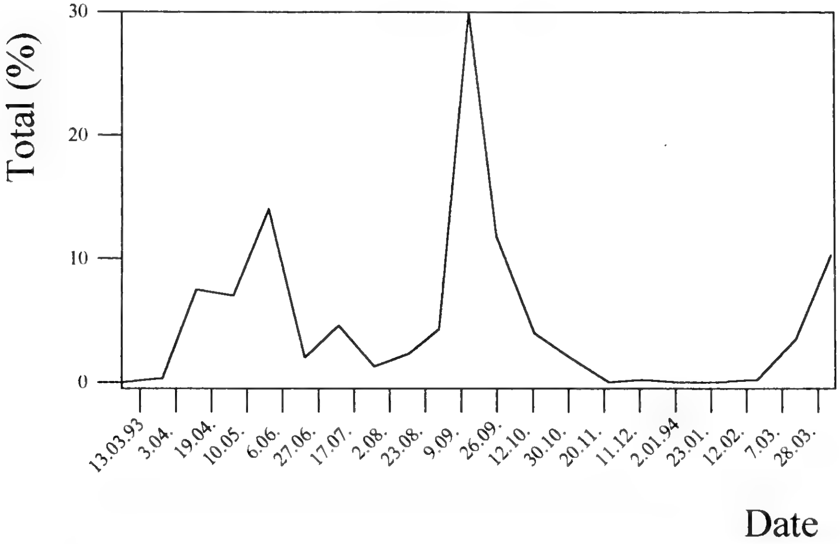

Fig. 2c: Seasonal distribution of *Psychoda parthenogenetica* at the Waldsieversdorf compost heap.

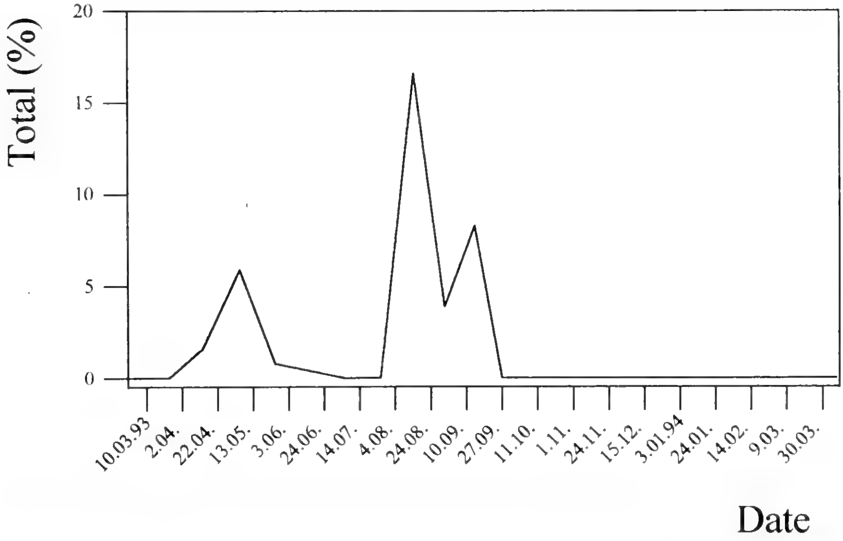

Fig. 3: Seasonal distribution of *Tinearia alternata* at the Schwanebeck tip.

Table 1: Species collected at the various study areas.

Species	Area found					Number of individuals total
	Schwanebeck	Wernsdorf	Eggersdorf	Falkenberg	Waldsievers-dorf	
Satchelliella trivialis	30	–	–	–	–	30
Tinearia alternata	100	53	–	–	61	214
Psychoda albipennis	7	–	–	–	37	44
Psychoda cinerea	4	–	–	–	18	22
Psychoda parthenogenetica	358	793	–	–	1544	2695
Clogmia albipunctata	28	–	–	–	–	28

reared from potatoes and cabbage. Weber (1993) also recorded this species in potatoes, together with *Psychoda minuta.* It was not possible to rear this species in other types of decaying material.

Psychoda cinerea is a multivoltine and euryoecious species with larvae that live in a wide range of conditions, for example on the bacterial slime in domestic household drains. Because of this it is doubtful whether they are able to survive extreme temperature fluctuations (R. Wagner pers. comm.). Specimens of *Psychoda cinerea* hatched from compost and from the Schwanebeck dump, but only in August and September and only in small numbers. Satchell (1947) found this species on farms, but never in high numbers.

Tinearia alternata, another cosmopolitan species, also requires decaying organic matter for its development. Vaillant (1971) refers to numerous types of larval nutrition. These range from, among others, saprobionts, coprobionts, urinobionts, psammabionts of various kinds in water from bryomadicoles to mycobionts. In the present investigation, specimens were found at the Schwanebeck and Wernsdorf dumps as well as on the Waldsieversdorf compost heap. Although the species occurred throughout the entire period of the investigation, the maximum development was in May and August although it was also able to continue into September. The seasonal distribution of *Tinearia alternata* at Schwanebeck is shown in Fig. 3. *Tinearia alternata* developed and hatched from various baits, such as celeriac, carrots, potatoes, oak leaves, rabbit droppings and manure. Skidmore (1991) reported the occurrence of *Psychoda cinerea* and *Psychoda parthenogenetica* on cow dung.

Clogmia albipunctata is a ubiquitous species of the tropics and subtropics whose larvae use all kinds of rotten organic matter for their basic food and breeding medium. This species has been known for many years to be widely distributed (Duckhouse 1989). It was previously known from Cuba and from various parts of tropical Africa. The present specimens emerged from samples of manure from the Schwanebeck dump in August 1993. The pH-value of both samples was between 8.2 and 8.3. Species from other families of Diptera were also developing in these manure samples, for example Syrphidae and Scatopsidae. *Clogmia albipunctata* is here recorded for the first time in Germany. It may be that special microhabitats enable the eggs and larvae of this species to survive winter outside the tropics and subtropics.

The larvae of the West Palaearctic *Satchelliella trivialis* commonly develop alongside brooks, streams and small rivers, in damp marginal soil or in mud mixed with plant remains. This species is highly tolerant of decaying matter (Vaillant 1979), and under optimum conditions there are two generations per year (Wagner 1979). *Satchelliella trivialis* is adapted to slightly brackish water and water with a high organic content of vegetable origin. In addition to adult flies collected with a suction trap, *Satchelliella trivialis* hatched from manure samples from the Schwanebeck dump, as did *Clogmia albipunctata.* Its occurrence was restricted to August and September. In central Europe there are two generations per year, while in Scandinavia the species is univoltine. Under optimum conditions in the Mediterranean area there are 3 to 4 generations. The specimens were found together with *Tinearia alternata.* Vaillant (1981) also includes *Psychoda cinerea* in this group. At the Schwanebeck dump, *Psychoda cinerea* was found at the same time but not in the same sample.

It is surprising that no Psychodidae were found at either the Falkenberg or the Eggersdorf dumps. At Eggersdorf it is possible that conditions are too heterogeneous or that the sites are too small or too temporary for moth fly development. At Falkenberg, as a result of the specific treatment of the layers, levels of temperature and humidity were established which should have been very favorable for these flies. There was constant humidity, atmospheric oxygen for respiration, and ample organic substances for food and breeding grounds. However, microbial breakdown of organic material led to a very high level of heat within the layers. As the process of decay continued, the extreme temperatures fell, but, when compared with its immediate environment and with the other dumps, this site has the most favorable temperatures.

It is possible that Psychodidae avoid these extreme temperatures, which are tolerated or even preferred by many other families. It is also possible that these features are of too short a duration for the development of moth fly larvae and pupae. The preimaginal stages need almost constant conditions throughout the life-cycle.

Further investigations will be necessary to examine fully the habitat and environmental requirements of this family.

ACKNOWLEDGMENT

I would like to thank R. Wagner, Limnologische Flußstation of the Max-Planck-Institut of Limnology for his assistance with the determination of difficult material.

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CONTRIBUTION TO THE SYSTEMATICS OF THE GENUS *CHELEOCLOEON* (EPHEMEROPTERA: BAETIDAE)[1, 2]

C. R. Lugo-Ortiz, W. P. McCafferty[3]

ABSTRACT: The Afrotropical genus *Cheleocloeon* (Ephemeroptera: Baetidae) is shown to constitute a small, but widespread, monophyletic group of species that are distinguished by an anteriorly convex medial process of the second segment of the labial palps and long, poorly denticulate tarsal claws. The genus is hypothesized to belong to the *Bugilliesia* complex of genera on the basis of the basally bulbous second segment of the male genital forceps and general morphology of the larval tarsal claws and gills. *Cheleocloeon dimorphicum*, n. comb., and *C. excisum*, n. comb., are transferred from the genus *Afroptilum*, and are distinguishable among species of *Cheleocloeon* by the presence of hindwings in male adults and modifications of the medial process of the second segment of the labial palps. The commonly collected larval stage of *C. excisum* is redescribed, and new figures are provided to illustrate previously overlooked characters of the species.

Wuillot and Gillies (1993) erected the genus *Cheleocloeon* for two distinctive species of small minnow mayflies (Ephemeroptera: Baetidae) from Guinea: *C. carinatum* Wuillot and *C. yolandae* Wuillot. Those authors distinguished larvae of *Cheleocloeon* by the long, distally acute medial process of the second segment of the labial palps (Wuillot and Gillies 1993: Figs. 6, 15), absence of hindwingpads, elongate first pair of gills (Wuillot and Gillies 1993: Figs. 9, 18), and relatively long, poorly denticulate tarsal claws (Wuillot and Gillies 1993: Figs. 8, 17). They stated, however, that adults of *Cheleocloeon* could not be confidently separated from other baetid adults with single marginal intercalaries in the forewings.

Our examination of the baetid fauna of Africa has revealed that *Afroptilum dimorphicum* (Soldán and Thomas), from Algeria, and *A. excisum* (Barnard), from southern Africa, belong in *Cheleocloeon*. Both species were originally described in the genus *Centroptilum* Eaton but later assigned to the *dimorphicum* group of *Afroptilum* Gillies by Gillies (1990). The inclusion of these two species in *Cheleocloeon* expands the concept of the genus because they have certain characteristics not present in the type of the genus, *C. yolandae*. Here, we provide a revised diagnosis of *Cheleocloeon* and discuss the newly observed variability in the genus. We also redescribe the larval stage of *C. excisum* and provide new figures showing characteristics overlooked by Barnard (1932). The material examined is housed in the Albany Museum (AM), Grahamstown, South Africa, and the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana.

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[1] Received December 9, 1996. Accepted January 28, 1997.

[2] Purdue Agricultural Research Program Journal No. 15288.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

Cheleocloeon Wuillot and Gillies

Cheleocloeon Wuillot and Gillies 1993:213.

Diagnosis. Larvae of *Cheleocloeon* are distinguished by the anteriorly convex medial process of the second segment of the labial palps (Figs. 6, 7; Soldán and Thomas 1985: Fig. 5; Wuillot and Gillies 1993: Figs. 6, 15) and the long, poorly denticulate tarsal claws (Figs. 8, 9; Soldán and Thomas 1985: Fig. 8; Wuillot and Gillies 1993: Figs. 8, 17). Male adults have the second segment of the genital forceps basally bulbous (Wuillot and Gillies 1993: Fig. 2), and, when hindwings are present, these are long and have two longitudinal veins and a hooked costar process located near the basal third (Barnard 1932: Fig. 14e). These adult characteristics, however, will not allow them to be distinguished from all other baetid genera with single marginal intercalaries in the forewings.

Type species. *Cheleocloeon yolandae* Wuillot.

Included species.

- *Cheleocloeon dimorphicum* (Soldán and Thomas), n. comb.
  - *Centroptilum dimorphicum* Soldán and Thomas 1985:180 (larva; male subimago; female adult).
  - *Afroptilum dimorphicum* (Soldán and Thomas): Gillies 1990:99.
- *Cheleocloeon excisum* (Barnard), n. comb.
  - *Centroptilum excisum* Barnard 1932:224 (larva; male, female subimagos; male, female adults).
  - *Afroptilum excisum* (Barnard): Gillies 1990:99.
- *Cheleocloeon carinatum* Wuillot
  - *Cheleocloeon carinatum* Wuillot, in Wuillot and Gillies 1993:214 (larva; male adult).
- *Cheleocloeon yolandae* Wuillot
  - *Cheleocloeon yolandae* Wuillot, in Wuillot and Gillies 1993:214 (larva; male adult).

Distribution. Algeria *(C. dimorphicum);* Guinea *(C. carinatum, C. yolandae);* Lesotho *(C. excisum);* South Africa: Eastern Cape, KwaZulu Natal, Mpumalanga, Western Cape *(C. excisum).*

Discussion. We consider the anteriorly convex medial process of the second segment of the labial palps (Figs. 6, 7; Soldán and Thomas 1985: Fig. 5; Wuillot and Gillies 1993: Figs. 6, 15) and long, poorly denticulate tarsal claws (Figs. 8, 9; Soldán and Thomas 1985: Fig. 8; Wuillot and Gillies 1993: Figs. 8, 17) to be autapomorphies that cladistically define *Cheleocloeon.* This monophyletic group is now known to include species with larvae that have either an apically blunt or pointed medial process of the second segment of the labial palps, and that have male adults with or without hindwings. *Cheleocloeon dimorphicum* and *C. excisum* differ from *C. carinatum* and *C. yolandae* in the morphology of the medial process of the second segment of the labial palps. In

C. excisum, that process is apically pointed (Figs. 6, 7), but it is not as long as in *C. carinatum* (Wuillot and Gillies 1993: Fig. 15) or *C. yolandae* (Wuillot and Gillies 1993: Figs. 6). In contrast to those three species, *C. dimorphicum* has a process that is somewhat short and apically blunt (Soldán and Thomas 1985: Fig. 5). Only the male adults of *C. dimorphicum* and *C. excisum* have hindwings, but both males and females of *C. carinatum* and *C. yolandae* have hindwings. The hindwings of the male alate stages of *C. excisum* are somewhat long and possess two longitudinal veins and a hooked costal process located near the basal third (Barnard 1932: Fig. 14e). Male adults of *C. dimorphicum* are not known; however, the hindwings were described by Soldán and Thomas (1985) based on male subimago hindwings dissected from mature larvae, and their morphology is similar to that of *C. excisum.*

The inclusion of *C. dimorphicum* and *C. excisum* in *Cheleocloeon* considerably extends the known geographic range of the genus. Not only is the genus widespread in Africa (see Distribution, above), but it occurs at low and high altitudes and in arid, semiarid, and humid biomes (Soldán and Thomas 1985, Palmer et al. 1993, Wuillot and Gillies 1993).

Wuillot and Gillies (1993) suggested that *Cheleocloeon* and *Demoulinia* Gillies are sister groups due to the shared absence of hindwings, pointed medial process of the second segment of the labial palps, and long, poorly denticulate tarsal claws. We cannot agree based on that assessment alone. Irrespective of the fact that hindwings are now known to be present in some species of *Cheleocloeon,* the absence of hindwings in Baetidae has been shown to be a generally unreliable characteristic for inferring common ancestry and generic constraints due to the numerous instances of convergence among unrelated species throughout the family (McCafferty and Waltz 1990). The morphology of the medial process of the second segment of the labial palps is actually quite different in *Cheleocloeon* and *Demoulinia.* In *Demoulinia,* that process is anteriorly straight and distally convex (Crass 1941: Fig. 27d), not anteriorly convex as in *Cheleocloeon* (Figs. 6, 7; Soldán and Thomas 1985: Fig. 5; Wuillot and Gillies 1993: Figs. 6, 15), and it is not always pointed in *Cheleocloeon* (Soldán and Thomas 1985: Fig. 5). Furthermore, the presence of long, poorly denticulate tarsal claws in *Cheleocloeon* and *Demoulinia* may or may not be commonly derived because such claws are found in many unrelated taxa in Baetidae (e.g., *Apobaetis* Day, *Paracloeodes* Day, *Potamocloeon* Gillies, *Pseudocentroptiloides* Jacob).

Cheleocloeon apparently belongs to the *Bugilliesia* complex of genera defined by Lugo-Ortiz and McCafferty (1996) because the second segment of the male genital forceps is basally bulbous (Wuillot and Gillies 1993: Fig. 2). Furthermore, within the hypothesized cladogram of the *Bugilliesia* complex, *Cheleocloeon* would be in a position intermediate between the two most ancestral genera of the complex, *Potamocloeon* and *Afrobaetodes* Demoulin

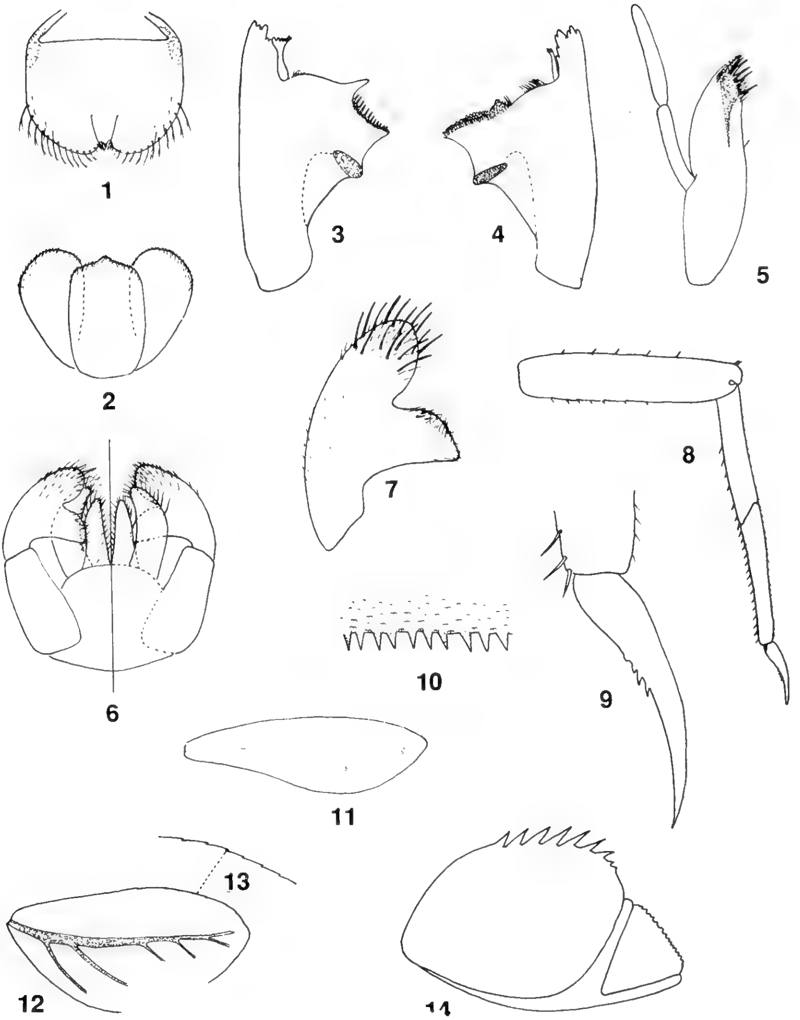
(Lugo-Ortiz and McCafferty 1996: Fig. 1). *Cheleocloeon* shares reduction of the tarsal claws (Fig. 9) and loss of the dorsal gill flaps (Figs. 11, 12) with *Afrobaetodes* and other more apotypic genera of the *Bugilliesia* complex; however, it does not share the absence of the third segment of the male genital forceps with that same group of genera. Thus, we hypothesize a sister relationship of *Cheleocloeon* with those genera, and the relatively basal phyletic derivation mentioned above. Although the larval characteristics and lack of hindwings in *Demoulinia* are inconclusive with respect to deducing its relationships, as noted above, there remains the possibility that the genus may also prove to belong to the *Bugilliesia* complex. Unfortunately, the male genital forceps figured by Crass (1947) are too schematic to allow a definitive analysis, and we have not been able to secure adult male specimens for examination.

Cheleocloeon excisum (Barnard), n. comb.

Larva. Body length: 5.9-6.2 mm; caudal filaments length: 2.5-2.7 mm. Head: Coloration yellow-brown, with vermiform markings on frons. Antennae nearly 2.0x length of head capsule. Labrum (Fig. 1) with submedial setae and bifurcate anterior marginal setae. Hypopharynx as in Figure 2. Left mandible incisors (Fig. 3) with 3 + 3 denticles; prostheca apically denticulate; small tuft of simple setae present between prostheca and mola; triangular process at base of mola somewhat sharp and elongate. Right mandible incisors (Fig. 4) with 3 + 4 denticles; prostheca apically setose; large tuft of simple setae present between prostheca and mola; small tuft of setae present at base of mola. Maxillae (Fig. 5) with four apical denticles on galealaciniae; three to four fine, simple setae present laterally near base of denticles; medial hump with stout, simple seta; palps two segmented, extending beyond galealaciniae, palp segment 2 slightly longer than segment 1. Labium (Fig. 6) with many long, simple setae marginally on glossae and paraglossae; palps two segmented; palp segment 1 subequal to segment 2; segment 2 (Fig. 7) with well-developed, distally pointed medial process, and abundant long, robust and short, fine, simple setae on surface. Thorax: Coloration yellow-brown, with no distinct pattern. Hindwingpads present in males, absent in females. Legs (Fig. 8) pale yellow-brown; femora dorsally with four to six short, simple setae and ventrally with six to eight short, simple setae; tibiae dorsally with numerous minute, fine, simple setae and ventrally with six to eight short, simple setae; tarsi dorsally with numerous minute, fine, simple setae and ventrally with 15-17 short, simple setae, somewhat increasing in length distally; tarsal claws (Fig. 9) long, nearly 0.5x length of tarsi, with three to four poorly developed denticles. Abdomen: Coloration medium brown to cream, with variable color patterns. Terga 1, 3, 5, 6, and 9 usually medium brown with various cream markings; other terga usually cream with various medium brown markings. Tergal surfaces (Fig. 10) with minute scale bases, mostly in pairs; posterior margins with sharp triangular spination. Sterna cream to pale yellow. Gill 1 (Fig. 11) elongate, paddle-shaped, poorly tracheated, without marginal serrations; gills 2-7 (Fig. 12) broadest in middle, well tracheated, with minute marginal serrations (Fig. 13). Paraprocts (Fig. 14) with six to seven sharp marginal spines. Caudal filaments cream to pale brown; terminal filament subequal to cerci.

Adult. See description by Barnard (1932).

Material examined. LESOTHO: Linakeng-Sengu, Sani R, pool above Sani bridge, IX-23-1988, P. H. Skelton, larvae (AM); SOUTH AFRICA: Eastern Cape Province: Klein Vispruit at Groot Valley, ca 20 km SW of Cradock, X-11-1990, W. P. and N. McCafferty, larvae (PERC);



Figs. 1-14. *Cheleocloeon excisum*, larva. 1. Labrum. 2. Hypopharynx. 3. Left mandible. 4. Right mandible. 5. Right maxilla. 6. Labium (left-ventral; right dorsal). 7. Segment 2 of labial palps (enlarged). 8. Right foreleg. 9. Right foretarsal claw. 10. Detail of tergum 4. 11. Gill 1. 12. Gill 4. 13. Detail of gill 4. 14. Paraproct.

Fish R, N of Karoo Sulphur Springs, nr Cradock, XI-10-1990, W. P. and N. McCafferty, larvae (PERC); Little Fish R, at R 32, nr Sheldon, XI-11-1990, W. P. and N. McCafferty, larvae (PERC); Kap R crossing, Bathurst St. For., 10 km S of Rd N 2, nr Grahamstown, IX-14-1990, W. P. and N. McCafferty, larvae (PERC); Blaukrans R at Blaukrans Pass, on Rd 67, between Grahamstown and Bathurst, XI-14-1990, W. P. and N. McCafferty, larvae (PERC); KwaZulu-Natal Province: Howick Falls, Umgeni R, X-2-1971, G. F. and C. H. Edmunds, larvae (PERC); Umzinkulu R, between Underberg and Boesmansnek, 15.5°C, X-2-1971, G. F. and C. H. Edmunds (PERC); Krantzkloof Nat. Res., Molweni R, nr Kloof, X-4-1971, G. F. and C. H. Edmunds, larvae (PERC); Umlaas R, at Durban waterworks filtration plant, nr Pinetown, X-4-1971, G. F. and C. H. Edmunds, larvae (PERC); Umgeni R, above Nagel Dam Impoundment, IX-21-1990, W. P. and N. McCafferty, larvae (PERC); Wilge R, at R 714, W of Warden, X-16-1990, W. P. and N. McCafferty, larvae (PERC); Molweni R, at Krantzkloof Nat. Res., nr Durban, IX-21-1990, W. P. and N. McCafferty and B. Fowles, larvae (PERC); Mpumalanga Province: Buffelspruit at Shalom (Aalwan), 4 km W of Badplaas paralleling Rt 38, off Avantune Rd, 1167 m, X-17 1990, W. P. and N. McCafferty, larvae (PERC); Sabie-Sand Game Res., Sand R at Londolozi, X-20-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Ntl. Pk., Sabie R at Molondozi, X-23-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Ntl. Pk., Sabie R, SE corner of Old Rhino Camp, X-24-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Ntl. Pk., Sabie R at Lisbon Estates, X-27-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Nat. Pk., Olifants R, 15 km from Blacktop Rd, at Fig Tree Site, X-29-1990, W. P. and N. McCafferty, larvae (PERC), Kruger Nat. Pk., Olifants R at bridge on dirt rd, nr Olifants Camp, X-29-1990, W. P. and N. McCafferty, larvae (PERC).

Discussion. Barnard (1932) described *C. excisum* based on larvae and reared adults from the Western Cape Province in South Africa. However, his description of the larval stage is brief and his drawings are schematic and inaccurate.

Larvae of *C. excisum* are distinguished from those of *C. dimorphicum* by the distally pointed medial process of the second segment of the labial palps (Figs. 6, 7). Larvae of *C. carinatum* and *C. yolandae* are generally similar to those of *C. excisum,* but the medial process of the second segment of the labial palps of *C. carinatum* and *C. yolandae* is longer (Wuillot and Gillies 1993: Figs. 6, 15), and their males and females lack hindwingpads.

Larvae of *C. excisum* are found in riffles and stony backwaters (Crass 1947, Palmer et al. 1993). Palmer et al. (1993) found that they mostly feed on ultrafine and fine particulate organic matter (0.5-250 µm), but mature individuals are capable of handling relatively large diatoms. Adults emerge primarily during the south-temperate winter months (June-August) according to Crass (1947).

ACKNOWLEDGMENTS

We thank H. Barber-James and F. de Moor (Grahamstown, South Africa) and N. McCafferty (West Lafayette, Indiana) for their assistance. Research funds were provided to WPM by the South African Foundation for Research Development and the Anglo-American and de Beers Chairman's Fund. The Albany Museum kindly provided office and laboratory facilities to WPM during his stay in South Africa.

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SCIENTIFIC NOTE

OBSERVATION OF THE BURYING BEETLE, *NICROPHORUS TOMENTOSUS* (COLEOPTERA: SILPHIDAE), BURYING A MOLE[1]

Paul P. Shubeck[2, 3]

On September 28, 1996 at 6:15 P.M. I approached a dead mole which had been lying near a garbage container, next to my home, about 3 days. It was breezy, and had been for several hours, and for the first time in 3 days I detected the characteristic odor of a decomposing animal. I was surprised to see what appeared to be a "bumble bee" flying around the dead mole and I bent down for a better look. Close observation revealed that the insect was actually a beetle, *Nicrophorus tomentosus* Weber, which then landed next to the mole and immediately crawled beneath it. Possible mimicry by this beetle has been commented on by Milne and Milne (1944) and by Shubeck (1971). While observing the mole and beetle I realized that only about 10 centimeters from the cadaver was another burying beetle. It was perched upon the upper edge of a stone walk with its head pointed downward and the tip of its abdomen, above the pavement, pointed straight up. In Pukowski's European study (1933), *Nicrophorus* males crawl from a small cadaver to a stone or plant and extend their abdomens obliquely and thus release odors to attract a mate.

At 6:45 P.M. (official sunset) I returned to the scene and found the "calling" individual had left its perch and apparently crawled under the mole where there was much activity. The carcass was wiggling and I could see the sides of at least 2 beetles as they excavated. The mole had sunk at least 1/2 cm along its entire length (about 15 cm).

(Continued on page 299)

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[1] Received October 17, 1996, Accepted March 5, 1997.

[2] Professor Emeritus, Montclair State University.

[3] Present Address: 65 Pleasantview Ave., New Providence, NJ 07974.

NOTES ON SOME FLEAS (SIPHONAPTERA) FROM AMAZONAS AND BAHIA STATES, BRAZIL[1, 2, 3]

Michael W. Hastriter[4], Norman E. Peterson[5]

ABSTRACT: Ten species of fleas collected from 19 mammalian host species are reported from the Brazilian States of Amazonas and Bahia. Validity of previously used taxonomic characters are considered and new ones presented.

U.S. Army Medical personnel collected small mammals in Brazil, for biomedical research, from August 1980 to February 1986. Collections included 548 fleas (10 species) from 164 mammals (19 species). Although the majority of specimens were collected from Bahia State, some were collected from the State of Amazonas where few records have been established. The purpose of this paper is to establish new distributional records, to present relevant characters to distinguish several species of *Polygenis* females, and to clarify an anatomical inconsistency published by Cerqueira and Linardi (1976) distinguishing *Polygenis tripus* (Jordan 1933) from *P. rimatus* (Jordan 1932). Data representing host/parasite associations, collection localities, and remarks on individual flea species follows. Mammal classifications follow Wilson and Reeder (1993).

Study Sites: Abbreviated collection localities and ecological data are provided as follows:

STATE OF AMAZONAS –

Loc. A: Carauarí, Gaviãe - 4°52´S 66°52´W, elev: 100 meters.

Loc. B: Tefé, Cidade Juruá - 3°23´S 66°01´W, elev: 100 meters. Collected in the Amazon Basin along the Jurua River in or adjacent to humid tropical forest where the commercially important trees have been removed.

STATE OF BAHIA –

Loc. C: Caatinga de Moura - 10°59´S 40°45´W, elev: 600 meters. Collected along streams, or marsh in the dry Caatinga region of northeastern Brazil.

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[1] Received January 9, 1997, Accepted February 24, 1997.

[2] Supported by U.S. Army Medical Research and Development Command Research Contract DAMD 17-88-H-8008.

[3] The opinions contained herein are those of the authors and should not be construed as official or reflecting the views of the Department of the Army.

[4] Monte L. Bean Life Science Museum, Brigham Young University, 290 MLBM, P.O. Box 20200, Provo, Utah 84602-0200.

[5] U.S. Army Medical Research Unit, Brazil, Unit 3501, APO AA 34030.

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Loc. D: Corte de Pedra - 13°20´S 39°28´W, elev: 200-450 meters.

Loc. E: Gandu - 13°47´S 39°35´W, elev: 300 meters.

Loc. F: Três Braços - 13°32´S 39°45´W, elev: 200-550 meters. Collected in the Atlantic Forest Region approximately 150 kilometers southeast of Salvador. This area has steep hills and valleys where cacao is grown. The region was originally covered with a humid tropical forest which has been cleared for agricultural purposes. Tall forests remain only on the hilltops. Banana and cacao plantations, secondary scrub, pasture and varying degrees of secondary forest are close to the houses.

RESULTS AND DISCUSSION

Mammalian species are arranged alphabetically followed by the species of fleas in descending order of abundance on each specific host. The numbers following the flea species indicate the number of fleas collected per number of hosts that harbored one or more fleas. *Metachirus nudicaudatus* (21%), *Proechimys iherinqi* (18%), and *Bolomys* sp. (18%) comprised 57% of the mammals which harbored fleas.

Mammalia

Carnivora (Canidae): *Cerdocyon thous* (Linnaeus, 1766): *Adoratopsylla intermedia intermedia* (1/1), *Ctenocephalides felis felis* (1/1).

Didelphimorphia (Didelphidae): *Didelphis albiventris* Lund, 1840: *A. i. intermedia* (9/11), *Adoratopsylla antiquorum antiquorum* (2/11), *Polygenis bohlsi jordani* (2/11), *Polygenis pradoi* (1/11), *Polygenis rimatus* (1/11), *Polygenis roberti roberti* (1/11); *Didelphis marsupialis* Linnaeus, 1758: *A. i. intermedia* (3/3), *P. r. roberti* (1/3); *Marmosa murina* (Linnaeus, 1758): *A. i. intermedia* (2/3), *A. a. antiquorum* (1/3; *Marmosa* sp.: *A. a. antiquorum* (1/1); *Marmosops parvidens* Tate, 1931: *A. a. antiquorum* (1/1); *Micoureus demerarae* (Thomas, 1905): *A. a. antiquorum* (2/3), *P. r. roberti* (1/3); *Metachirus nudicaudatus* (Desmarest, 1817): *A. i. intermedia* (35/35), *A. a. antiquorum* (2/35); *Monodelphis americana* (Muller, 1776): *A. a. antiquorum* (4/4); *Philander opossum* (Linnaeus, 1758): *A. i. intermedia* (2/2).

Rodentia (Cavidae): *Cavia aperea* Erxleben, 1777: *Polygenis tripus* (3/4), *P. r. jordani* (2/4), *A. i. intermedia* (1/4).

Rodentia (Echimyidae): *Proechimys iheringi* Thomas, 1911: *Hectiella nitidus* (27/29), *A. i. intermedia* (2/29), *P. pradoi* (1/29); *Proechimys longicaudatus* (Rengger,1830): *Gephyropsylla klagesi samuelis* (3/3).

Rodentia (Muridae): *Bolomys lasiurus* (Lund, 1841): *P. rimatus* (2/5) *A. i. intermedia* (1/5), *P. pradoi* (1/5), *P. tripus* (1/5); *Bolomys* sp.: *P. pradoi* (17/25), *P. rimatus* (6/25), *A. i. intermedia* (2/25), *A. a. antiquorum* (1/25), *P. tripus* (1/25); *Holochilus brasiliensis* (Desmarest, 1819): *G. k. samuelis* (1/2), *P. pradoi* (1/2); *Nectomys squamipes* (Brants, 1897): *P. r. roberti* (5/6), *A. a. antiquorum* (1/6), *A. i. intermedia* (1/6); *Oryzomys capito* (Olfers, 1818): *P. r. roberti* (2/2), *H. nitidus* (1/2); *Oryzomys subflavus* (Wagner, 1842): *A. a. antiquorum* (2/2); *Oryzomys* sp.: *P. r. roberti* (3/7), *A. i. intermedia* (2/7), *A. a. antiquorum* (1/7), *P. b. jordani* (1/7); *Oxymycterus* sp.: *P. rimatus* (14/14), *P. r. roberti* (2/14), *A. a. antiquorum* (1/14); *Rhipidomys masticalis* (Lund, 1840): *A. a. antiquorum* (1/1).

Siphonaptera

The number of male and female fleas found on any particular host species precedes the host for each locality at which they were collected.

Pulicidae: *Ctenocephalides felis felis* (Bouché, 1835) — Loc. C: 1♀, *C. thous.*

Ctenophthalmidae: *Adoratopsylla* (*Adoratopsylla*) *antiquorum antiquorum* (Rothschild, 1904) — Loc. D: 2♂,3♀, *M. americana*; 1♀ each, *M. demerarae, Marmosa* sp., *N. squamipes, O. subflavus,* and *Oryzomys* sp.; Loc. F: 4♀, *M. demerarae*; 2♂, 1♀, *M. murina*; 2♂, *M. nudicaudatus*; 2♀, *D. albiventris;* 1♂, 1♀, *O. subflavus;* 1♂ each, *M. parvidens, Marmosa* sp., *Oxymycterus* sp., and *R. masticalis*; 1♀, *Bolomys* sp.

REMARKS: The known distribution of *A. a. antiquorum* extends from Venezuela (Tipton and Machado-Allison, 1972) to southeastern Brazil. Guimarães (1972) found this species widely distributed in the Brazilian States of Alagoas, Ceara, Bahia, and Pernambuco mainly on marsupial hosts and sporadically on various species of *Bolomys, Oryzomys,* and *Proechimys.*

Adoratopsylla (Tritopsylla) intermedia intermedia (Wagner, 1901) — Loc. C: 2♂, *C. aperea;* 3♂, *B. lasiurus;* Loc. D: 24♂, 4♀, *M. nudicaudatus;* 15♂,18♀, *D. marsupialis;* 1♀ each, *C. thous, N. squamipes,* and *Oryzomys* sp.; Loc. E: 67♂, 46♀, *M. nudicaudatus;* 2♂, 3♀, *D. albiventris;* 1♂, 1♀, *Bolomys* sp.; 1♂, 1♀, *M. murina;* 1♂, *Oryzomys* sp.; Loc. F: 61♂, 47♀, *M. nudicaudatus;* 14♂, 10♀, *D. albiventris;* 1♂, 2♀, *P. opossum;* 1♂, 1♀, *P. iheringi.*

REMARKS: *Adoratopsylla i. intermedia* has the broadest distribution of all the species of Adoratopsylla, occurring from Venezuela south through Argentina on marsupials. It comprised 60 percent (329/548) of all species collected. *Metachirus nudicaudatus* and *D. albiventris* were the predominant hosts in Bahia. Ninety-six percent of the combined species collected in the genera *Metachirus* and *Didelphis* were infested with *A. i. intermedia.* Tipton and Machado-Allison (1972) reported large numbers of *A. i. intermedia* from *Didelphis azarae* in Venezuela, while Guimarães (1972) found none on *D. azarae* in Bahia. It should be noted that *D. azarae* is synononomized with *D. albiventris* in Venezuela and with *Didelphis aurita* in Bahia according to Hershkovitz (1969) and Wilson and Reeder (1993), respectively. Thus, two closely related marsupials, *D. albiventris* and *D. aurita,* do not appear to harbor the same common flea, *A. i. intermedia.*

Rhopalopsyllidae: *Gephyropsylla klagesi samuelis* (Jordan and Rothschild, 1923) — Loc. A: 3♂, 1♀, *H. brasiliensis;* 2♂, 1♀, *P. longicaudatus;* Loc. B: 3♀, *P. longicaudatus.*

REMARKS: Linardi and Guimarães (1993) erected *Gephyropsylla,* a subgenus established by Smit (1987) under *Polygenis,* to full generic status. Although *G. k. samuelis* has been reported from Costa Rica, Panama, Venezuela, Colombia, Ecuador, Bolivia and Brazil, this is the first record of its presence south of the Amazon River in the State of Amazonas. Specimens were collected from *H. brasiliensis* and *P. longicaudatus* along the corridor of the Juruá River. According to a study of Venezuelan populations of *G. k. samuelis* and the nominate subspecies by Machado-Allison and McLure (1963), both prefer species of *Proechimys* as hosts.

Hectiella nitidus (Johnson, 1957) — Loc. F: 32♂, 41♂, *P. iheringi;* 1♀, *O. capito.*

REMARKS: *Hectiella,* once considered a subgenus of *Polygenis,* was erected to full generic status by Linardi and Guimarães (1993). *Hectiella nitidus* was found on 27 of 29 *P. iheringi* examined in the area of Três Braços, while only a single specimen (probable accidental association) was found on *O. capito.* Although the species was originally described from two females by Johnson (1957) and collected from *D. marsupialis* in Bahia, the male was later described by Linardi and Nagem (1980) from *Proechimys dimidiatus* in Caratinga, State of Minas Gerais, Brazil. Botelho, et al. (1981) also collected specimens from the latter area and determined species of *Proechimys* as the preferred host. In the State of Bahia, *P. iheringi* is clearly the preferred host for this species and few other flea species were collected from this host. The distribution of *H. nitidus* is restricted to Brazil.

Polygenis (Polygenis) bohlsi jordani (Costa Lima, 1937) — Loc. c: 1♂, 1♀, *C. aperea;* Loc. E: 2♂, 1♀, *D. albiventris;* 1♂, *M. nudicaudatus;* 1♀, *Oryzomys* sp.

REMARKS: This subspecies was collected on the southern edge of its known range of northeastern Brazil. *Polygenis b. jordani* displays little host specificity, occurring on numerous host species. Guimarães (1972) found this species the most ubiquitous flea from areas collected in Bahia State to northeastern Brazil and indicated a close association with domestic rats. Because of its potential for transmitting plague between the urban and sylvatic mammalian reservoirs, this species should be considered important during plague outbreaks in Brazil.

Polygenis (P.) pradoi (Wagner, 1937) — Loc. D: 1♂,10♀, *Bolomys* sp.; Loc. F: 8♂,11♀, *Bolomys* sp.; 2♂,1♀, *B. lasiurus;* 1♂ each, *D. albiventris* and *P. iheringi.*

REMARKS: Botelho and Linardi (1980) collected *P. (P.) pradoi* primarily from *B. lasiurus*, and indicated the most northern limit as Caratinga County, Minas Gerais, Brazil. Our collections (also found on *B. lasiurus*) extend the species range north to Corte de Pedra and Três Braços, Bahia. It is reported to range south to Buenos Aires Province, Argentina, and a disjunct population is also reported in southwestern Colombia by Mendez (1977). Linardi (1979) thinks a complex of *P.* (*P.*) *pradoi* along coastal Brazil needs revision. Populations from Colombia and those extending from Brazil to Argentina should also be included in such a revision.

Polygenis (P.) rimatus (Jordan, 1932) — Loc. C: 1♂, 1♀, *B. lasiurus;* Loc. D: 4♂, 3♀, *Oxymycterus* sp.; 1♂, 1♀, *Bolomys* sp.; Loc. F: 9♂, 9♀, *Oxymycterus* sp.; 4♀, *Bolomys* sp.; 1♂, 1♀, *D. albiventris;* 1♀, *B. lasiurus.*

REMARKS: These collection records constitute the northern range of this species occurring on numerous cricetine rodents. *Polygenis rimatus* females from Bahia State differ from those examined from Argentina. The duct of the spermatheca is characteristically enlarged from its proximal origin to approximately 2/3 its length *(pars dilatata).* The *pars dilatata* has a greater diameter in all specimens examined from Argentina than those from Bahia, but no portion is sclerotized. The Bahia State populations of *P. rimatus* possess a distinctly sclerotized U-shaped region (Fig. 1) not present in Argentina populations examined. The sclerotization abruptly begins, and diminishes as it traverses towards the spermatheca. Maceration alters the position and orientation of this structure, but the evident rigidity of the obvious sclerotization maintains the consistently uniform U-shape. The posterior margin of the 7th sternite is also gently rounded, without lobes, undulations, or angular features.

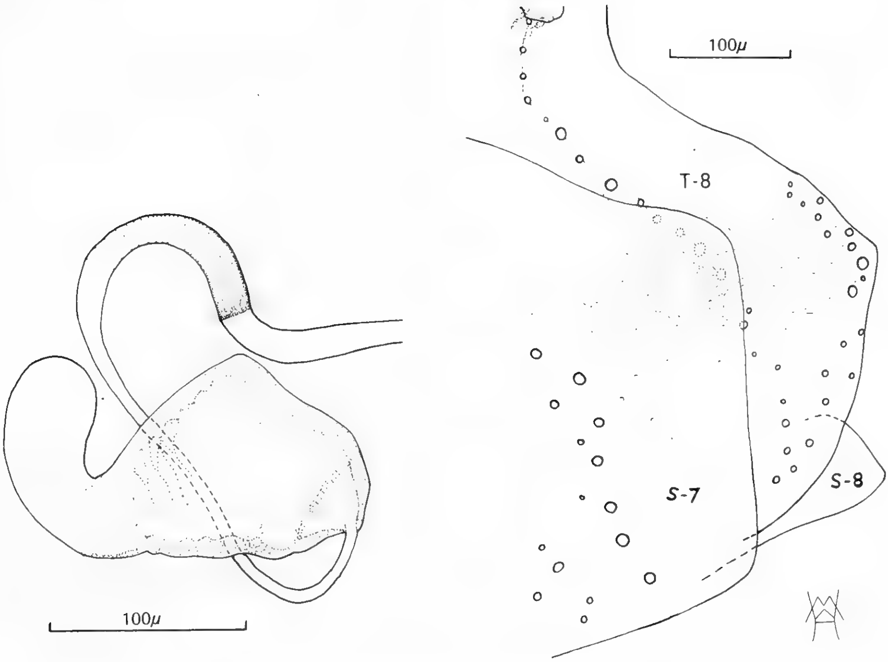
Many specimens of the following species borrowed from the British Museum that might be confused with *P. rimatus (P. acodontus, P. axius axius, P. axius proximus, P. brachinus, P. litargus, P. occidentalis occidentalis,* and *P. tripus)* were examined. Although the spermathecal ducts may vary within each species, only *P. rimatus, P. tripus* and *P. brachinus* have an enlarged *pars dilatata.* Excluding *P. rimatus,* neither possessed an area of sclerotization except for a population of *P. tripus* from Salta Province, Argentina. The latter specimens were illustrated by Smit (1987) to separate *P. tripus* from all the species above. Of the material examined from the British Museum (Argentina, Bolivia and Brazil), only the Salta Province, Argentina population possessed this character, negating its usefulness to distinguish *P. tripus* from others. In general, little or no expansion or sclerotization of the duct of the spermatheca exists in *P. acodontus* (Argentina), *P. axius axius* (Argentina), *P. litargus* (Peru), and *P. o. occidentalis* (Brazil). These observations might be considered for future revisionary work on *Polygenis,* which is badly needed.

Polygenis (P.) roberti roberti (Roths., 1905) — Loc. D: 5♂, 4♀, *Oryzomys* sp.; 3♀, *N. squamipes;* 1♂, 1♀, *M. demerarae;* 1♀, *D. marsupialis;* 1♂, *Oxymycterus* sp.; Loc. F: 2♂, *N. squamipes;* 2♀, *O. capito:* 1♀ each, *D. albiventris, H. brasiliensis,* and *Oxymycterus* sp.

REMARKS: Linardi (1977) indicated this species to be rather host specific, although it was sporadically collected on five mammalian genera. Specimens were most frequently collected on species of *Oryzomys.*

Polygenis (P.) tripus (Jordan, 1933) — Loc. C: 4♂, *C. aperea;* Loc. F: 1♀, *Bolomys* sp.

REMARKS: This species was reported by Linardi, et al. (1984) and Cerqueira and Linardi (1977, 1981) as the most common *Polygenis* species in



1 2

Fig. 1. *Polygenis rimatus*, spermatheca and sclerotized *pars dilatata*. Fig. 2. *P. tripus*, eighth tergite illustrating "scale-like clear spot" beneath seventh sternite.

Belo Horizonte, Minas Gerais, Brazil on *Bolomys lasiurus*. It is also commonly found on species of *Oryzomys*, but none were collected from either of these usual host species in Bahia. Cerqueira and Linardi (1976) reported a diagnostic feature for distinguishing *P. tripus* females from those of *P. rimatus*. The latter paper indicates (both in text and in photo caption) a "scale-like clear spot" in the integument of the 7th sternite, and references the same morphological feature on the 8th sternite in the English summary. This unique character, keenly observed and reported by these authors, is located on neither the 7th nor 8th sternite, but rather on the 8th tergite, occurring just beneath the dorso-caudal angle of the 7th sternite (Fig. 2). This clear area occurs within a heavily sclerotized region of the 8th tergite bearing coarse reticulations in the vicinity of the clear area. The clarity of this spot in specimens examined from Brazil, Argentina, and Bolivia was distinct in some specimens and obscure in others. This seemed to be a function of proper specimen preparation (not over, or under-clearing).

ACKNOWLEDGMENTS

Grateful appreciation is extended to Robert E. Lewis, Iowa State University, Nancy Adams, Curator of the Siphonapteran collection, U.S. National Museum of Natural History, and Theresa Howard, The Natural History Museum, London, England for providing specimens of *Polygenis* for study; to Paulo R. L. Lago, of the Ministry of Health (SUCAM), Brazil, who assisted in mammal and flea collections; and to Clive D. Jorgensen, Glenn E. Haas, and Eustorgio Méndez for providing helpful suggestions with the manuscript.

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A NEW DISTRIBUTIONAL RECORD FOR *HAIDEOPORUS TEXANUS* (COLEOPTERA: DYTISCIDAE), A STYGOBIONTIC BEETLE FROM THE EDWARDS AQUIFER, TEXAS[1]

David E. Bowles[2], Ruth Stanford[3]

ABSTRACT: *Haideoporus texanus* recently was collected from the Edwards Aquifer at Comal Springs, New Braunfels, Texas. This is a significant new distributional record for this rare subterranean beetle formerly known only from an artesian well in San Marcos, Texas, suggesting the species may be more widely distributed in the Edwards Aquifer than previously thought.

The Edwards Aquifer located in south-central Texas has the highest known diversity of endemic subterranean aquatic species in the world (Longley 1981). Presently, there are 44 endemic, stygobiontic species reported from this aquifer (Bowles and Arsuffi 1993, Spangler and Barr 1995). Spangler (1996) defined stygobiontic species as those found almost exclusively in all their developmental stages in subterranean aquatic habitats and exhibiting various morphological adaptations associated with such habitats. Adaptations to subterranean habitats may include reduction or loss of eyes, loss of hindwings in some insects, greatly elongated sensory setae on the body and appendages, and decreased pigmentation and sclerotization of the integument (Young and Longley 1976). Represented among the primarily crustacean fauna of the Edwards Aquifer are three beetles (Coleoptera) including *Haideoporus texanus* Young and Longley (Dytiscidae: Hydroporinae), *Comaldessus stygius* Spangler and Barr (Dytiscidae: Bidessini), and *Stygoparnus comalensis* Barr and Spangler (Dryopidae). Stygobiontic beetles occurring in the United States have been reviewed by Barr and Spangler (1992), Larson and LaBonte (1994), Longley and Spangler (1977), Spangler and Barr (1995), and Young and Longley (1976).

Haideoporus texanus previously was known only from an artesian well located on the campus of Southwest Texas State University in San Marcos, Texas (Young and Longley 1976, Longley and Spangler 1977). The well was drilled into the San Marcos pool of the Edwards Aquifer in the late 1800's and has been the source for most of the collections of stygobiontic species from the aquifer. Recent collections from natural spring orifices at Comal Springs in New Braunfels, Texas, also yielded examples of *H. texanus*. Comal Springs,

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[1] Received January 30, 1997. Accepted March 4, 1997.

[2] Texas Parks and Wildlife Department, 300 C. M. Allen Parkway, Building B, San Marcos, TX 78666.

[3] United States Fish and Wildlife Service, Ecological Services, 10711 Burnet Road, Suite 200, Austin, TX 78758.

ENT. NEWS 108(4): 297-299, September & October, 1997

the largest spring system in Texas, issues from the San Antonio pool of the Edwards Aquifer approximately 24 km south of the artesian well in San Marcos. This new collection record shows that *H. texanus* is more widely distributed in the Edwards Aquifer than previously thought. However, the complete extent of this species' distribution in the aquifer remains unknown. The Edwards Aquifer extends for approximately 282 km from Brackettville in Kinney County northward to Georgetown in Williamson County and varies from eight to 48 km in width (Klemt et al. 1979, Barker et al. 1994). Numerous springs and wells occur in this broad area (Brune 1981) and *H. texanus* eventually may be found at other locations fed by the aquifer.

Several studies have shown that the Edwards Aquifer is being rapidly depleted due to excessive groundwater pumping (Longley 1992), and water quality is threatened by the encroachment of poor quality, saline water (Perez 1986, Barker et al. 1994) and contamination from the surface. Because of these threats, some of the unique and diverse aquatic fauna inhabiting the aquifer is at risk of extinction (Bowles and Arsuffi 1993). Recently, the United States Fish and Wildlife Service published proposed rules for listing some of these species as endangered though *H. texanus* was not among them (Stanford and Shull 1995).

Three adult specimens were collected by placing Wildco® stream driftnets (363 μm mesh) at various orifices at Comal Springs for 24 hours on various sampling dates during 1993-1994. Samples were preserved in the field with 70% isopropyl alcohol and the beetles were later removed and pinned. Specimens are deposited in the National Museum of Natural History, Washington, DC (NMNH), the Essig Museum of Entomology, Berkeley, California (EME), and the Texas A&M University Entomological Collection, College Station, Texas (TAMU). Immature stages were not collected during this study.

SPECIMENS EXAMINED: United States, Texas, Comal County, New Braunfels, Landa Park, Comal Springs, spring-run 2, D. E. Bowles, and R. Stanford, 24-hour drift net, Oct 1993, 1 ♂ (NMNH); same data, but spring run 3, 26 Jan 1994, 1 ♀ (TAMU); same data, but Apr 1994, 1 ♀ (EME).

ACKNOWLEDGMENTS

We thank Paul Spangler, Cheryl Barr and Sharon Jasper for reviewing an earlier draft of this paper and for confirming our identification of the beetle.

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(Continued from page 289)

At 7:00 A.M. the following morning (official sunrise had occurred at 6:50 A.M.) I returned to the scene and found the interment had been completed. There was no mound or any evidence of a burial except that the surface of the soil had been perfectly smoothed over and was even with the soil surface adjacent to the site of burial.

In a previous study (Shubeck et. al., 1981), it had been noted that seasonal activity for *N. tomentosus* virtually ended in October and November. It is possible then, this burial provided food and protection for overwintering adult and/or immature individuals. Another previous study showed also that this species of *Nicrophorus* is active diurnally (Shubeck 1971). In the observations described in this scientific note, I noted the following: (1) the cruising, searching, and "calling" activity of *N. tomentosus* apparently can continue up to the very end of the diurnal period, *and* (2) the interment of the cadaver can be completed nocturnally.

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SYNAPTONECTA ISSA (HETEROPTERA: CORIXIDAE), FIRST NEW WORLD RECORD OF AN ASIAN WATER BUG IN FLORIDA[1]

J. T. Polhemus[2], R. P. Rutter[3]

ABSTRACT: The Asian corixid *Synaptonecta issa* was first discovered in south Florida in October 1993. A single male was taken in a dipnet sample from an herbaceous depressional wetland in St. Lucie County, Florida. Its presence in Florida may be the result of commercial trade in aquarium plants. Despite state regulation and federal inspection, there is ample opportunity for the importation and subsequent release of foreign aquatic insects.

Synaptonecta issa (Distant) was discovered in Florida when a single male was taken in a dipnet sample from an herbaceous depressional wetland in St. Lucie County, south Florida, in October 1993. The wetland was one of two, measuring 3.6 and 7.8 h, that had been constructed in the spring of 1990. Both wetlands were disked with donor mulch from nearby wetlands to help establish aquatic vegetation, and some shoreline was made contiguous with natural wetlands to promote water and propagule exchange. Both wetlands were qualitatively sampled again in April 1994, but no *S. issa* were found; the only corixid found was *Sigara bradleyi* (Abbott). Sampling was conducted again in October 1995, at which time several adults and immatures of *S. issa* were collected from two locations in the wetland where the species was first found. Water depth was 51 cm, and predominant vegetation was maidencane (*Panicum hemitomon*), umbrella grass (*Fuirena scirpoidea*), fragrant water lily (*Nymphaea odorata*), and the filamentous alga *Spirogyra* sp. No specimens were recorded from the other constructed wetland, although it was only 46 m distant and had periodically experienced exchange of surface water.

In September 1994, a single adult female was collected in a dipnet sample from the shoreline of oligotrophic Lake Viola in Highlands County, south central Florida. The predominant vegetation in the sample area was torpedograss (*Panicum repens*), spikerush (*Eleocharis* sp.), and associated filamentous algae. Values for selected physiochemical parameters measured at the time of sampling were: water temperature 30° C, specific conductance 227 µmhos/cm, pH 7.8 (8.2 in March 1994), and alkalinity 34 mg/l. No other corixids were collected in the sample.

A multitude of other habitats in south Florida, with varying water quality

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[1] Received January 9, 1997. Accepted February 23, 1997.

[2] Colorado Entomological Museum, 3115 S. York St., Englewood, CO. 80110.

[3] Florida Department of Environmental Protection, South District, 2295 Victoria Avenue, Fort Myers, Florida 33901.

ENT. NEWS 108(4): 300-304, September & October, 1997

conditions including rivers, streams, canals, lakes, ponds, and wetlands, have been sampled for aquatic macroinvertebrates since 1980 as part of the Florida Department of Environmental Protection's water quality monitoring program, but no other specimens of *S. issa* have been collected.

Synaptonecta issa (Distant)

Micronecta issa Distant, 1910:350 (Holotype, macropterous male, Travancore, S. India); Lundblad, 1933:100 (systematics; distribution); Chen, 1960:102 (key to species); Fernando & Leong, 1963:548 (dispersal); Leong, 1966:84 (systematics; distribution); Wrobleswki, 1968:775 (checklist); Fernando & Cheng, 1974:37 (distribution).

Synaptonecta breddini Lundblad, 1933:109 (Holotype, brachypterous male, Buitenzorg, Java); Hutchinson, 1940:398 (synonymy).

Synaptonecta issa; Hutchinson, 1940:346, 348, 398, pl. XXXI, figs. 411-415 (systematics; distribution; brachypterous form from Burma); Wroblewski, 1972:4, 14 (systematics; distribution; redescription, macropterous form); Jansson & Meyer-Rochow, 1990:328 (sound production; distribution).

Micronecta (Synaptonecta) issa; Wrobleswki, 1967:243 (systematics; distribution).

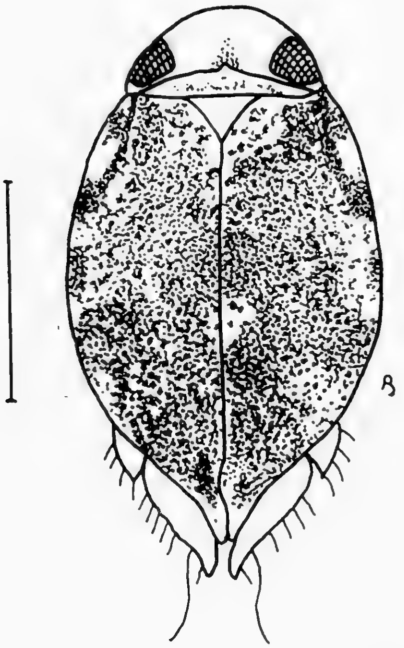

Figure 1. *Synaptonecta issa* (Distant). Female, dorsal habitus. Scale bar= 1 mm.

Macropterous females are relatively common in southeast Asia, and are often taken in light traps (Fernando & Leong 1963), but specimens of the brachypterous morph, mostly males, are not common in collections. Wroblewski (1967:248) states that, with respect to light trap material, the "immense dominance of females in ... *Synaptonecta issa* (Dist.) is easy to explain. The males are mostly, or almost exclusively, brachypterous, not able to fly." The brachypter differs radically in appearance from the more common macropter. Distant (1910) provided a habitus illustration of the macropterous morph, but the brachypterous morph, with coleopteroid hemelytra, has never been adequately illustrated (see Fig. 1). Lundblad (1933) provided a line drawing of the left hemelytron and some other structures (of the synonymous *S. breddini*). Even when the two morphs are compared side by side, it is very easy to believe that they represent different species, as Lundlbad (1933) did when he described the synonym, *Synaptonecta breddini*. One of us (JTP), when confronted with the first brachypterous specimens from Florida, thought it might represent an undescribed New World genus (which would be truly remarkable, from well collected Florida), but recently he found similar brachypterous specimens in a sample from Thailand (Phattalung Province; Sites and Nichols leg.). The male genitalic morphology is diagnostic, as is the low elliptical carina on the vertex of the head.

DISTRIBUTION AND ECOLOGY

Synaptonecta issa is a widespread species, naturally distributed from Sri Lanka and India to Java, Malaysia and Thailand, and recently accidentally introduced into New Zealand (Jansson & Meyer-Rochow 1990).

Jansson & Meyer-Rochow (1990) suggest that the most plausible mode of introduction into New Zealand was through eggs attached to aquatic aquarium plants brought from Singapore, where the species is common. We believe it likely that the species was brought to Florida in the same way. Because the Singapore suppliers of aquatic plants undoubtedly ship to many parts of the world, this species can be expected to turn up in aquariums anywhere, and in the wild in warm climates.

Aquatic plants imported from southeast Asia enter Florida weekly at Miami International Airport, and can include the following species (list provided by Brad McLane, State of Florida Aquatic Plant Association, August 1995):

Singapore	*Cabomba caroliniana, Crinum thaianum, Echinodorus blerhi, Hygrophila difformis, Microsorium pteropus. Vallisneria* sp. (Corkscrew)
Thailand	*Anubias nana, Barclaya longifolia, Cabomba caroliniana, Crinum thaianum, Cryptocoryne balansae, C. retrospiralis. Vesicularia dubyana*
Sri Lanka	*Aponogeton crispus, Cryptocoryne wendtii* (red), *Nymphaea stellata*
Madagascar	*Aponogeton boivinianus, A. capuroni, A. fenestralis, A. longiplumulosus, A. ulvaceus*

Most imported plants are nursery grown, but not under quarantine conditions. Growers dam up streams to allow water to flood their crops. Plants collected from the wild are generally inferior in appearance and are hence less marketable; these plants are trimmed and propagated in nurseries before exportation (Brad McLane, pers. comm.). USDA inspection of incoming plants is limited, as only about 2% of each species is visually inspected for the presence of potential pests (e.g., Lepidoptera) and parasite vectors of public health concern (e.g., Gastropoda). If a potential pest is found, the entire species lot is fumigated with methyl bromide (Tad Dobbs, pers. comm.). There is no intentional control of nonpest/nonvector species. *Synaptonecta issa* in any life stage would go unnoticed because of its small size, but even if found it would go untreated because aquatic hemipterans are presumed to be predatory (although most corixids are not) and therefore not of quarantine concern (Tad Dobbs, pers. comm.).

Both the Florida Department of Agriculture and Consumer Services, and the Florida Department of Environmental Protection (FDEP) have regulatory control over the importation, cultivation, and distribution of aquatic plants in Florida. Rules in chapter 62C-52 state that "No person, except aquatic plant nurseries regulated by the Department of Agriculture and Consumer Services, shall engage in any business activity involving the importation, transportation, sale or possession of any aquatic plant species without a permit issued by the department...." Florida maintains an *Aquatic Plant Locator,* which as of June 1993 (Rogers 1993) listed 250 businesses that supply aquatic plants, imported and native. Despite state regulation and federal inspection, there is opportunity for the importation and subsequent release of aquatic insects.

This is not the first documentation of an Asiatic aquatic insect becoming established in south Florida. Paulson (1978) recorded the presence of an Asiatic dragonfly, *Crocothemis servilia* (Drury), from Dade County, Florida in 1977, which by 1993 had spread to six additional counties (Daigle and Rutter 1984), and is now established in Hawaii as well (Polhemus 1995).

ACKNOWLEDGMENTS

Our compliments to Ed Emmons for collecting, as far as we know, the first Florida specimen of *Synaptonecta issa,* and also our thanks for providing the monitoring reports for the constructed wetlands. Brad McClane, Tad Dobbs, and Rob Kipker were helpful in providing information on the importation and regulation of aquatic plants. We thank R. L. Sites and B. Nichols for making available specimens from Thailand. R. T. Schuh and D. A. Polhemus provided constructive reviews of the manuscript. JTP carried out this research as a faculty affiliate of the Entomology Department, Colorado State University, Fort Collins.

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(Continued from page 258)

Dr. Edwards described an elegant developmental model used to determine the distribution of temperatures experienced by adult *M. grandii* in both Delaware and Korea. Though there were significant differences in the temperature distributions between populations, the differences in distributions between generations within populations were greater. Laboratory experiments showed no difference in the effects of temperature on ovipositional performance between *M. grandii* from Delaware and Korea. This result suggests no adaptation with respect to this fitness trait. At both locations, however, *M. grandii* would be expected to have greater fitness (ovipositional performance) in the first generation than in the second. Dr. Edwards is continuing to research these questions.

Several items of entomological news were related, including publication in the *Philadelphia Inquirer* of a report that the last remaining habitat for Regal Fritillary *(Speyeria idulia)* in Pennsylvania is threatened, and a report from Dave Wright on the earliest ever adult Spring Azure *(Celastrina lucia* of authors) in New Jersey, Feb. 27, in Cape May.

W. J. Cromartie
Corresponding Secretary

NEW STATE AND U. S. RECORDS AND OTHER DISTRIBUTIONAL NOTES FOR HETEROPTERA (INSECTA)[1]

J. T. Polhemus[2]

ABSTRACT: *Buenoa pallens* is recorded for the first time in the United States, from Val Verde, Co., TX. Fifteen new state records are established, and distributional data are given for six additional species.

The following represent range extensions, or records of seldom-collected but previously reported species for the United States. Voucher specimens are found in the J. T. Polhemus Collection, Colorado Entomological Museum (JTPC), unless otherwise noted; a significant amount of material reported here is from the Texas A & M University collection. These state or U. S. records were not included in the *Catalog of Heteroptera of North America* (Henry & Froeschner 1988). Several of these species are rather common in the states listed and some were collected over 50 years ago; but to my knowledge they have never been reported in the literature.

The collection location (CL) numbers following localities refer to codes used by JTP to reference ecological data. Unless otherwise stated, the known distributions are based on Henry and Froeschner (1988).

NEW U. S AND STATE RECORDS

Enicocephalidae

Systelloderes biceps (Say) New Record for Kansas

This species is widespread in the eastern and southern U. S.

Material examined: KANSAS, Riley Co.: 1 male, 29 May 1968, R. L. Bertwell (University of Wyoming, Laramie).

Lygaeidae

Ischnodemus falicus (Say) New Record for Colorado

Common over the eastern half of the U. S., this is the westernmost record for this species.

Material examined: COLORADO, Jefferson Co.: many males & females, marsh, Chatfield State Park, 14 May 1992, J. T. Polhemus

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[1] Received January 9, 1977. Accepted February 23, 1977.

[2] Colorado Entomological Museum, 3115 S. York St., Englewood, Colorado, 80110, USA.

Reduviidae

Reduvius personatus Linnaeus New Record for Colorado

This cosmopolitan species is widespread in the U. S.

Material examined: COLORADO, Arapahoe Co.: males & females, Englewood, in home or at light at home, J. T. Polhemus, on the following dates: 13 July 1984; 21 June 1986; 5 June 1988; 23 June 1989; 16 Dec. 1989 (nymph found in home, raised to adult over 18 months); 9 July 1990; 11 July 1993; 2 June 1994; 13 June 1994; 16 July 1994; 6 Aug. 1994; 2 July 1996; 14 July 1996, between timbers.

Belostomatidae

Belostoma bakeri Montandon New record for Colorado

Previously known from Kansas, New Mexico, and other states further west.

Material examined: COLORADO, Las Animas Co.: many males & females, pond, head of Carrizo Creek, S. of Kim, CL 2729, 26 Aug. 1992, J. T. Polhemus.

Hebridae

***Hebrus comatus* Drake & Harris** New record for Colorado

Previously known from Kansas, New Mexico, and Texas.

Material examined: COLORADO, Yuma Co.: 2 females, Chief Creek, nr. Wray, el. 1098 m., CL 2690, 6 June 1992, J. T. Polhemus & C. N. McKinnon; 2 males, 3 females, same data as for preceding record, but on seeps at head of Chief Creek, west of Wray, el. 1113 m., CL 2691.

Hydrometridae

Hydrometra martini Kirkaldy New records for Nevada and Washington

Common in the eastern U. S. as far west as Arkansas, Oklahoma, and Texas, and previously known but scarce in Arizona, California, Colorado, Idaho, and Oregon. The occurrence in Oklahoma was recorded by Schaefer & Drew (1967) but overlooked in the Catalog of Heteroptera of North America (Smith 1988).

Material examined: NEVADA, Lincoln Co.: 1 male, Crystal Spring, S. of Hiko, el. 1234 m, CL 2710, 20 July 1992, J. T. & D. A. Polhemus. WASHINGTON, Grant Co.: 1 male, 1 female, Soda Lake nr. O'Sullivan Dam, Columbia Nat. Wildlife Ref., 10 June 1973, D. Corredor; Yakima Co., 1 male, 1 female, 8 mi. SW of Tieton RS, Snoqualmie NF, Bear Cr., 11-12 June 1973, M. Jackson.

Mesoveliidae

Mesovelia mulsanti White New records for Arizona, Colorado, and Nebraska

This species is very widespread in the Western Hemisphere.

Material examined: ARIZONA, Mohave Co.: 1 male, Beaver Lodge, 13 May 1961, J. T. Polhemus. COLORADO, Jefferson Co.: 1 female, Lakewood, 14 May 1992, J. T. Polhemus; Yuma Co.: 2 males, 2 females, Hale Ponds, 6 mi. E. Hale, CL 1920, 10 July 1987, J. T. Polhemus. NEBRASKA, Douglas Co.: 1 female, Omaha, 9 July 1952, J. T. Polhemus..

Mesovelia cryptophyla Hungerford New record for Texas

Previously known from the eastern U. S., as far west as Iowa, Michigan, Mississippi, and Oklahoma.

Material examined: TEXAS, Collin Co.: 2 males, 2 females, McKinney, Heard Pond, 7 May 1991, T. Vasarhelyi.

Naucoridae

Ambrysus thermarum La Rivers New record for Utah

This species occurs in Arizona, New Mexico, and three widely separated regions of Colorado, including West Creek, near Gateway, on the eastern side of the La Sal Mountains (Polhemus, unpubl. data). Mill Creek originates on the west side of the La Sal Mountains and flows into Moab, Utah. The record for *Ambrysus woodburyi* from Moab (La Rivers 1951) is a misidentification of *A. thermarum*.

Material examined: UTAH, Grand Co.: many males & females, Moab, Mill Creek, CL 2907, 5 Aug. 1993, J. T. Polhemus.

Notonectidae

Buenoa margaritacea Torre Bueno New record for Iowa

Common and widespread in the United States and northern Mexico.

Material examined: IOWA, Boone Co.: 1 female, Ledges State Park, 28 March 1946, J. T. Polhemus; 4 males, 6 females, Ledges State Park, 22 Sept. 1960, J. C. Schaffner (TAMU); Clay Co.: 1 female, E. of Peterson, 2 Aug. 1975, J. T. Polhemus; Story Co.: 1 female, Ames, 20 Sept. 1945, J. T. Polhemus; 3 males, 5 females, Lake Comar, 18 June 1945, J. T. Polhemus.

Buenoa pallens (Champion) New record for Texas and U. S.

Anisops pallens Champion, 1901:374.
Buenoa pallens Kirkaldy, 1904:121.

Common from central Mexico and the West Indies southward to Chile and Peru (Truxal 1953).

Material examined: TEXAS, Val Verde Co.: many males & females, Dolan Falls Ranch, The Nature Conservancy of Texas, pools in side canyon to Dolan Creek, 20 April 1996, J. T. Polhemus; same data as for preceding record, but from Leon Spring, 21 April 1996, J. T. Polhemus.

Notonecta lunata Hungerford New record for Indiana

Widespread in eastern Canada and the northeastern U. S., as far west as Michigan.

Material examined: INDIANA, Monroe Co.: many males & females, Lake Beanblossom, 7-25 March 1961, J. C. Schaffner; Brown Co.: 1 male, 1 female, Yellowwood S. F., 28 March 1961, J. C. Schaffner.

Notonecta undulata Say New record for Colorado

Previously known from states surrounding Colorado.

Material examined: COLORADO, Arapahoe Co.: 1 male, 1 female, spring fed pond along Highline Canal Trail, Cherry Hills Village, 27 May 1996, J. T. Polhemus; Saguache Co.: 2 males, 1 female, Russell Lakes SWA, 7-8 Aug. 1994, R. Durfee (CSUC).

Notonecta unifasciata unifasciata Guérin New record for Colorado

Previously known from California, New Mexico, and Mexico.

Material examined: COLORADO, Saguache Co.: 2 males, 4 females, Russell Lakes SWA, 7-8 Aug. 1994, R. Durfee (CSUC).

Saldidae

Salda obscura Provancher New record for Utah

This is a boreal species that, in the southernmost part of its range, inhabits relatively dry biotopes in the mountains of the midlatitude western U. S. It was previously known from Canada, a few northern states of the U. S., the Rocky Mountains of Colorado, and the Ruby Mountains of Nevada (Polhemus, unpubl. data).

Material examined: UTAH, Grand Co.: many males & females, La Sal Mtns., Gold Basin, off Geyser Pass Rd., 6 August 1993, J. T. Polhemus, S. Kaneno & M. Satô.

OTHER DISTRIBUTIONAL RECORDS

Gelastocoridae

Gelastocoris rotundatus Champion Additional record for Texas

Common in Mexico and Arizona, and occurs in California. To my knowledge, this is only the third record for Texas, and the first for Val Verde Co.

Material examined: TEXAS, Val Verde Co.: many males & females, Dolan Falls Ranch, The Nature Conservancy of Texas, Dolan Creek, 20 April 1996, J. T. Polhemus.

Notonectidae

Buenoa marki Reichart Additional record for Florida

Previously known only from the type series taken in Everglades National Park.

Material examined: FLORIDA, Collier Co.: 9 males, 10 females, ponds in cypress hammock nr. Turner River at Hwy. 41, 15 Nov. 1989, D. A. Polhemus.

Buenoa platycnemis (Fieber) Additional record for Texas

Rather common from Mexico and the West Indies southward to Brazil and Peru, and was previously known in the U. S. from a few localities in Texas and one in the Florida Keys (Truxal 1953).

Material examined: TEXAS, Cameron Co.: 1 male, 1 female, Sabal Palm Grove Sanct., 16 Oct. 1993, at UV light, Blackmon, Quinn & Riley (TAMU).

Buenoa speciosa Truxal Additional record for Texas

Previously known from Mexico and the Davis Mountains of Texas (Truxal 1953).

Material examined: TEXAS, Presidio Co.: 2 females, Big Bend Ranch S. N. A., La Sauceda (Hdqtrs.), 27 April 1991, J. C. Schaffner (TAMU).

Buenoa uhleri Truxal Additional record for Texas

Widespread in Mexico, and previously known from one locality each in California and Texas (Truxal 1953).

Material examined: TEXAS, Presidio Co.: 1 male, Big Bend Ranch S. N. A., La Sauceda (Hdqtrs.), 27 April 1991, J. C. Schaffner (TAMU).

Ochteridae

Ochterus banksi Barber Additional record for Texas

Widespread in the eastern and southern United States, including eastern Texas. This is the westernmost record for this species.

Material examined: TEXAS, Val Verde Co.: 2 males, Dolan Falls Ranch, The Nature Conservancy of Texas, springs along Dolan Creek, 20 April 1996, J. T. Polhemus

ACKNOWLEDGMENTS

I am grateful to J. A. Slater, Univ. Connecticut, Storrs, for identification of *Ischnodemus falicus*. I am also indebted to the following for the gift or loan of specimens: T. Vasarhelyi, Budapest; Scott Shaw, University of Wyoming, Laramie, WY; Boris Kondratieff, Colorado State University, Fort Collins, CO (CSUC); J. C. Schaffner and E. G. Riley, Texas A. & M. University, College Station, TX (TAMU). I thank D. A. Polhemus and R. T. Schuh for their reviews.

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SCIENTIFIC NOTE

MATING BEHAVIOR OF *DASYMUTILLA OCCIDENTALIS* (HYMENOPTERA: MUTILLIDAE)[1]

Jeffery K. Tomberlin[2]

Because of the short time required for successful mating to occur in velvet ants (Hymenoptera: Mutillidae), very few observations have been recorded (Manley 1977). *Dasymutilla occidentalis* (L.) is a common species, whose mating behavior has not been recorded. From 1 to 10 July 1996, I made field observations on nine occasions during three periods of the day: 0700 - 0900 h (morning), 1145 - 1400 h (noon), and 1530 - 1630 h (afternoon) (three for each period). Copulation was recorded three times during afternoon observations.

Observations were made in Clemson, South Carolina, in a fallow field which had been plowed two weeks prior to observed activity. Soil was dry and sandy with no vegetative growth. Sweet potatoes, cantaloupe, and watermelon were planted in a field located at the north end of the fallow field. Four to eight males were observed during morning and afternoon sessions, whereas female numbers were never above two/session. Neither sex was observed during the noon session. Manley and Spangler (1983) observed similar activity patterns for species of the genus *Dasymutilla*. Maximum daily temperatures ranged from 32 to 35 °C. Males patrolled approximately 30 cm above the surface of the field, but returned to shaded areas (2.5 °C cooler) to take in water from the irrigation system.

The behavioral pattern was similar for each mating. One male landed within 20 cm of the female and moved towards the female. Following contact with the female, the male grasped her dorsally from behind. The female remained still until the male extended and attached his genitalia to the female's posterior end. Following genital contact, the female began stridulating. Spangler and Manley (1978) observed similar mating stridulations for *Dasymutilla foxi* (Cockerell). *Dasymutilla occidentalis* copulation lasted from 2 to 5 seconds. Once the male removed his genitalia from the female, stridulation ceased and the pair moved apart. The male resumed low

(Continued on page 317)

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[1] Received September 3, 1996. Accepted September 30, 1996.

[2] Department of Entomology, Clemson University, Clemson, SC 29634-0365.

NEW STATE RECORDS FOR SCARAB BEETLES (COLEOPTERA: SCARABAEIDAE) FROM NORTH DAKOTA AND MINNESOTA[1]

Paul K. Lago[2]

ABSTRACT: State records are presented for *Omorgus punctatus* and *Cremastocheilus wheeleri* from North Dakota and for *Stephanuca pilipennis* and *Cremastocheilus nitens* from Minnesota.

Since the publication of the latest survey paper on the North Dakota scarab fauna (Lago et al. 1979), I have had the opportunity to do some additional collecting in the state and have examined a considerable amount of material collected by the students and staff of both the Department of Entomology and the Department of Geology, North Dakota State University, Fargo, ND. During this time, two new records for North Dakota and two from neighboring Minnesota have been discovered. Since it is doubtful that a major faunistic study of scarabs will be conducted in this area anytime in the near future, I wish to add these new records to the North Dakota state list to bring it up to date.

Cremastocheilus wheeleri LeConte occurs in the western Great Plains, and is often found in association with ants of the genus *Formica* (Potts 1945; Ratcliffe 1991). Although known to occur as far north as southern Alberta, Saskatchewan and Manitoba (Alpert 1994; Bousquet 1991) and as far east as eastern Nebraska (Ratcliffe 1991) the species has not been reported from the Dakotas. On 19 May, 1981, I collected a single female at Walcott Dunes, Richland Co., N.D., in a nest of *Formica obscuripes* Forel. This area of Richland County is characterized by its active sand dunes, but the ant nest, which also contained adult *Euphoria inda* (L)., was located in a grassy area on the edge of a mixed stand of green ash *(Fraxinus pennsylvanica* Marsh.) and bur oak *(Quercus macrocarpa* Michx.).

Omorgus punctatus (Germar) is a fairly common species found throughout the Great Plains, the southwestern U.S.A., and into central Mexico. Based on the range presented by Vaurie (1955), the presence of this species in North Dakota was considered a distinct possibility by Lago et al. (1979). On 2 August 1993, David Cuthrell, using a mercury vapor light, collected a single male at Burning Coal Vein, Slope County, N.D., confirming our suspicions.

The distribution of *Cremastocheilus nitens* LeConte appears to be centered around the 100th meridian, the species occurring from southeastern

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[1] Received November 25, 1996. Accepted January 28,1997.

[2] Department of Biology, University of Mississippi, University, MS 38677.

sandhills of North Dakota (Lago et al. 1979) through Oklahoma (Alpert 1994) and Missouri (Blackwelder and Arnett 1974). One female, collected by T. L. McCabe at Bird Prairie (46.51.20-96.28.40), Clay County, MN, 9 May 1972, represents the first record for this species from Minnesota.

Stephanuca pilipennis Kraatz inhabits sandy, upland habitats in the eastern Great Plains from Kansas through North Dakota (Lago et al. 1979; Ratcliffe 1991). I recently examined two specimens of this species collected by David Cuthrell, 2 miles south of Fertile, Polk County, MN, 26 April, 1993. This represents the first record for this species east of the Red River of the North. This area contains sand prairie habitat very similar to the blowouts in southeastern North Dakota where I have previously encountered the species. Known as Agassiz Dunes, this is the largest dune field in Minnesota associated with Glacial Lake Agassiz. The sand blowouts contain creeping juniper *(Juniper horizontalis* Moench). Large bur oaks occur in the area. Other common plants include silky prairie clover *(Dalea villosum* Nutt.), skeletonweed *(Lygodesmia juncea* (Pursh)), two species of blazing star *(Liatris* spp.), gramma grass *Bouteloua* spp.), and, of course, the bluestems *Andropogon gerardii* Vitman and *Schizachyrium scoparium* (Michx.).

The specimens of *Cremastocheilus wheeleri* and *C. nitens* reported above are housed in my personal collection. The other specimens are part of David Cuthrell's collection.

ACKNOWLEDGMENT

I wish to thank David Cuthrell and Tim McCabe for the opportunity to examine their specimens. In addition, David provided a detailed description of the Agassiz Dunes area and made valuable comments concerning the contents of this manuscript. Ed Zuccaro and Brett Ratcliffe also provided helpful editorial comments, as did two anonymous reviewers.

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ANNOTATED CHECKLIST OF THE MECOPTERA (SCORPIONFLIES) OF ARKANSAS[1]

Henry W. Robison[2], George W. Byers[3], Christopher A. Carlton[4]

ABSTRACT: Collection data are presented for 16 species representing 3 families of Mecoptera (scorpionflies and their close relatives) from Arkansas as the first checklist for the state. *Panorpa submacalosa* (Panorpidae) and *Hylobittacus apicalis* (Bittacidae) are reported from the State for the first time.

Little is known about the Mecoptera (scorpionflies and their close relatives) of Arkansas. This checklist brings together all known records of the mecopteran fauna from the state, based on data gleaned from previous literature (Byers 1973, 1993, 1996; Carpenter 1931; and Webb et al., 1975), museum records, and recent collecting by the authors within the state. Collection localities, dates of capture, collector (where known), brief data on habitat, and known range of each species are included. Sixteen species representing three families of scorpionflies (Mecoptera) were documented from Arkansas including one of Meropeidae, ten of Panorpidae, and five of Bittacidae. *Panorpa submaculosa* Carpenter and *Hylobittacus apicalis* (Hager) are reported from Arkansas for the first time.

Arkansas includes portions of the Ozark and Ouachita Highlands, which are of considerable biogeographic significance as areas of endemism and refugia for disjunct populations of organisms, particularly those with faunal affinities to the southern Appalachian Mountains (Ross and Ricker 1971; Mayden 1985; Carlton and Cox 1989; Poulton and Stewart 1991; Mohlenbrock 1993; Robison and Allen 1995; Carlton and Nobles 1996; Moulton and Stewart 1996). This paper is part of our continuing effort to document the distribution and composition of inadequately known insect taxa in Arkansas and to improve our understanding of arthropod distribution patterns in North America.

Meropeidae

Merope tuber Newman. Montgomery Co.: 5 mi. NE of Mt. Ida, one male, 9 June 1993, flight intercept trap, C. E. Carlton; habitat: moist north slope deciduous forest. Newton Co.: Buffalo National River, road to Fitton Cave, 36 05' 30" N, 93 14' 54" W, one female, flight inter-

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[1] Reeeived October 1, 1996. Accepted February 14, 1997.

[2] Dept. of Biology, Southern Arkansas University, Magnolia, AR 71753-5000. Corresponding author.

[3] Snow Entomological Museum, Univ. of Kansas, Lawrence KS 66045.

[4] Louisiana State University Agricultural Center, Dept. of Entomology, Baton Rouge, LA 70893.

cept trap, 26-28 lune 1994, C. E. Carlton; same except trail to Fitton cave, 2 km. NW of Erbie Campground, 3 females, 26-28 June 1994, C. E. Carlton. Washington Co.: Fayetteville, 15 specimens: 5-12 Sept. 1992, in flight intercept trap, C. E. Carlton; one male, one female, 20-27 June 1995, in flight intercept trap, C. E. Carlton.

Range: N GA to ME west to OK, KS, and MN.

Panorpidae - Scorpionflies

Panorpa anomala Carpenter. Lee Co.: St. Francis National Forest, Bear Creek Lake, 5 mi. SE Marianna, 16 May 1988, D. W. Webb, one male and one female, sweeping herbaceous vegetation along outlet creek, *Impatiens* sp. and stinging nettle. Washington Co.: 21 May 1926.

Range: TN and GA to WI, KS, and AR.

Panorpa braueri Carpenter. Benton Co.: Bentonville (within city limits), 21 September 1977, G. W. Byers; habitat: mints and other herbaceous plants in ravine shaded by white oaks, sycamores, elms; stream dry on this date. Washington Co.: 18 September 1975, C. Daggett; 1964, no collector; Lake Weddington Park, west of Fayetteville, 20 August 1967, J. Scott; Blue Springs campground, south arm of Beaver Lake, 29 May 1974, R. L. Heitzman; Lake Weddington Park, 20 Aug. 1967, R. L. Heitzman; 10 October 1976 (no other data); 9-10 June 1975, W. D. Wylie; 6 May 1975, W. D. Wylie; 15 Sept. 1975, Walker; 3 mi. NE of Fayetteville, 3-7 June 1995, C. E. Carlton.

Range: AR and MO.

Panorpa capillata Byers. Montgomery Co.: 14.4 km. N of Pencil Bluff, 21 May 1978, G. W. Byers and C. W. Young; Gap Creek, 2.1 km. SE of Joplin, Ouachita National Forest, 22 May 1978, G. W. Byers and C. W. Young; 5 mi. NE of Mt. Ida, 25 May 1993, C. E. Carlton; same locality, 9 June 1993, C. E. Carlton. Polk Co.: Rich Mountain, 6 July-November 1995, pitfall trap, H. W. Robison.

Range: AL to KY, W to MS, and AR.

Comments: This is a species of field-woodland ecotones.

Panorpa choctaw Byers. Johnson Co.: Gilliam Bog, 10 mi. N of Clarkeville, 11 September 1995, H. W. Robison. Newton Co.: Dogpatch, 5 September 1971, A. S. Menke. Montgomery Co.: 9 mi. NW of Langley, 17 September 1995, H. W. Robison. Pike Co.: 21 September 1974, P. McLeod. Polk Co.: U.S. Hwy. 270 near Scott Co. line, altitude 1160 ft., 27 September 1979, G. W. Byers; Bard Springs, 11 October 1995, H. W. Robison; Rich Mountain, jct. of St. Hwys. 88 and 272, 6 July - 10 November 1995, pitfall trap, H. W. Robison, pitfall trap; Rich Mountain at jct. of St. Hwys. 272 and 88, 10 October 1996, H. W. Robison, pitfall trap. Searcy Co.: 20 September 1976, R. L. Brown. Scott Co.: Mill Creek at Y-City, altitude 740 ft., 27 September 1979, G. W. Byers; Ouachita National Forest, TIN, R30W, Sec. 33, altitude 1020 ft., 27 September 1979, G. W. Byers; on shaded, low herbaceous vegetation primarily at edges of woods. Washington Co.: 2 July 1975, E. Sizemore; 13 September 1976, E. Brack; 29 September 1974, P. McLeod; 13 September 1974, D. Dunn; 22 September 1974, D. Dunn; 23 September 1975, Graves.

Range: KY S to GA, W to OK and MO.

Panorpa helena Byers. Garland Co.: Blue Springs (near Hot Springs National Park), 23 May 1966. Pope Co.: 17 June 1970, R. Flanigan. Washington Co.: October 1961, H. Roberts; July 1970, G. W. Wallis.

Range: GA to MA and W to Manitoba and AR; isolated record from UT (Gurney, 1937, as *P. venosa).*

Panorpa nuptialis Gerstaecker. Arkansas Co.: 11 August 1975, Rhinehart; White River Refuge, August 1969, R. L. Brown. Calhoun Co.: 14 October 1993, J. Rader. Columbia Co.: Village, 28 October 1996, K. Arbuckle. Craighead Co.: Jonesboro, 27 September 1966, Hopkins. Crittenden

Co.: West Memphis, 22 October 1966, no collector. Drew Co.: Tillar, 5 October 1939, E. C. VanDyke. Garland Co.: Hot Springs, 4 October 1939, E. C. VanDyke. JeffersonCo.: Pine Bluff at UAPB Campus, Lot 129, September 1990 (no other data). Lawrence Co.: Imboden (no other data). Nevada Co., 13 October 1976, H. Greenbaum. Nevada Co.: 3 October 1964, G. Wallis. Ouachita Co.: 10 mi. N Camden, 1-3 November 1960, M. Verley. Pope Co.: 5 July 1970, R. Flanigan. Pulaski Co.: Burns Park, North Little Rock, 22 September 1977, G. W. Byers (collected together with *P. rupeculana;* see for habitat). Scott Co.: Mill Creek at Y City, 27 Sept. 1979, G. W. Byers.Van Buren Co., 2 October 1985, N. Brock.Washington Co.: 25 October 1937, no collector; 20 September 1938, no collector; October 1938, no collector; 8 August 1956, D. M. Powell; Cove Creek Valley, 1958, M. Hite; October 1960, L. O. Warren; September 1961, M. Roberts; October 1961, N. Roberts; 14 October 1962, O. Hite; 1 May 1970, no collector; August 1971, no collector; 20 June 1975, J. Welch; 30 September 1975, Prichett; 21 May 1976, J. Fitz; September 1976, McCormick; 7 October 1984, A. Wilburn; Fayetteville, 17 August 1985, S. Tedder.

Range: AL to MO W to KS, OK, TX.

Panorpa rupeculana Byers. Miller Co.: 0.5 mi E of Doddridge, 26 April 1987, D. W. Webb, one female. Ouachita Co.: 8.7 mi. NE of Camden. 24 Oct. 1957, I. J. Cantrall, T. Cohn, D. Eades. Pulaski Co.: Burns Park, North Little Rock, 22 September 1977, G. W. Byers.

Range: AR, northern LA, MS.

Comments: At the type locality near Little Rock, the specimens were collected from low growth of honeysuckle, greenbriers, and brambles (*Rubus* sp.) shaded by oaks, hickory, maple, red gum, black gum, and pine.

Panorpa speciosa Carpenter. Washington Co.: 19 June 1964, A. E. Shumate; Sept. 1961, H. Roberts; 21 May 1925, no collector; White River, 0.5 mi. N of Brentwood, 21 May 1978, G. W. Byers.

Range: AR, TN, KY, OH to MN and WI.

Panorpa submaculosa Carpenter. Johnson Co.: Bull Creek Flats Spring, N of Clarkeville, 25 May 1993, H. W. Robison, one male; **New State Record.** Footprint Spring, ca. 10 mi. N of Clarkeville, 7 June 1996, G. Leeds, four females in pitfall trap.

Range: GA to MA and W to AR and WI.

Panorpa vernalis Byers. Bradley Co.: 14 April 1967, I. Brown (paratype); 1 mi. SE El Dorado, 6 May 1984, D. W. Webb.

Range: MS, LA, southern AR.

Comments: The usual habitat is in somewhat open areas by mixed hardwoods and pine; the specimens were found on low growth of honeysuckle, poison ivy, greenbrier with some patches of "pine straw" about 2 inches deep.

Bittacidae - Hangingflies

Hylobittacus apicalis (Hager). Johnson Co.: N of Clarksville (T13N, R24W, Sec. 4), 2 June 1995, G. Leeds. Lee Co.: St. Francis National Forest, Bear Creek Lake, 5 mi. SE Marianna, 16 May 1988, D. W. Webb, one male, one female, sweeping herbaceous vegetation along outlet creek, *Impatiens* sp. and stinging nettle. **New State Record.**

Range: NC to NY and W to OK and AR.

Bittacus pilicornis Westwood. Benton Co.: 12 May 1941 (no other data); Johnson Co.: Lake Dardanelle, Spadra, 27 May 1978, G. W. Byers; habitat: poison-ivy, wild roses, and herbaceous plants. Logan Co.: Magazine Mountain, altitude 1350 ft., 17 May 1989, in black light trap, J.

MacGowan and Q. Fang; Magazine Mountain, 25 May 1978, L. D. Newson; in light trap; *(Note:* A large male, front wing 25 mm, was taken at the light trap and has one pair of pheromone-dispersing organs everted. In the left fore wing, R4 divides, then branches coalesce before the wing margin. Det. G.W. Byers). Montgomery Co.: 9 mi. NW of Pencil Bluff, 21 May 1978, G.W. Byers and C. W. Young; 6.5 mi. NW of Bonnerdale, S. of FSR 476 (Sec. 22, T3S, R23W), 22 May 1996, H. W. Robison, black light. Union Co.: 1 mi. SE El Dorado, 6 May 1984, D. W. Webb. Washington Co.: 4 June 1962, no collector; 18 May 1963 (no data); 5 mi. W. Fayetteville, 15 May 1986, D. E. Bowles; 15 mi. W. Fayetteville, 16 May 1986, D. E. Bowles; 24-25 May, no collector; 15 mi. S Prairie Grove (no date or collector); Devil's Den State Park, altitude approx. 1400 ft., 24 May 1977, G. W. Byers.

Range: FL to Canada and W to MN and TX.

Comments: Habitat of *B. pilicornis* is typically herbaceous undergrowth 1-3 ft. high in mixed deciduous woods.

Bittacus punctiger Westwood. Johnson Co.: Spadra, U.S. Corps of Engineers Park on Lake Dardanelle, 27 May 1978, G. W. Byers; habitat: these bittacids were taken low in the undergrowth, 8-12 inches above the ground, while other *Bittacus* sp. were higher in the shaded vegetation.

Range: FL to PA and W to MO, OK and TX.

Bittacus stigmaterus Say. Arkansas Co.: 4 mi. E. Ethel, 3 July 1969, R. L. Brown; 19 July 1969, R. L. Brown; 31 July 1969, R. L. Brown; 13 August 1969, R. L. Brown. Polk Co.: Rich Mountain, jct. of St. Hwys. 88 and 172, 6 July - 10 November 1995, pitfall trap, H. W. Robison. Washington Co.: 10 July 1965, H. R. Dodge.

Range: GA to NY and W to MN and TX.

Bittacus strigosus Hagen. Carroll Co.: 1 mi. NW Berryville, 27 June 1972, D. W. Webb. Newton Co.: Buffalo National River, trail to Fitton Cave, 2 km. NW of Erbie Campground, 26-28 June 1994, C. E. Carlton. Washington Co.: 22 June 1968. J. Kimbrough; 3 mi. NE of Fayetteville, moist deciduous woodland, 20-27 June 1995, C. E. Carlton.

Range: SC to southern Canada W to Manitoba, MT, WY, and TX.

Undoubtedly, other species of mecopterans await discovery in Arkansas as much additional collecting is needed, particularly in remote mountain areas. Such species as *Panorpa sigmoides* Carpenter, *Bittacus occidentis* Walker, and *Bittacus texanus* Banks inhabit neighbortng states and possibly occur in Arkansas. Our studies will continue in an attempt to define further the state scorpionfly fauna.

ACKNOWLEDGMENTS

Travel funds for Henry Robison were graciously provided by the Southem Arkansas University Research Committee. Field work by Chris Cariton was funded in part by grants from the USDA-Forest Service and Department of Interior, Buffalo National River. Special thanks are extended to Jan Rader and Nick Covington, Southern Arkansas University students, for their assistance in the field and to Gene Leeds, USDA-Forest Service, Pleasant Hill Ranger District, who kindly loaned us several specimens of scorpionflies for this study.

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elevation flight over the field, while the female retreated into surrounding vegetation dragging her posterior end on the soil. Following mating, no other males attempted to copulate with the female.

Similar mating behaviors have been observed for different species of Mutillidae (Manley and Deyrup 1989; Manley and Taber 1978; Fattig 1936). Males present in mass numbers have been observed swarming 20 to 30 cm above the ground, apparently searching for females (Manley and Deyrup 1989). However, the number of males I observed was not as high as that observed for other species (Manley and Taber 1978). In general, mating of mutillids occurred within a few seconds and once a female was mated, no other male attempted further copulation.

ACKNOWLEDGMENT

I would like to thank Peter H. Adler and Donald G. Manley for their helpful comments on this manuscript. This is Technical Contribution No. 4222 of the South Carolina Agricultural Experiment Station, Clemson University.

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SCIENTIFIC NOTE

NAME ADJUSTMENTS AND A NEW SYNONYM FOR NORTH AMERICAN EPHEMEROPTERA SPECIES[1,2]

W. P. McCafferty[3]

While researching the original orthography for the list of North American mayflies, as it is to appear in volume 4 of *Nomina Insecta Nearctica,* I discovered that three specific epithets had not been corrected to gender agreement when recombined by McCafferty and Waltz (1990) or listed again by McCafferty (1996); these names are corrected to *Baetis futilis* (McDunnough), 1936 [originally *Pseudocloeon futile*], *Baetis rubrolateralis* (McDunnough), 1931 [originally *Pseudocloeon rubrolaterale*], and *Baetis virilis* (McDunnough), 1923 [originally *Pseudocloeon virile*]. One specific epithet had not been correctly formed by Berner (1940) or corrected subsequently either with its original genus or in recombination; this name is corrected to *Procloeon viridoculare* (Berner), 1940 [originally *Centroptilum viridocularis* and subsequently *P. viridocularis*]. One specific epithet had not been corrected to gender agreement by McDunnough (1926) or any North American authors listing or treating the name subsequently; this name is corrected to *Cinygma lyriforme* (McDunnough), 1924 [originally *Ecdyonurus lyriformis* and subsequently *C. lyriformis*]. One additional specific epithet had been incorrectly formed by McDunnough (1939); this name is corrected to *Baetis persecutor* McDunnough, 1939 [originally *B. persecuta* and subsequently *B. persecutus*].

With regard to the first three corrections, the specific epithets are transformed to the masculine gender from the original neuter to agree with the masculine name *Baetis*. In the case of *P. viridoculare,* both the original *Centroptilum* Eaton and subsequent *Procloeon* Bengtsson generic combinations required neuter agreement. In the case of *Cinygma* Eaton, McDunnough (e.g., McDunnough 1924) formed all his epithet names that were associated with this genus, and derived from the nominative singular, in the incorrect feminine gender. It is clear from Eaton (1885) that his genus is neuter. The "a" ending of the name, which is most often indicative of the Latinized feminine gender was evidently misleading. Notably, *Stenonema* Traver is another example of a mayfly genus group name ending in "ma" (latinization of ending Greek letters "µac") that is neuter, not feminine and that has confused workers. The emendation to *B. persecutor* is based on the fact that the correct spelling of the Latin noun in apposition is "persecutor."

McCafferty (1993) synonymized *Drunella conestee* (Traver), 1932 with *Drunella tuberculata* (Morgan), 1911. Further examination of North Carolina material has revealed that *Drunella wayah* (Traver), 1932 also falls within the range of variation of *D. tuberculata* as discussed by McCafferty (1993). This variablility involves, for example, frontal shelf, genae, and tuberculation development. Allen and Edmunds (1962) drew the forefemur of *wayah* with a forefemoral ridge somewhat less apparent than that drawn for *tuberculata* or *conestee,* but the ridge is nonetheless present. No adults have ever been associated with the name *D. wayah,* and its known distribution is consistent with that recorded for *D. tuberculata* and, more precisely, *D. conestee*. Therefore, I place *D. wayah* as a junior subjective synonym of *D. tuberculata: Drunella tuberculata* (Morgan) [= *D. wayah* (Traver), n. syn.].

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[1] Received February 22, 1997. Accepted March 21, 1997.

[2] Purdue Agricultural Research Program Journal No. 15325.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

SCIENTIFIC NOTE

NEW RECORDS OF NOTONECTIDS (HETEROPTERA) FOR PENNSYLVANIA[1, 2]

A. M. Yeakel[3], E. Larsen[3]

Members of the family Notonectidae are predaceous aquatic insects. Two principal genera, *Notonecta* and *Buenoa,* are found in the lentic habitats of North America. Four species have been recorded from Pennsylvania (Truxal 1953, Polhemus and Polhemus 1988). We report here four additional species, two of *Buenoa* and two of *Notonecta,* from Pennsylvania. This note is a contribution to ongoing attempts to document the distribution of Heteroptera of North America, north of Mexico (see Henry and Froeschner 1988).

Buenoa confusa occurs generally across the eastern United States and Canada, but has been unrecorded from PA until now (Truxal 1953, Polhemus and Polhemus 1988). Collections of *B. confusa* were made from a permanent man-made drainage pond at the corner of Lancaster Avenue (PA state route 30) and King of Prussia Road, Villanova, Delaware County, PA. This pond is 0.5 to 1 meter deep around the edges and over 2 meters deep in the center. There is little emergent or submerged aquatic vegetation and the diameter of the pond is approximately 25 meters. Despite the pollution and litter from the drainage into this pond, invertebrates are abundant, including other notonectids such as, *B. margaritacea* and *Notonecta undulata.* Four individuals (3 males, 1 female) of *B. confusa* were found in June, 1995. Sampling efforts in May, 1996 produced no individuals of this species, while 4 and 3 individuals of *B. confusa* were collected in September and October, 1996, respectively. The previously recorded distribution in northeast North America for *B. confusa* includes CT, DC, ME, NJ, NY and Nova Scotia (Truxal 1953). Collection of this species in PA fills a gap in the distribution record.

Buenoa scimitra is known from Mexico and the southern half of the United States (Truxal 1953, Polhemus and Polhemus 1988). To date, this species has not been recorded from any locality in the northeast. *Buenoa scimitra* was collected from the same pond described above; 25 males in September, 1995 and 31 males in October, 1996. Six males of *B. scimitra,* also collected in September 1995, were taken from a temporary pool created by construction activities on Villanova University's west campus. The pool was shallow and muddy, and filled in soon after the collection. An additional 8 male *B. scimitra* were collected in September, 1995 from a decorative pond, approximately 20 x 40 meters in size, located on the west campus of Villanova University. *Buenoa margaritacea* was also present at both of these sites. Because the females of these two species are indistinguishable (Truxal 1953), only the number of males are reported here. This record of *B. scimitra* in Pennsylvania extends the range for this species farther north from its previously northernmost record of VA and its presence in southeastern PA suggests that it may be found in DE, MD, and NJ as well.

Notonecta insulata is known from northeast North America, including CT, MD, NJ and NY (Hungerford 1933, Polhemus and Polhemus 1988). One individual of *N. insulata* was collected from the previously mentioned drainage pond on the corner of Lancaster Avenue and King of Prussia Road, during June, 1993 and eight specimens were collected in October of the same year.

(Continued on bottom of page 320)

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[1] Received December 9, 1996. Accepted January 18, 1997.

[2] We thank J. Gelhaus, Academy of Natural Sciences of Philadelphia, J. Polhemus, Colorado Entomological Museum, and two anonymous reviewers for comments on an early draft of this note.

[3] Department of Biology, 800 Lancaster Avenue, Villanova University, Villanova PA 19085.

(Continued from page 318)

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(Continued from page 319)

One female was collected from the same pond in October, 1996. This site provides another state record for *N. insulata* in the Middle Atlantic States.

Notonecta lunata is known from northeast (Hungerford 1933) and midwest North America (Polhemus and Polhemus 1988, J. Polhemus, pers. comm.). *Notonecta lunata* was collected from the Great Marsh in Nantmeal and Wallace Townships, Chester County, PA. The marsh is approximately 33 miles northwest of Philadelphia and is part of the Marsh Creek watershed. Part of the marsh property is adjacent to Pennsylvania State Route 100 and Interstate Route 76. This site is characterized by small areas of open water surrounded by grasses and sedges, along with interior floating plants. Thirteen individuals were collected in July, 1994, numerous individuals were collected in July, 1995, 5 individuals were found in September, 1995, and 7 individuals in June, 1996. This site provides an additional state record for *N. lunata* in the Middle Atlantic States (Hungerford 1933, Polhemus and Polhemus 1988).

Representative voucher specimens of the four species are deposited in the collection of the Entomology Department, Academy of Natural Sciences of Philadelphia, Philadelphia, PA.

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US ISSN 0013-872X
VOL. 108 NOVEMBER & DECEMBER, 1997 NO. 5

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THE AMERICAN ENTOMOLOGICAL SOCIETY

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ALLOPERLA (PLECOPTERA: CHLOROPERLIDAE) OF WESTERN NORTH AMERICA [1]

Mary Leigh Lyon, Bill P. Stark[2]

ABSTRACT: Seven species of the stonefly genus *Alloperla* are recognized in western North America. Scanning electron micrographs of epiproct structures and eggs are presented for each species, and adults are keyed.

Adult *Alloperla* are distinguished from most other chloroperlid genera by their pale green or yellow body coloration, the lack of dark markings on the head and pronotum, and the reduced anal area of the hind wing with less than five anal veins. Several western *Alloperla* species with median dorsal abdominal stripes may be confused with *Suwallia*, or other chloroperlid genera, but these are easily distinguished by male genitalic and female subgenital plate characters (Harper & Stewart 1996; Surdick 1985). Presently there are seven species of *Alloperla* known in western North America (Stark et al. 1986). While each has been discussed elsewhere (e.g., Baumann et al. 1977; Jewett 1959), no single publication has treated all seven species. Therefore, we have used scanning electron microscopy to develop descriptions of epiprocts and eggs, and we present the first key to the adults of all the western Nearctic *Alloperla*.

MATERIALS AND METHODS

Epiproct samples were taken from museum specimens stored in alcohol. The terminal abdominal segments were severed, placed in acetone and agitated in an ultrasonic cleaner for one minute. Samples were air dried, placed on double-stick copper tape on SEM stubs, coated with gold-palladium, and scanned using an AMRAY model 1810 SEM.

Egg samples were collected by opening the abdomen of the female specimens and gently dislodging the eggs into alcohol. Eggs were pipetted into acetone, cleaned in an ultrasonic cleaner for 10-20 seconds, air dried on forceps, and placed on the taped specimen stubs. Eggs were coated and scanned following the same procedure used for the epiprocts. Female subgenital plates from these specimens were examined with light microscopy after clearing in hot 10% KOH.

Epiproct samples were examined from two or more populations for each species except *A. chandleri*; egg samples were taken from specimens repre-

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[1] Received March 15, 1997. Accepted April 19, 1997.

[2] Biology Department, Mississippi College, Clinton, MS 39058.

senting a single population. Terminology follows Stark and Szczytko (1988), Baumann et al. (1977) and Jewett (1959). Specimens are deposited in the Monte L. Bean Museum, Brigham Young University (BYU), the C. P. Gillette Museum of Arthropod Diversity, Colorado State University (CSU) and in the Stark Collection, Mississippi College (BPS).

KEYS TO *ALLOPERLA* OF WESTERN NORTH AMERICA

Males

1. Epiproct apex smoothly rounded (Figs. 1-6) 2
Epiproct apex serrate or crenulate (Figs.7-16) 4
2. Epiproct widest at mid-length (Figs. 5, 6); dorsal abdominal stripe present; known from higher elevations of the Colorado Rocky Mts .... *A. pilosa*
Epiproct widest at base or near apex (Figs. 1-4); dorsal abdominal stripe present or absent; known from the Coast, Cascades and Sierra Nevada Mts 3
3. Epiproct dumbbell-shaped (Fig. 3); dorsal abdominal stripe usually present .... *A. fraterna*
Epiproct parallel sided (Fig. 1); dorsal abdominal stripe usually absent .... *A. chandleri*
4. Anterolateral horns present on epiproct (Figs. 7, 10) 5
Anterolateral horns absent from epiproct (Figs. 15-16) 6
5. Epiproct apex triangular, projecting (Figs. 10-12); dorsal abdominal stripe usually absent .... *A. medveda*
Epiproct apex truncate (Figs. 7-9); dorsal abdominal stripe usually present .... *A. delicata*
6. Epiproct at least twice as long as wide, apex crenulate, basal half pilose (Fig. 13) .... *A. severa*
Epiproct about as wide as long, apex serrate, basal margin pilose (Fig. 15) .... *A. serrata*

Females with eggs

1. Egg collar present (Fig. 25) 2
Egg collar absent (Fig. 17) 5
2. Forewing length greater than 12 mm; dorsal abdominal stripe present .... *A. pilosa*
Forewing length less than 10 mm; dorsal abdominal stripe absent 3
3. Subgenital plate base broad, constricted to a rounded, tab-like apex (Fig. 41) .... *A. medveda*
Subgenital plate constricted or unconstricted, apex angular (Figs. 37-40) 4
4. Subgenital plate reaches at least center of segment nine with abdomen extended (Fig. 43), plate reaches posterior margin of segment nine in uncleared specimens .... *A. severa*
Subgenital plate barely reaches anterior margin of segment nine with abdomen extended (Fig. 39), plate reaches midpoint of segment nine in uncleared specimens .... *A. serrata*
5. Subgenital plate apex angular (Fig. 38); egg chorion coarsely pitted (Fig. 22) .... *A. delicata*
Subgenital plate apex rounded (Fig. 37); egg chorion essentially smooth (Fig. 17) 6
6. Dorsal abdominal stripe usually present .... *A. fraterna*
Dorsal abdominal stripe usually absent .... *A. chandleri*

Alloperla chandleri Jewett

Alloperla chandleri Jewett, 1954b. Holotype male, Miami Ranger Station, Mariposa Co., California.

Epiproct – Length 0.171 mm, basal width 0.067 mm, apical width 0.068 mm, constriction width 0.065 mm. Dorsal aspect almost parallel-sided, but slightly constricted mesally and rounded apically; apex slightly wider than base (Fig. 1). Epiproct covered with dense mat of thick setae except for bare apex. Apical bare area begins at point of greatest width and extends 0.02 mm. Setal mat less dense on posterior margin. Lateral aspect rather uniformly wide and subequal to dorsal width; margins clothed with setae (Fig. 2). Epiproct stem clothed with fine setae (Figs. 1, 2).

Egg – Length 0.33 mm, width 0.18 mm. Outline elongate oval, anterior pole more blunt than posterior pole. Micropylar row subequatorial; micropyle orifices sessile. Chorionic surface with indistinct hexagonal follicle cell impressions; eclosion line absent. Collar absent (Figs. 19-21).

Subgenital plate – Posterior margin broadly rounded, extending slightly over anterior margin of sternum nine (Fig. 37).

Material – CALIFORNIA: Sierra Co., Big Springs, Hwy 49 N Sierra City, 24 June 1980, R. W. Baumann, J. A. Stanger, 5 ♂, 6 ♀ (BYU, BPS).

Known distribution – CA (Stark et al. 1986).

Alloperla delicata Frison

Alloperla delicata Frison, 1935. Holotype male, Oak Creek, Benton Co., Corvallis, Oregon.
Alloperla delicata: Jewett, 1954a.

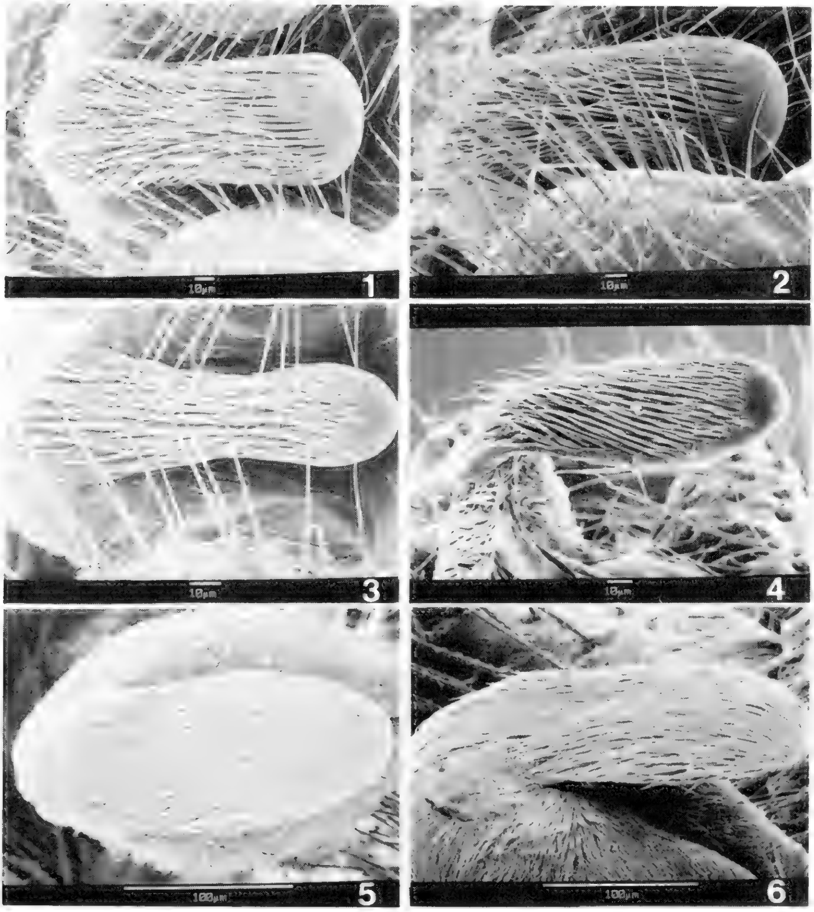
Epiproct – Length 0.123 mm, basal width 0.040 mm, mid-dorsal width 0.074 mm. Dorsal aspect ellipsoidal with two anterolateral horns extending from truncate apex (Fig. 7). Dorsal surface bare except for medial clusters of thick setae near base. Apex blunt with two large (0.015 mm long), ventrally directed, anterolateral horns; ca. six small serrations present between horns (Fig. 9). Lateral margins fringed with long setae (Fig. 8); stem clothed with dense mat of fine setae.

Egg – Length 0.26 mm, width 0.18 mm. Outline elongate oval, poles similar, collar absent (Fig. 22). Micropylar row subequatorial; turretted orifices arise from circular pits (Fig. 23). Chorionic surface prominently pitted with widely spaced, variably sized aeropyles on anterior and posterior third; equatorial third smooth; eclosion line absent (Figs. 22, 24).

Subgenital plate – Posterior margin rounded; plate somewhat triangular, extending slightly over anterior margin of sternum 9 (Fig. 38).

Material – CALIFORNIA: Humboldt Co., East Fork Campground, 4 mi W Willow Creek, 23 June 1985, B. P. Stark, 1 ♂, 1 ♀ (BPS). Grassy Creek, Fieldbrook, 22 May 1982, B. P. Stark, D. Ziegler, 1 ♂ (BPS). Marin Co., Redwood Creek, Mt. Tamalpais State Park, 22 April 4987, R. W. Baumann, B. P. Stark, C. R. Nelson, S. A. Wells, 4 ♂ (BYU). Redwood Creek, Muir Woods, 21 June 1985, B. P. Stark, 4 ♂, 7 ♀ (BPS). Nevada Co., Sagehen Creek, University of California Biological Station, 19 June 1985, B. P. Stark, 2 ♂, 4 ♀ (BPS).

Known distribution – AB, BC, CA, ID, MT, OR (Stark et al. 1986).



Figs. 1-6. Scanning electron micrographs of *Alloperla* epiprocts. 1. *A. chandleri*, dorsal aspect. 2. *A. chandleri*, lateral aspect. 3. *A. fraterna*, dorsal aspect. 4. *A. fraterna*, lateral aspect. 5. *A. pilosa*, dorsal aspect. 6. *A. pilosa* nearly lateral aspect.

Alloperla fraterna Frison

Alloperla fraterna Frison, 1935. Holotype male, Oak Creek, Benton Co., Corvallis, Oregon.
Sweltsa fraterna: Illies, 1966.
Alloperla fraterna: Surdick, 1985.

Epiproct – Length 0.124 mm, basal width 0.045 mm, apical width 0.03 mm, constriction width 0.027 mm. Dorsal aspect dumbbell shaped, constricted area nearer apex than base; apex smoothly rounded and bare (Fig. 3); length of bare apical area ca. 0.013 mm. Dorsal surface covered with dense mat of long setae (Figs. 3-4). Lateral aspect somewhat flattened at base and somewhat enlarged at apex (Fig. 4). Ventral surface and lip area around base without setae; stem clothed with dense mat of fine setae.

Egg – Length 0.28 mm, width 0.17 mm. Outline elongate oval. Micropylar row subequatorial, orifices sessile. Chorionic surface smooth, eclosion line absent. Collar absent (Figs. 17-18).

Subgenital plate – Posterior margin smoothly rounded, sides slightly convergent. Posterior margin extending slightly over anterior margin of sternum nine (Fig. 42).

Material – CALIFORNIA: Humboldt Co., Hwy 299, 10 mi W Willow Creek, 23 June 1985, B. P. Stark, 7 ♂, 6 ♀ (BPS). Santa Clara Co., Swanson Creek, Uras Canyon, 4 June 1969, D. G. Denning, 4 ♂ (BYU). Siskiyou Co., Castle Creek below Castle Lake, 7 July 1979, B. P. Stark, K. W. Stewart, 2 ♂, 4 ♀ (BPS). WASHINGTON: Jefferson Co., Taft Creek, 1 mi W Hoh Visitor Center, Olympic National Park, 16 July 1979, B. P. Stark, 1 ♂ (BPS).

Known distribution. - AK, BC, CA, OR, WA (Stark et al. 1986).

Alloperla medveda Ricker

Alloperla medveda Ricker, 1952. Holotype male, Bear Tooth Creek, Bear Tooth Mountains, Carbon Co., Montana.

Epiproct – Length 0.113 mm, basal width 0.062 mm, subapical width 0.04 mm; the 0.073 mm base of the triangular apex is formed by two large anterolateral horns (Figs. 10, 12). Dorsal aspect somewhat elliptical, surface bare except for medial clusters of thick setae near base (Fig. 10). Apical margins forward of anterolateral horns, deeply serrate with apices laterally directed (Fig. 12). Lateral margins fringed with long setae (Fig. 11); stem clothed with dense mat of fine setae.

Egg – Length 0.27 mm, width 0.19 mm. Outline elongate oval. Micropylar row subequatorial, orifices with circular raised lip (Fig. 26). Anterior and posterior third of chorionic surface covered with densely packed minute aeropyles; aeropyles of equatorial third more widely spaced (Figs. 25-26). Eclosion line absent. Collar stalked, rim irregularly incised, sides with several longitudinal carinae which terminate at shoulder (Fig. 27).

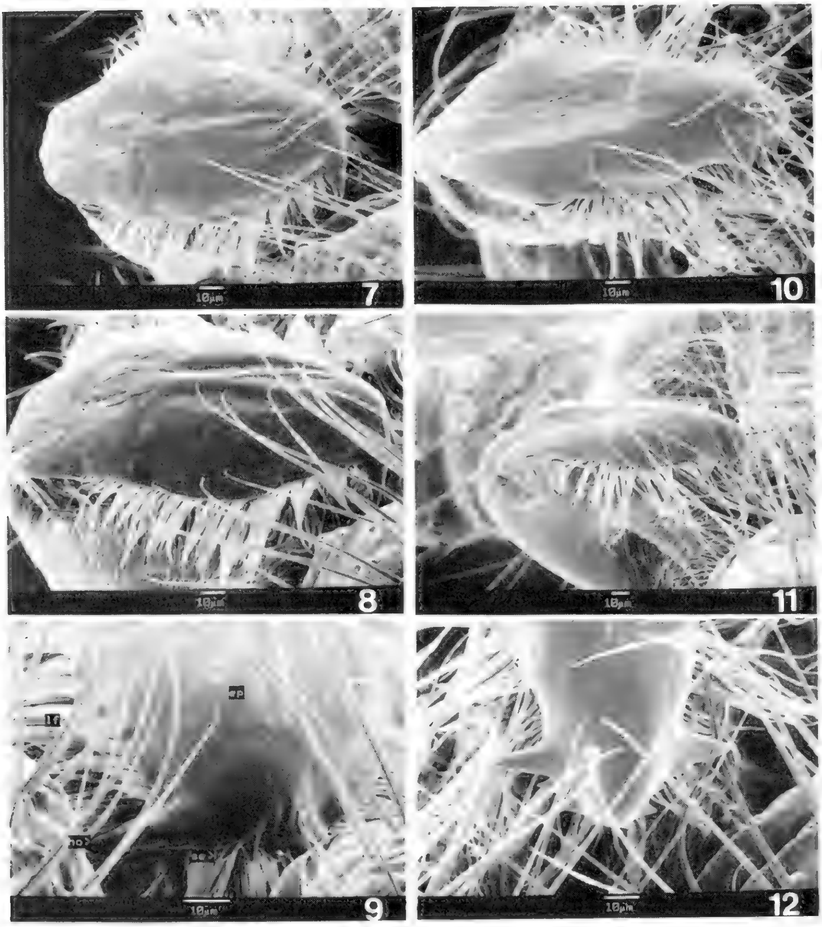
Subgenital plate – Posterior margin rounded, plate narrow and tab-like, extending over anterior margin of sternum nine (Fig. 41).

Material – MONTANA: Gallatin Co., Hyalite Creek, Squaw Creek Trailhead, 24 July 1979, B. P. Stark, K. W. Stewart, R. W. Baumann, 9 ♂, 4 ♀ (BPS). Granite Co., Butte Canyon Creek, 25 June 1966, M. L. Miner, 2 ♂ (BYU).

Known distribution – AB, BC, ID, MT, WY, YK (Stark et al. 1986).

Alloperla pilosa Needham & Claassen

Alloperla pilosa Needham & Claassen, 1925. Holotype male, Boulder, Boulder Co., Colorado.
Sweltsa pilosa: Illies, 1966.
Alloperla pilosa: Surdick, 1985.



Figs. 7-12. Scanning electron micrographs of *Alloperla* epiprocts. 7. *A. delicata*, dorsal aspect. 8. *A. delicata*, nearly lateral aspect. 9. *A. delicata*, apex (ep = epiproct, lf = lateral fringe, se = serrations, ho = anterolateral horns). 10. *A. medveda*, dorsal aspect. 11. *A. medveda*, nearly lateral aspect. 12. *A. medveda*, apex.

Epiproct – Length 0.218 mm, basal width 0.054 mm, mesal width 0.082 mm, apical width 0.038 mm; length bare apical area 0.013 mm Dorsal aspect somewhat barrel shaped, surface covered with dense mat of setae except for basolateral fold (Figs. 5, 6). Stem clothed with dense mat of fine setae.

Egg - Length 0.35 mm, width 0.25 mm. Outline elongate oval. Micropylar row subequatorial, orifices with raised circular lip (Fig. 29). Chorionic surface with obscure hexagonal follicle cell impressions, anterior and posterior regions covered with densely packed aeropyles, equatorial third with aeropyles more widely spaced (Figs. 28-29). Collar stalked, rim irregularly incised, sides with several longitudinal carinae (Fig. 30).

Subgenital plate – Posterior margin acute, sides convergent. Posterior margin extending well beyond anterior margin of sternum nine (Fig. 40).

Material – COLORADO: Clear Creek Co., Berthoud Pass, 5 August 1973, B. P. Stark, R. W. Baumann, 4 ♂, 2 ♀ (BPS). Larimer Co., Icy Brook, Loch Vale below Timberline Falls, Rocky Mountain National Park, 5 July 1988, B. C. Kondratieff, 2 ♂, 2 ♀ (CSU). same location, 2 August 1988, B. C. Kondratieff, 4 ♂, 7 ♀ (CSU).

Known Distribution – CO (Stark et al. 1986).

Alloperla serrata Needham & Claassen

Alloperla serrata Needham & Claassen, 1925. Holotype male, Moraine Lake, Alberta, Canada.

Epiproct – Length 0.13 mm, width 0.15 mm. Dorsal aspect somewhat triangular (Fig. 15); surface bare except for basal fringe of posteriorly directed, long setae; fringe ca. 0.022 mm wide. Apex rounded, but with median gap and ca. 12 deep laterally directed serrations (Fig. 15). Stem clothed with dense mat of fine setae.

Egg – Length 0.30 mm, width 0.22 mm. Outline elongate oval. Micropylar row subequatorial, orifices with oval lip (Fig. 32). Chorionic surface densely and uniformly punctate with deep aeropyles (Figs. 31-32). Eclosion line absent. Collar stalked, rim irregularly incised, sides with several longitudinal carinae (Fig. 33).

Subgenital plate – Posterior margin acute, outline triangular, margin extending to anterior margin of sternum nine (Fig. 39).

Material – ALBERTA: Moraine Creek, Banff National Park, 27. July 1972, A. R. Gaufin, 4 ♂ (BYU). MONTANA: Gallatin Co., Hyalite Creek, Squaw Creek Trailhead, 24 July 1979, B. P. Stark, K. W. Stewart, R. W. Baumannn, 4 ♂, 5 ♀ (BPS).

Known distribution – AB, AK, BC, ID, MT, WA, WY, YK (Stark et al. 1986).

Alloperla severa (Hagen)

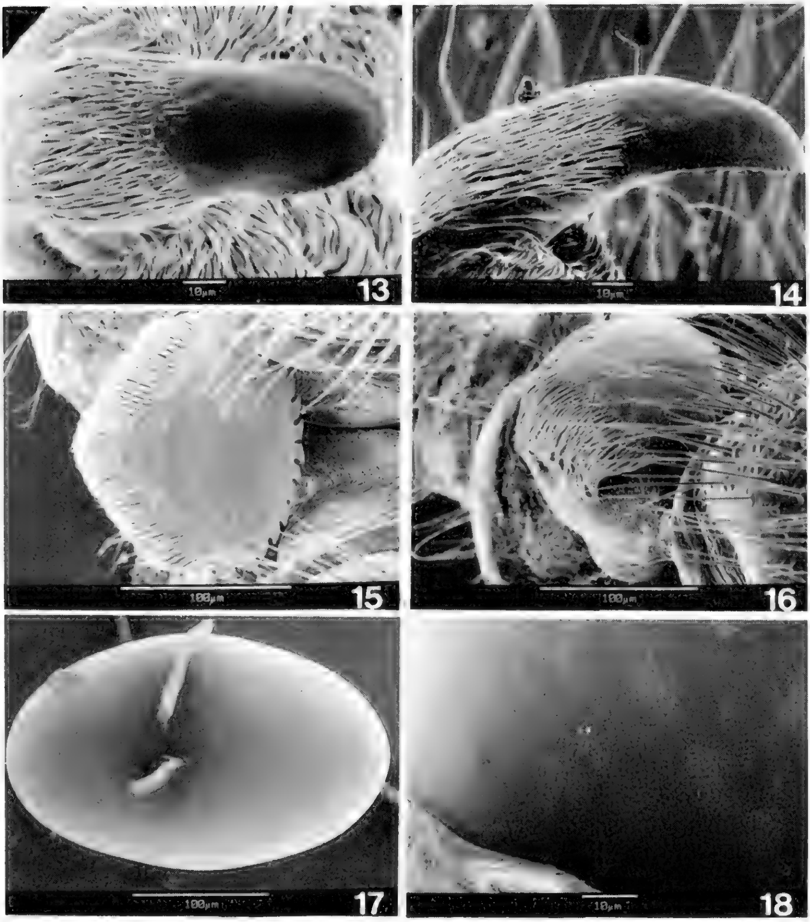
Perla severa Hagen, 1861. Holotype (abdomen missing), Unga Island, Alaska.

Alloperla elevata Frison, 1935. Holotype male, Floras Creek, Curry Co., Oregon. Syn. Ricker, 1954.

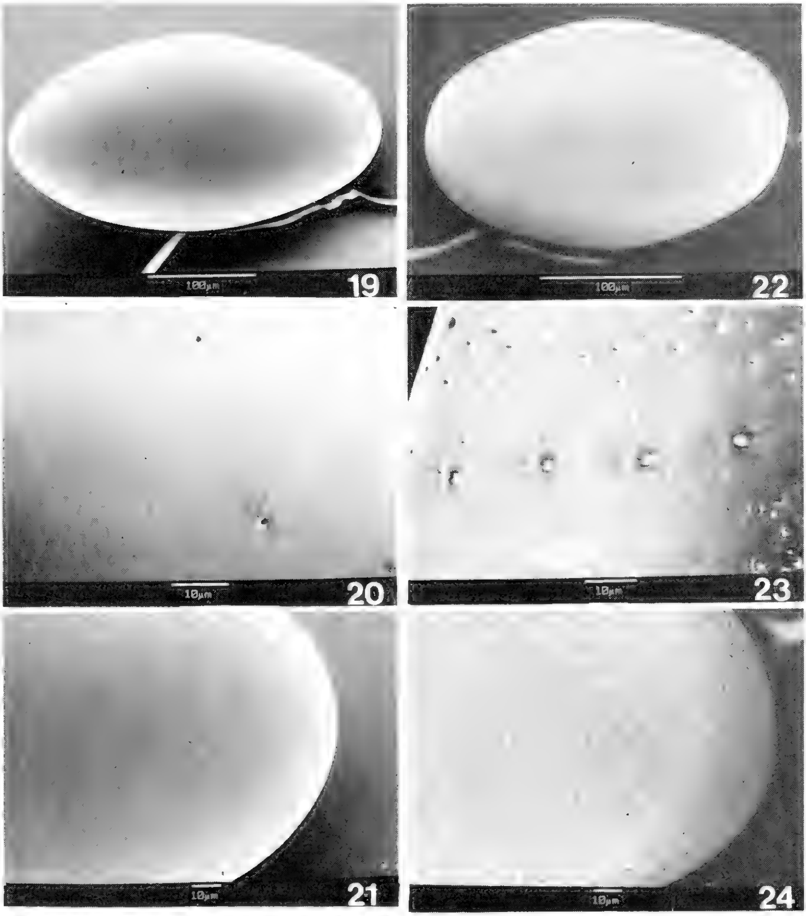
Alloperla thalia Ricker, 1952. Holotype male, Gallatin Co., Montana Syn. Ricker, 1954.

Epiproct – Length 0.11 mm, basal width 0.033 mm, subapical width 0.054 mm. Dorsal aspect elongate, slightly inflated at the base, apex rounded but with shallow crenulations (Fig. 13). Surface bare in apical half, densely pilose in basal half. Stem clothed with dense mat of fine setae.

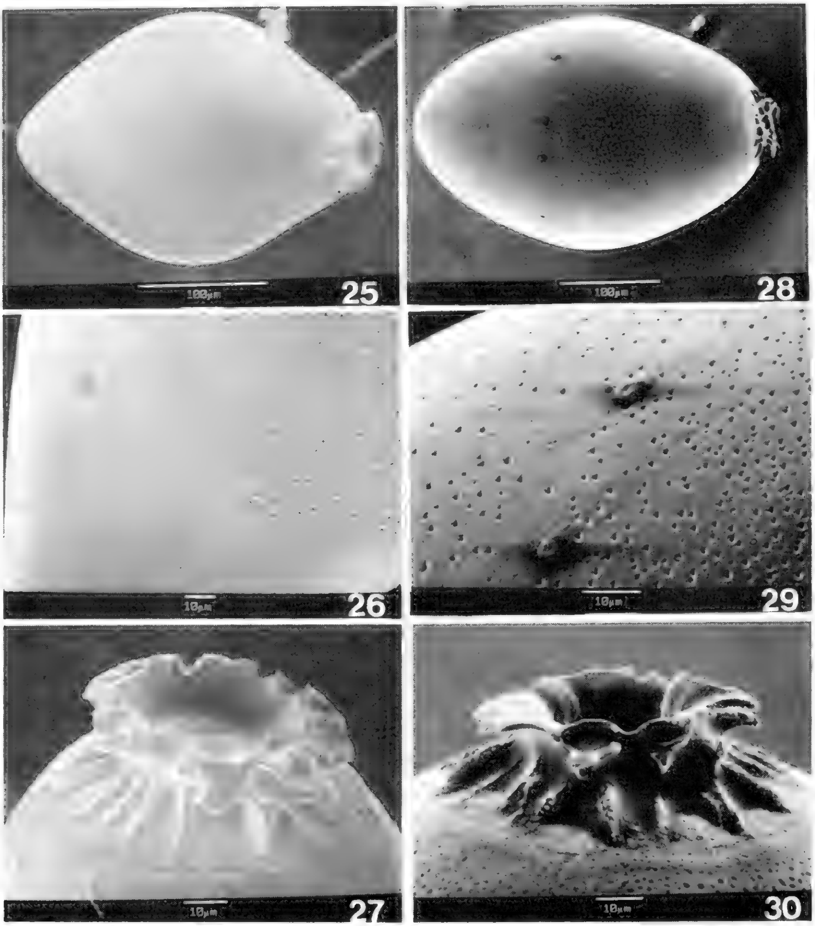
Egg – Length 0.31 mm, width 0.21 mm. Outline elongate oval. Micropylar row subequatorial, obscure, orifices slanted, lip oval (Fig. 35). Chorion densely and finely punctate throughout (Figs. 34-35). Eclosion line absent. Collar stalked, rim irregularly incised, sides with several longitudinal carinae (Fig. 36).



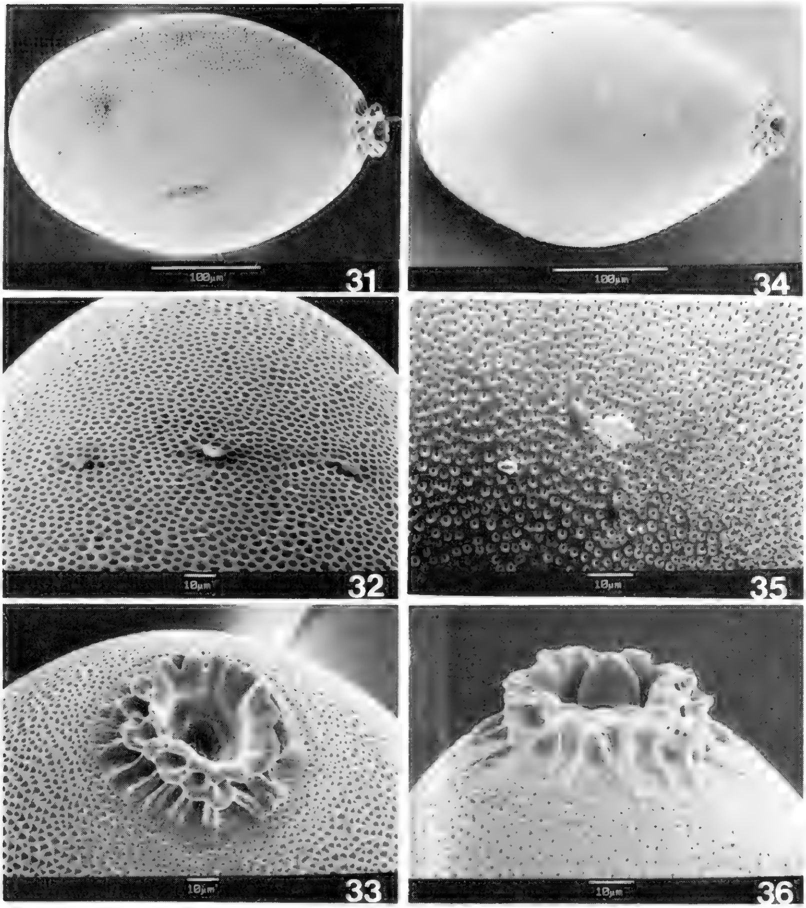
Figs. 13-18. Scanning electron micrographs of *Alloperla* epiprocts and eggs. 13. *A. severa*, dorsal aspect. 14. *A. severa*, lateral aspect. 15. *A. serrata*, dorsal aspect. 16. *A. serrata*, nearly lateral aspect. 17. *A. fraterna*, entire egg. 18. *A. fraterna*, chorionic detail showing micropyle.



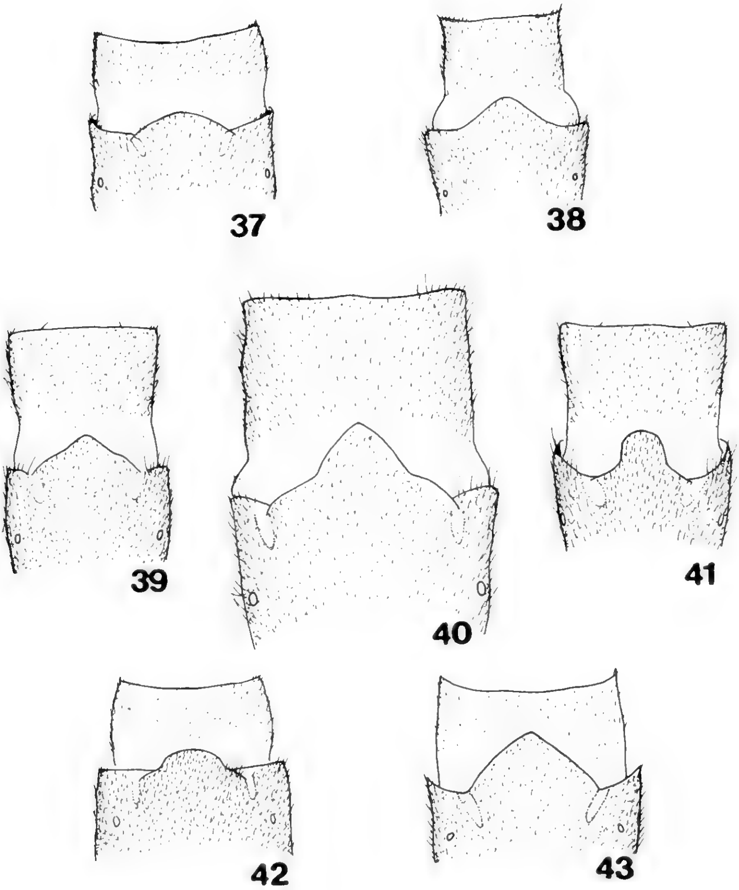
Figs. 19-24. Scanning electron micrographs of *Alloperla* eggs. 19. *A. chandleri*, entire egg. 20. *A. chandleri*, chorionic detail showing micropyle. 21. *A. chandleri*, follicle cell impressions on anterior pole. 22. *A. delicata*, entire egg. 23. *A. delicata*, chorionic detail showing micropyle. 24. *A. delicata*, aeropyles on anterior pole.



Figs. 25-30. Scanning electron micrographs of *Alloperla* eggs. 25. *A. medveda*, entire egg. 26. *A. medveda*, chorionic detail showing micropyle. 27. *A. medveda*, collar. 28. *A. pilosa*, entire egg. 29. *A. pilosa*, chorionic detail showing micropyle. 30. *A. pilosa*, collar.



Figs. 31-36. Scanning electron micrographs of *Alloperla* eggs. 31. *A. serrata*, entire egg. 32. *A. serrata*, chorionic detail showing micropyle. 33, *A. serrata*, collar. 34. *A. severa*, entire egg. 35. *A. severa*, chorionic detail showing micropyle. 36. *A. severa*, collar.



Figs. 37-43. Female *Alloperla* subgenital plates. 37. *A. chandleri*. 38. *A. delicata*. 39. *A. serrata*. 40. *A. pilosa*. 41. *A. medveda*. 42. *A. fraterna*. 43. *A. severa*.

Subgenital plate Posterior margin acute, outline triangular, margin reaching center of sternum nine (Fig. 43).

Material – MONTANA: Glacier Co., St. Mary's River, 2 mi S Babb, 28 July 1966, A. R. Gaufin, 18 ♂, 43 ♀ (BPS). Lincoln Co., Fischer River, Hwy. 2, 30 June 1973, A. R. Gaufin, 2 ♂ (BYU). NEVADA: Elko Co., Secret Creek near Secret Pass, 15 June 1974, B. P. Stark 3 ♂, 4 ♀ (BPS). UTAH: Summit Co., Yellow Pine Creek, 8 mi E Kamas, 22 July, 1974, B. P. Stark, R. W. Clubb, 1 ♂ (BPS).

Known distribution – AB, AK, BC, CA, CO, ID, MT, NT, NV, OR, UT, WA, WY, YK (Stark et al. 1986).

DISCUSSION

The *Alloperla* of western North America include three sets of similar appearing species pairs (*A. chandleri-A. fraterna*, *A pilosa-A. severa* and *A. delicata-A. medveda*) and one fairly distinctive species, *A. serrata*. The eggs and epiprocts of each pair are difficult to differentiate using light microscopy.

Alloperla chandleri and *A. fraterna* have similar epiproct morphology and the presence or absence of a dorsal abdominal stripe may be variable. In our material, however, all *A. fraterna* specimens possessed the stripe, and all *A. chandleri* lacked it. Compared to *A. fraterna,* the epiproct of *A. chandleri* is longer and broader, the apical bare area is wider and more nearly truncate, and the dorsal constriction is much less conspicuous (Figs. 1, 3). In lateral aspect, the epiproct of *A. chandleri* is uniform in width, but in *A. fraterna* it is conspicuously narrower at the base than at the apex (Figs. 2, 4). The eggs of both species are oval, collarless, and without distinctive chorionic sculpturing (Figs. 17, 19).

Although *A. severa* and *A. pilosa* are usually identified on the basis of size and abdominal striping, their epiprocts are difficult to distinguish with light microscopy. The dorsal shapes of the epiprocts are very similar, and it may be difficult to detect the shallow apical crenulations of *A. severa* (Figs. 5, 13). The epiproct of *A. severa* is shorter and narrower than in *A. pilosa*, but the most conspicuous difference is in the setation. *A. pilosa* has only a tiny bare, button-like apex to the epiproct (Fig. 5), whereas *A. severa* has at least the apical third bare (Figs. 5, 13). The eggs of these species have similar collars, and the chorionic surfaces of both are pitted throughout with aeropyles (Figs. 28, 34). In *A. pilosa* the aeropyles are larger and more widely spaced in the equatorial area than in the polar areas, but in *A. severa* the aeropyles are rather uniform in size and spacing.

The dorsal surface of the epiprocts of *A. medveda* and *A. delicata* are nearly bare, but scattered clusters of thick setae are located along the midline (Figs. 7, 10). The epiprocts of both species have lateral setal fringes (Figs. 8, 11) and conspicuous anterolateral horns (Figs. 9, 12). In dorsal aspect, the epiproct of *A. delicata* is nearly oval, and the area between the anterolateral horns is somewhat truncate (Fig. 9). In *A. medveda,* the dorsal aspect diverges to mid-length, then constricts to the apex, and a small triangular area projects from between the anterolateral horns (Fig. 12). *A. delicata* has a mid-dorsal abdominal stripe which is lacking in *A. medveda*. Eggs of *A. delicata* are collarless, but the eggs of *A. medveda* have a stalked collar (Figs. 22, 25).

Alloperla serrata is easily distinguished from all other western *Alloperla* by the button-like epiproct, subequal in length and width, with deep marginal serrations (Fig. 15). The basal edge is covered with thick posteriorly-directed setae, and the anterior portion is bare. Eggs of *A. serrata* are oval with a stalked collar and large aeropyles (Figs. 31-33).

ACKNOWLEDGMENTS

We thank B. C. Kondratieff (Colorado State University) and R. W. Baumann (Brigham Young University) for their generous loan of specimens. We also thank R. F. Surdick and B. C. Kondratieff for their helpful reviews of an earlier draft of this manuscript. This study was supported in part by the Howard Hughes Medical Institute, Undergraduate Biological Sciences Education Program Grant # 71195-538901.

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REVIEW OF THE NEARCTIC GENUS *CERAMPHIS* (COLEOPTERA: SCYDMAENIDAE)[1]

Sean T. O'Keefe[2]

ABSTRACT: The Nearctic genus *Ceramphis* (Coleoptera: Scydmaenidae) is reviewed and includes a single species, *C. deformata,* from southern California and western Arizona. Habitus and male genitalic illustrations are included, as well as illustrations of the female genitalia and mouthparts. The phylogenetic placement of *Ceramphis* within Scydmaenini and as sister group of *Scydmaenus* is discussed.

Taxonomy of the beetle family Scydmaenidae generally has been neglected for North America since the monograph by Casey (1897). Nearly all of the genera are in need of review or revision. Some, such as *Lophioderus* Casey (O'Keefe 1996), *Euconnus* Thomson (*s.str*) (A. Davies unpublished), and *Papusus* Casey (O'Keefe unpublished), include numerous undescribed species. Others, such as *Chevrolatia* Jacquelin du Val (O'Keefe 1997a), *Drastophus* Casey, *Noctophus* Casey, *Xestophus* Casey, and *Pycnophus* Casey (O'Keefe unpublished) include few or no new species. *Ceramphis* Casey falls into the latter category. This review is a continuation of my work on a revision of the Nearctic scydmaenid fauna (O'Keefe 1996, 1997a, 1997b).

Casey (1897) erected the genus *Ceramphis* to include a single interesting species of scydmaenid, *Scydmaenus deformatus* (Fig. 1), described by George Horn (1885) from southern California. Casey placed *Ceramphis* in the Eumicrini (= Scydmaenini) along with *Eumicrus* LaPorte (= *Scydmaenus* Latreille) and *Acholerops* Casey (= *Scydmaenus* Latreille) based on the presence of elongate metatrochanters, arcuate abdominal sutures, a large, vertical pygidium (Fig. 2), and short and rounded maxillary palpomere IV (Fig. 4). He justified placing *S. deformatus* in a new genus based on the presence of a metasternum that extends from side to side without a visible metepisternal suture, the conical pronotum, and the extent to which the prosternum is developed anterior to the procoxae. Franz (1985), upon reexamining the few specimens of *C. deformata* in the Horn collection (MCZC), confirmed Casey's placement of this genus near *Scydmaenus* based primarily on the structure of the male genitalia.

Casey described but did not illustrate the mouthparts and Franz described and inadequately illustrated the male genitalia. I am taking this opportunity to redescribe the species, improving upon Casey's description of the mouthparts and Franz's description of the male genitalia, and describing the female genitalia for the first time.

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[1] Received March 3, 1997. Accepted March 22, 1997.

[2] Dept. of Environmental Science, Policy and Management Division of Insect Biology, University of California, Berkeley, CA 94720.

Ceramphis Casey

Casey 1897: 538; Franz 1985: 177.
Type species: *Scydmaenus deformatus* Horn (by monotypy)

DIAGNOSIS. Members of *Ceramphis* can be identified by having an elongate metatrochanter, a conical pronotum (Fig. 1), a large, vertical, and exposed pygidium (Fig. 2), an antennal club composed of two antennomeres, both densely covered with short setae, and a posteriorly extended antennomere V (Fig. 3).

Ceramphis deformata (Horn)

(Figs. 1-9)

Scydmaenus deformatus Horn 1885, pl. 5, fig. 11.
Ceramphis deformata (Horn) Casey 1897:539; Csiki 1919:86; Leng 1920:91; Franz 1985:178, fig. 11.

Lectotype female (number 3029) in Horn Collection, MCZC; NEW DESIGNATION. Type locality: Los Angeles, California. Label information: "Cal" typed white label; "Lectotype 3029" typed red label; "*S. deformatus* Horn" handwritten; "MCZ type 34844" handwritten on red label; "*Ceramphis* det. W. Suter '77" handwritten; "Lectotype ♀ *Ceramphis deformata* Horn S. O'Keefe des. '97" handwritten on red label.

DESCRIPTION. Length 1.63-1.83 mm; reddish-brown throughout; vestiture sparse, pale in color, erect.

Head. Rounded, as high as long, slightly longer than wide, 0.41-0.43 mm wide, widest at eyes; eyes median in position, convex, ovoid, more than 70 facets; vertex slightly raised with sparsely distributed long setae; temples with dense row of short setae behind row of sparsely spaced long setae; antennal bases nearly contiguous, separated by a thin septum, covered dorsally by vertex; antennae (Fig. 3) slightly under two-thirds body length; antennomere I subcylindrical, slightly compacted dorsoventrally, gradually widened distally, twice as long as wide, distal end notched dorsally, interior and ventral surfaces densely covered with short setae; antennomere II conical, widest at distal end, 1.5 times longer than wide at distal end; antennomeres III-IV subconical, III 1.5 times longer than wide at distal end, IV as long as wide; antennomere V modified, posterior margin greatly expanded posteriorly and cup-shaped, twice as wide as IV; antennomeres VI-VII subquadrate, subequal, somewhat flattened, slightly wider than long; antennomere VIII subquadrate, as long as wide, slightly narrower than either VII or IX; antennomere IX subcylindrical, 1.5 times longer than wide, 1.5 times longer than VIII; antennomere X tear-drop shaped, widest at distal end, nearly twice as long as wide at distal end, nearly twice as long as IX; antennomere XI ovoid, widest near middle, nearly twice as long as wide, as wide as X; antennomeres X-XI with denser and shorter setation than preceding antennomeres. Maxillae (Fig. 4) with distal margins of galea and lacinia fringed with elongate setae; galea subquadrate; lacinia elongate, about three times longer than wide; maxillary palpomere II elongate, subcylindrical, four times longer than wide, slightly wider at distal end; maxillary palpomere III slightly longer than II, gradually and distinctly expanded distally, distal end twice as wide as basal end; maxillary palpomere IV small, rounded, as long as wide at base. Labrum (Fig. 5) short, transverse, lateral margins rounded; basal margin broadly emarginate; distal margin slightly concave; with four elongate, three medium, and two short setae. Mandible (Fig. 6) with apex elongate, curved, with single tooth at base of incisor; base broad; prostheca present, 1

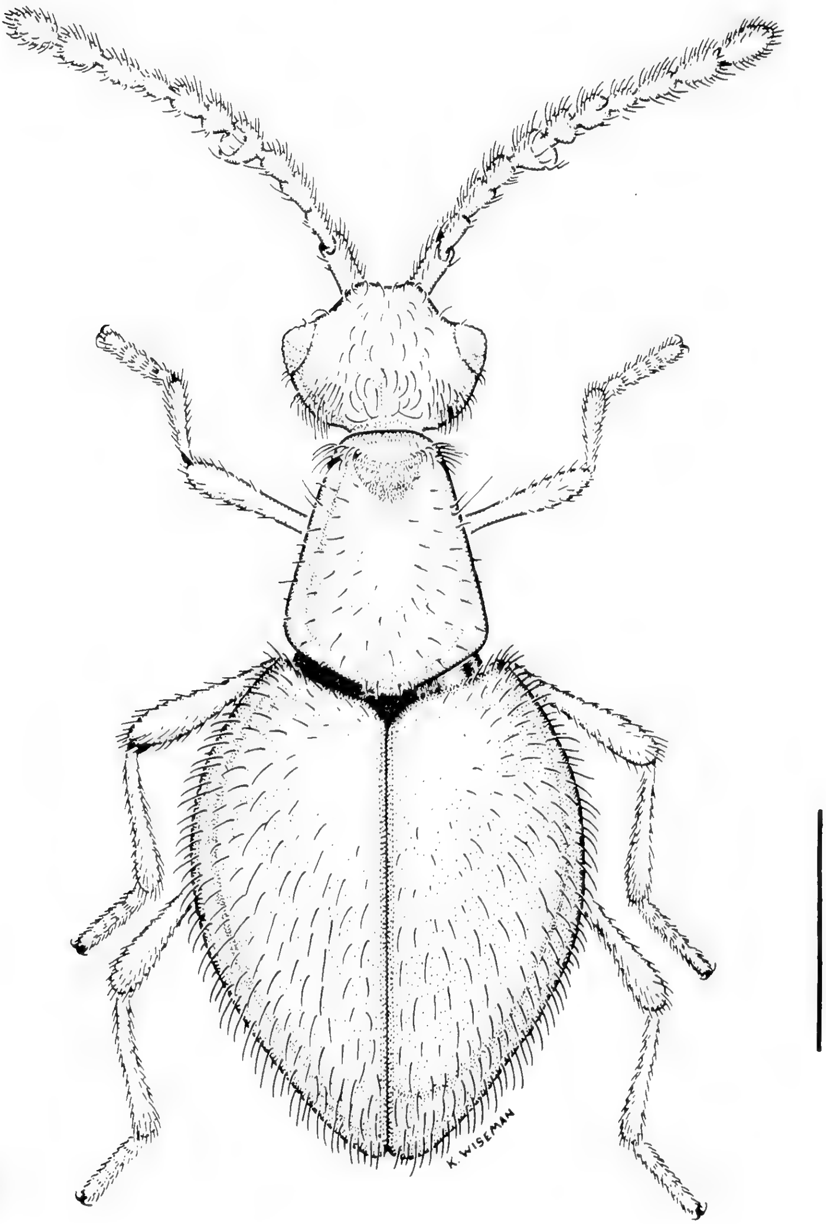


Figure 1. *Ceramphis deformata* (Horn). Habitus, dorsal view. Scale bar = 0.50 mm.

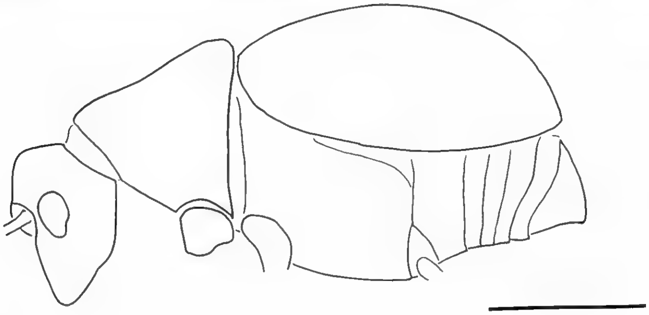
extended entire length from base of mandible to base of incisor, setae elongate, dense. Labium (Fig. 7) with mentum subquadrate, with two elongate setae; palpomere II cylindrical, slightly longer than broad; palpomere III elongate, tapered at apex, five times longer than wide at base; single long and two short setae at apex of paplomere II.

Pronotum. Distinctly conical, widest at base, sides evenly narrowed to anterior end; 0.48-0.53 mm wide at base, 0.48-0.54 mm long; no basal impression or foveae on dorsal posterior margin; pronotal vestiture short, sparse, with dense row of short setae along anterior lateral margin from dorsum to venter.

Elytra. Scutellum visible; elytra entire, 0.95-1.10 mm long, 0.85-1.03 mm wide, strongly convex, broadly rounded at apex, setation long, erect, moderately dense; without basal fovea; humeri evident, but weak.

Legs. Moderately long; distal half of femora clavate, with short, dense setation on inner margins. Protrochanters with anterior margin sharp, anteriorly rounded. Hind femora and coxae widely separated by trochanters.

Venter. Prosternum flat, glabrous, narrowed anteriorly, 1.5 times wider than long, with patch of long setae at posterior lateral margin near coxal bases; procoxal margin expanded medially to cover bases of profemora; mesepimeron fused to body; mesocoxae separated by carinate mesosternum; metasternum large, convex, with moderately dense short setation; hindcoxae sepa-



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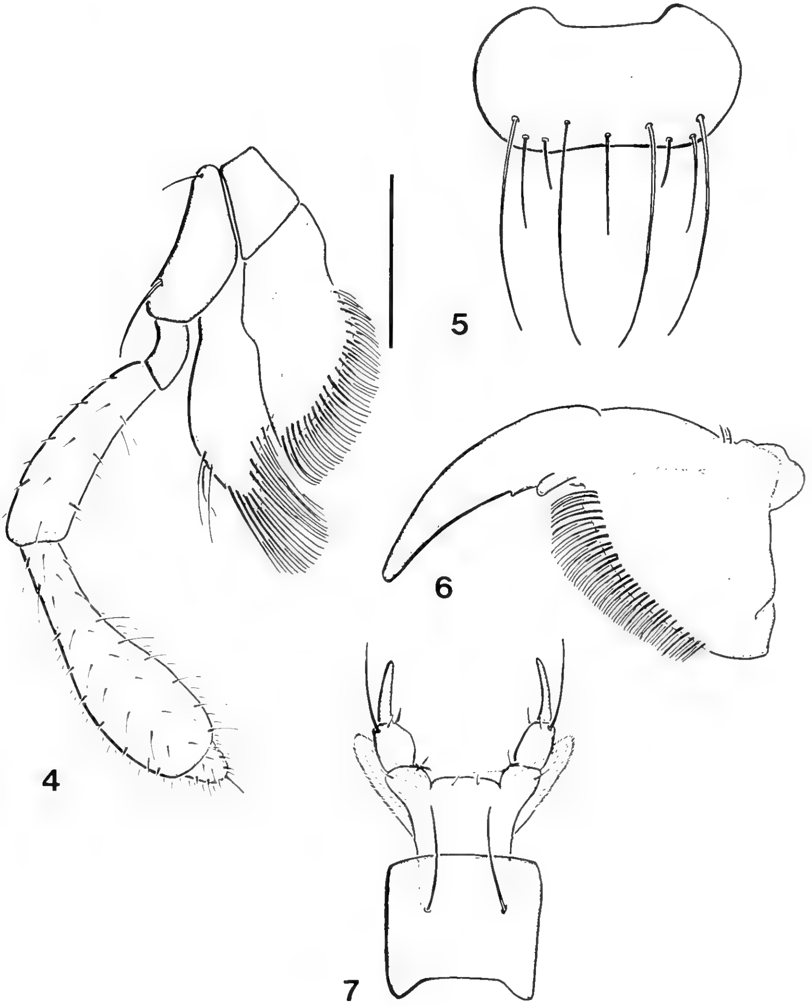
Figures 2-3. *Ceramphis deformata* (Horn). Fig. 2. Habitus, left lateral view. Scale bar = 0.50 mm. Fig. 3. Right antenna, dorsal view. Scale bar = 0.20 mm.

rated by at least their width, subtransverse, not extended to lateral margin; abdominal segment I as long as II and III combined; segments II-IV equal in length; segment V half as long as IV; segment VI 1.5 times longer than II; sutures rounded apically; pygidium large, convex, vertical (Fig. 2).



Figures 4-7. *Ceramphis deformata* (Horn). Fig. 4. Left maxilla, posterior view. Fig. 5. Labrum, anterior view. Fig. 6. Left mandible, posterior view. Fig. 7. Labium, ventral view. Scale bar = 0.10 mm.

Male Genitalia. (Fig. 8). Parameres present, fused together along distal half, difficult to distinguish from median lobe, extended well beyond median lobe. Median lobe subcylindrical, slightly expanded basally, truncate distally, lightly sclerotized ventrally. Endophallus cylindrical, extended beyond median lobe half length of median lobe, terminated in elongate, slightly curved, acuminate process. Ventral-basal portion of median lobe surrounded by sclerotized plate.

Female Genitalia. (Fig. 9). Ovipositor reduced, faintly sclerotized. Proctiger subtrapezoidal, flat, slightly narrowed at distal end. Single sclerotized structure laterally, either paraproct, or valvifer, or fused paraproct + valvifer; visible dorsally only at lateral sides, each extended to cover one-third of ventral region; coxites absent. Spermatheca spherical; spermathecal duct very long, 4 times diameter of spermatheca.

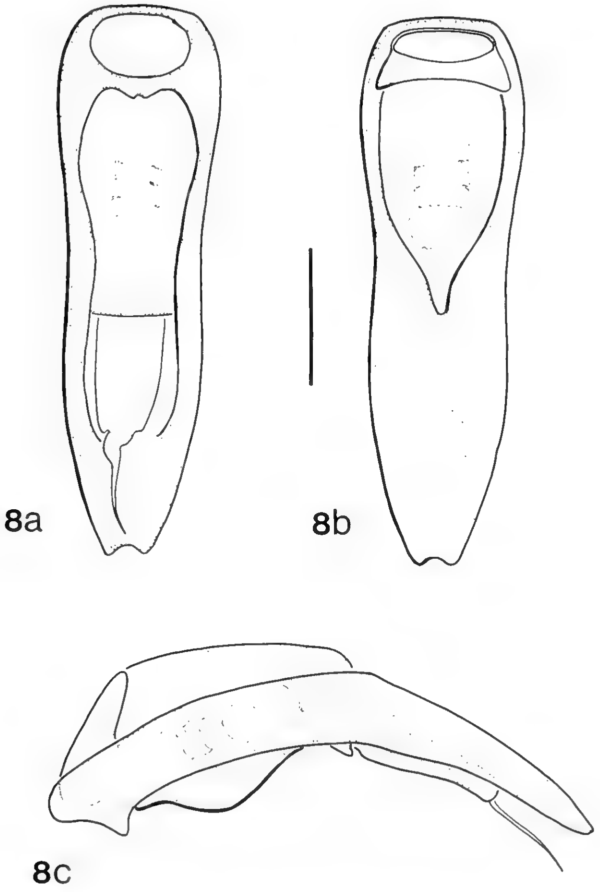


Figure 8. *Ceramphis deformata* (Horn). Male genitalia; a, dorsal view; b, ventral view; c, right lateral view.

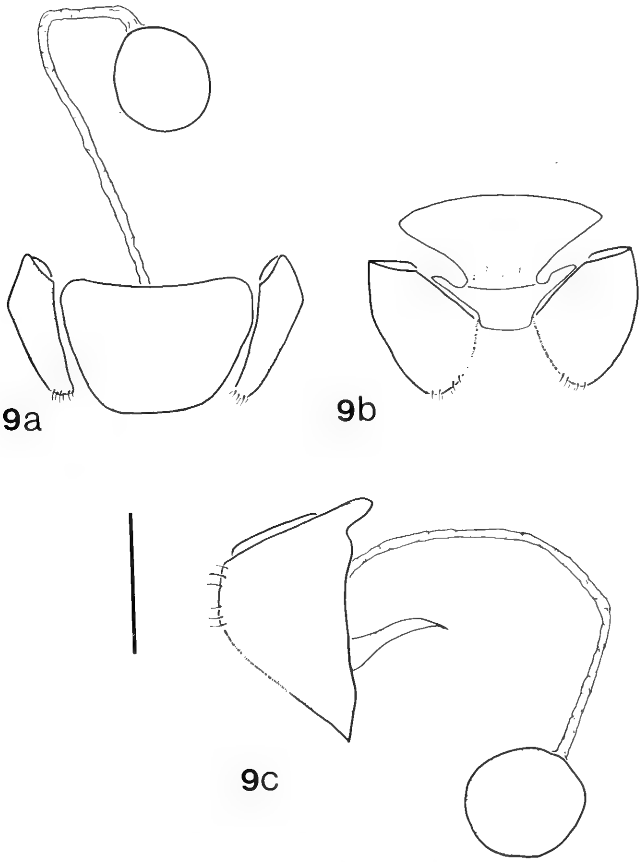


Figure 9. *Ceramphis deformata* (Horn). Female genitalia; a, dorsal view; b, ventral view; c, right lateral view. Scale bars = 0.10 mm.

SPECIMENS EXAMINED. 33. ARIZONA. Graham Co.; 18 specimens, Aravaipa Canyon, 3,050 ft, 9-II-1977, D.S. Chandler, under rock, (WRSC, FMNH). State record only: 1 specimen, Bolter coll. (INHS); 8 specimens, C.V. Riley coll., (USNM); 1 specimen, (USNM). CALIFORNIA. Los Angeles Co.; 1 specimen, Los Angeles, Hubbard and Schwartz coll., (USNM). State records only: 4 specimens (including lectotype), Horn collection (MCZC).

DISTRIBUTION. Known from southern California (Los Angeles) and Arizona. I have been able to locate only about three dozen specimens of *C. deformata* in museum collections. I could find no differences between specimens from southern California and those from Arizona.

HABITAT AND COLLECTION METHODS. Habitat information is associated only with specimens collected by Don Chandler. These were collected underneath rocks in association with *Solenopsis* sp. (Hymenoptera: Formicidae). Specimens of the latter are mounted on points under Chandler's specimens of *Ceramphis*.

COMMENTS. Horn (1885) neglected to designate a holotype specimen for *Ceramphis deformata*, nor was one designated by Casey (1897) or Franz (1985); therefore, of the four specimens in the type series in the MCZC, I chose as the lectotype the specimen with both the handwritten label "*S. deformatus* Horn" and the typed label "Lectotype 3029". This specimen was not in the best condition (head + prothorax separated from the rest of the body and right antennomeres VII-XI are missing) but has the distinct characteristics of antennomere V, body setation, etc of the others in the series.

Three statements of Casey (1897) need minor clarification. First, he stated that the antennal club is "3-jointed and finely pubescent as in *Eumicrus*" (Casey 1897:539). In *Ceramphis* only antennomeres X and XI are distinctly enlarged and densely covered with short setae. Antennomere IX, though slightly larger than VIII and having short setae, is not like those of *Scydmaenus*, in which antennomere IX is distinctly larger than VIII and is as densely covered with short setae as either antennomeres X or XI. Second, Casey stated that the mesosternum is "apparently not carinate" (Casey 1897:539). In all of the specimens I have examined, the mesosternum is distinctly carinate, though not so much as in other Scydmaenidae. Third, Casey stated the antennae were three-fourths as long as the body. In actuality, the antennae are slightly under two-thirds the body length. Except for the above listed discrepancies, Casey's description is fairly accurate.

DISCUSSION

Ceramphis clearly belongs in the Scydmaenini based on the putative synapomorphies of 1) metatrochanters elongate, 2) pygidium vertical, 3) antennomeres forming antennal club compact and densely covered with short setae, 4) antennomeres I notched at distal margin, 5) abdominal sutures curved, and 6) maxillary palpomeres IV short and rounded. The exact position of *Ceramphis* within the Scydmaenini is uncertain.

The tribe Scydmaenini currently includes seven genera: *Adrastia* Broun (1881), *Ceramphis* Casey, *Clavigeroscydmaenus* Franz (1986), *Eudesis* Reitter (1881), *Palaeoscydmaenus* Franz (1975), *Pseudoeudesis* Binaghi (1948), and *Scydmaenus* Latreille (1802). *Scydmaenus* is further divided into 31 recognized subgenera (Newton, A.F., Jr. and H. Franz, unpublished, World Catalog of the Genera of Scydmaenidae (Coleoptera), 23 Oct., 1996 draft).

Palaeoscydmaenus, Eudesis, and *Pseudoeudesis* are most distantly related to *Ceramphis,* based on the form of the male genitalia. In these three genera, the genitalia of males are bulbous and have free parameres (Binaghi 1948, Franz 1975). In *Adrastia, Ceramphis,* and most *Scydmaenus,* the male genitalia are elongate and have fused parameres. Males are unknown for *Clavigeroscydmaenus* (Franz 1986).

Members of *Ceramphis* have the autapomorphies of 1) pronotum distinctly conical and 2) antennomere V with a posteriorly directed extension.

The sister group of *Ceramphis* is to be found within the Scydmaenini; most likely it will be either *Scydmaenus* or a clade included within *Scydmaenus.* To date, there has been no phylogenetic treatment of the 31 recognized subgenera of *Scydmaenus.* Figured male genitalia of members of the Australian subgenera *Scottiscydmaenus* Franz and *Heterognathus* King (Franz 1975) are quite similar in shape to those of *Ceramphis,* but this similarity may represent a symplesiomorphy. Unfortunately, there are approximately 450 species currently placed as *Scydmaenus* incertae sedis; therefore, the probable sister group taxon of *Ceramphis* cannot be recognized until further study of *Scydmaenus* is undertaken. For now, I suggest considering *Scydmaenus* as the sister taxon to *Ceramphis.*

ACKNOWLEDGMENTS

I thank David Furth, Phil Perkins, and Michael Kelley (Museum of Comparative Zoology, Cambridge, Massachussets, MCZC), Gloria House (United States National Museum, Washington, D.C., USNM), Kathleen Methven (Illinois Natural History Museum, Champaign, Illinois, INHS), Alfred Newton (Field Museum of Natural History, Chicago, Illinois, FMNH), and Walt Suter (Carthage College, Kenosha, Wisconsin, WRSC) for arranging loans of specimens, and Michael Kelley for allowing me to examine the lectotype from the LeConte and Horn Collection (MCZC). I thank John Doyen, Dave Kavanaugh, Felix Sperling and two anonymous reviewers for helpful comments on this manuscript. I also thank Kevin Wiseman for illustrating figure 1. The work was funded in part by California Agriculture Experiment Station Grant to Felix Sperling, Sigma Xi, Vice Chancellors Grants in Aid, and the Margaret C. Walker Fund.

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SOCIETY MEETING OF APRIL 24, 1997

Tom Wood
University of Delaware, Newark, DE

Tom Wood began with an illustrated introduction to the stunning and beautiful diversity of membracids and a recording of their recently discovered "sounds" or, more correctly, substrate vibrations, which, recorded and amplified, could be mistaken for elephant love calls or Bronx cheers. He went on to discuss his twenty-five years' research on speciation by host plant shifts in *Enchenopa binotata.* As far back as 1964, he found that this species feeds on perhaps a dozen different trees or shrubs in five different families. The nymphs from different hosts are noticably different, and closer examination revealed at least eight sets of distinguishing features among hostplant races, including aggregating habits and chemical composition of the egg froth.

When he began his experiments, he found females clearly prefer to lay eggs on the hostplant they grew up on and that mating is similarly mostly confined to individuals from the same host. Furthermore, electrophoresis revealed that populations are genetically differentiated. Tom wondered how the isolation was maintained.

(continued on page 371)

ADVENTIVE *ONTHOPHAGUS* (COLEOPTERA: SCARABAEIDAE) IN NORTH AMERICA: GEOGRAPHIC RANGES, DIAGNOSES, AND NEW DISTRIBUTIONAL RECORDS[1]

E. Richard Hoebeke[2], Kyle Beucke[3]

ABSTRACT: Five Old World species of the dung beetle genus *Onthophagus* (*nuchicornis, depressus, bonasus, gazella,* and *taurus)* are presently recorded in the United States, Canada, and Mexico. The current North American range of each, based on numerous literature records, specimens from private collections, from the insect collections of Cornell University and the Carnegie Museum of Natural History, and our own collecting, is mapped. A brief diagnosis, habitus photographs, and illustrations of other diagnostic features are provided to aid in accurate identification of these adventive species. We also report the presence of *O. gazella* in 2 new states in the U.S. (Kansas, Tennessee), and of *O. taurus* in 6 new states in the U.S. (Missouri, New York, Pennsylvania, Ohio, Tennessee, West Virginia).

Species of dung-burying beetles (Scarabaeidae: Scarabaeinae) have been intentionally introduced into North America to assist the native dung beetle fauna in their efficaceous and rapid removal of livestock feces from pastureland (Fincher 1981, Hunter and Fincher 1985). Some of the adventive species of the genus *Onthophagus* Latreille are quickly becoming the most dominant members of the dung beetle fauna in pastures in the United States, and the geographic range of these species is changing with their dispersal into new habitats.

Prior to 1970, 37 species of *Onthophagus* were recorded in the United States and Canada (Howden and Cartwright 1963), including 2 species3 additional species (*taurus, gazella,* and *bonasus)* have been either intentionally released or discovered in the United States.

Between 1985-87, 3 other exotic species of *Onthophagus* [*sagittarius* (F.), *binodis* Thunberg, and *nigriventris* d'Orbigny] have been released in Texas to aid in the control of the horn fly, but these have not become established (refer to Fincher 1990) and they are not discussed further in this paper.

Of the 5 species of non-indigenous *Onthophagus* now recorded in North America, 4 (*nuchicornis, depressus, taurus,* and *gazella*) are securely established and the status of 1 (*bonasus)* is equivocal. Here, we review and map the

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[1] Received February 22, 1997. Accepted April 23, 1997.

[2] Department of Entomology, Cornell University, Ithaca, New York 14853-0901.

[3] 5 Ivy League Lane, Stony Brook, New York 11790.

ENT. NEWS 108(5) 345-362, November & December, 1997

known geographic distribution of these exotic *Onthophagus* in the United States, Canada, and Mexico based on available records in the literature, and on new data gleaned from specimens examined in the private collections of Kyle Beucke, Kipling W. Will, Robert A. Androw, and Darren A. Pollock, and from the collections of Cornell University (Ithaca, NY) and the Carnegie Museum of Natural History (Pittsburgh, PA). We also provide a brief diagnosis and habitus illustration of each of these species to aid in their identification.

The following acronyms are used to indicate deposition of specimens: private collections of Kyle Beucke (KBC), Kipling W. Will (KWC), Robert A. Androw (RAAC), and Darren A. Pollock (DAPC); Cornell University Insect Collection (CUIC), and Carnegie Museum of Natural History (CMNHC).

SPECIES ACCOUNTS

Onthophagus nuchicornis (L.)

Geographic Range: *Onthophagus nuchicornis,* a common and widespread dung beetle occuring throughout much of Europe, the British Isles, and western Asia, is also widely distributed in North America. All previously recorded North American distributional data (taken from Howden and Cartwright 1963; Hatch 1953, 1971; Macqueen and Beirne 1975; Morris 1983; Cervenka and Moon 1991; and McNamara 1991) and additional locality records taken from voucher specimens in the Cornell University Insect Collection and from the private collections of D. A. Pollock and R. A. Androw are mapped in Figure 1.

This Old World dung beetle is firmly established in western Canada (Alberta and British Columbia), in the northwestern United States (Idaho, Montana, and Washington), in eastern Canada (Ontario, Quebec, Newfoundland, New Brunswick, and Nova Scotia), and in a vast area of the northeastern United States (Connecticut, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Wisconsin). McNamara (1991) also recorded *O. nuchicornis* from the prairie province of Manitoba.

This Palearctic species is believed to have been accidentally introduced into northeastern North America prior to the 1840s. Melsheimer (1844) described the species *Onthophagus rhinoceros* from Pennsylvania which was later found to be a junior synonym of *O. nuchicornis*, the Old World species. Henshaw (1887) reported this species being taken from cattle droppings in the Magdalen Islands in the Gulf of the St. Lawrence in 1881. Later, specimens of *O. nuchicornis,* "doubtless introduced with ballast refuse," were captured near Camden, New Jersey (Bland 1889). By the late 1890s and early 1900s, it was reported in the Canadian Maritimes (New Brunswick, Nova Scotia) and Quebec (Evans 1899, Roy 1899, Fletcher 1904). Earliest records of *O. nuchicornis*

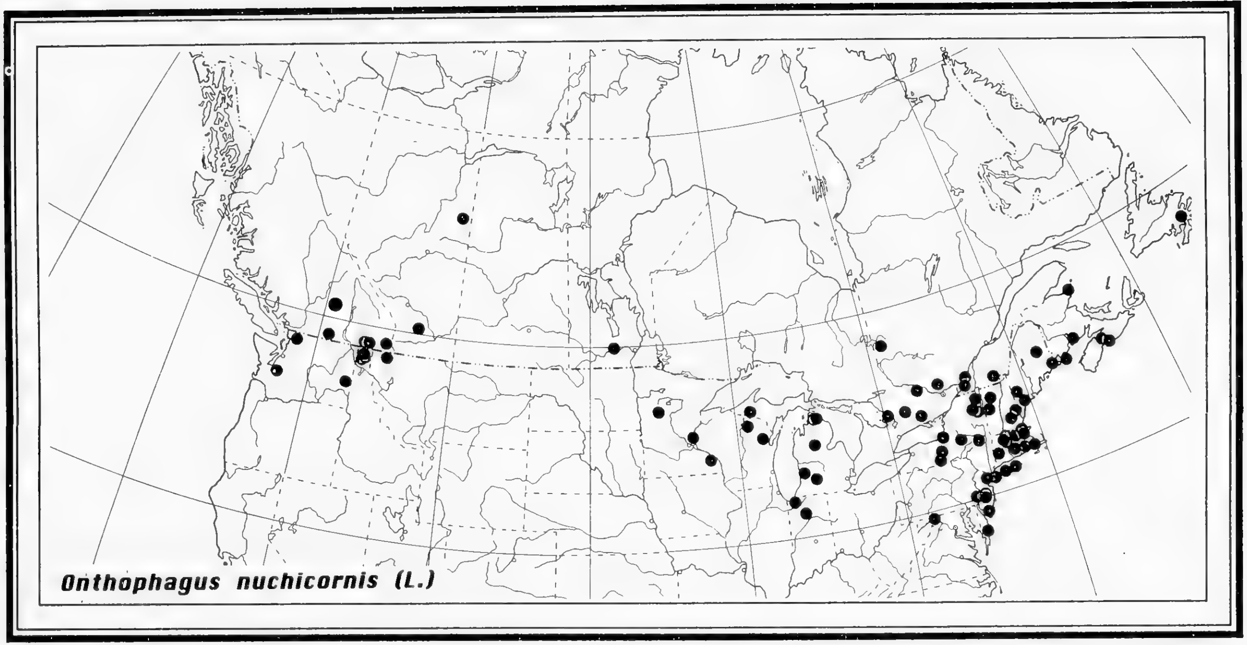


Fig. 1. Known distribution of *Onthophagus nuchicornis* in North America.

in the Pacific Northwest include collections made in southeastern British Columbia in 1945 (Hatch 1953). The occurrence of *O. nuchicornis* in the Pacific Northwest and the Northeast suggests multiple introductions. Brown (1940) gave a brief chronology of the early spread of this immigrant species in eastern North America.

Diagnosis: Length 6.3-8.1 mm (males and females). **Coloration.** Head and pronotum black; elytra tan mottled with black, with suture and base black; pygidium, ventral surfaces, and appendages black.

Remarks: *Onthophagus nuchicornis* (Fig. 2) can be distinguished from other North American species by its moderately large size (6-8 mm) and its black head and pronotum, and tan elytra mottled with black (Fig. 2).

Major males can be recognized by the single, very distinctive, cylindrical median horn arising from the vertex of the head behind the eyes (Fig. 3), but this median horn is barely indicated in minor males. In the female, the pronotal outline is less convex than in males and a median conical protuberance projects slightly beyond the anterior margin (occasionally reduced to a poorly defined arcuate ridge). The species is keyed in Howden and Cartwright (1963).

Additional Canadian and United States Records: CANADA: ALBERTA: Clear Lake (6 km. E. Stavely), 25-VIII-1984, D. Pollock, J. & B. Carr (2) (DAPC). BRITISH COLUMBIA: Kinnaird, 4-IX-1957, G. Stace Smith, A. & H. Dietrich (1) (CUIC). ONTARIO: Orrville, 18-VI-1961, 1-VIII-1962, L. L. Pechuman (2) (CUIC). UNITED STATES: INDIANA: *Pulaski Co.*, Jasper-Pulaski St. Pk., 2-VII-1988, R. A. Androw & M. Bratain (1) (RAAC). MICHIGAN: *Allegan Co.*, Saugatuck, 22-V-1972, E. R. Hoebeke (3) (CUIC). *Gogebic Co.*, Watersmeet, 4-VIII-1975, J. K. Liebherr (2) (CUIC). *Kalamazoo Co.*, Gull Lake Biol. Sta., VII-1970 (3) (CUIC). MINNESOTA: *Hubbard Co.*, Hubbard, 3-4-IX-1979, 8-IX-1979, 17-V-1980 (4) (RAAC). NEW HAMP-

Figs. 2-3. *Onthophagus nuchicornis*. 2, dorsal habitus, major male; 3, head, major male, dorsolateral aspect. Scale line for Fig. 2 = 5.0 mm.

SHIRE: *Strafford Co.,* W. Milton, no date (1) (CUIC). MARYLAND: *Worcester Co.,* Assateague Isl., 11-V-1957, R. G. Beard (3) (CUIC). NEW YORK: *Cayuga Co.,* Sterling, 18-V-1967, D. G. Nielson (1) (CUIC). *Essex Co.,* Mt. MacIntyre top, 19-VI-1941, 27-VI-1941, H. Dietrich (3) (CUIC). *Suffolk Co.,* Montauk Pt., no date (1) (CUIC); Shelter Isl., 14-VI-1944, R. Latham (1) (CUIC); Stony Brook, Scholar Field, 23-V-1980, J. S. Miller (2) (CUIC). VERMONT: *Addison Co.,* no locality, 19-VII-1963, R. A. Morse (1) (CUIC). WASHINGTON: *Thurston Co.,* Rocky Prairie, 4 mi. S. Tenino, 10-IV-1976, R. Hagen (1) (CUIC).

Onthophagus depressus Harold

Geographic Range: *Onthophagus depressus,* a species of dung beetle native to South Africa, was first collected in the United States in 1937 near Vidalia (Toombs Co.), Georgia (Cartwright 1938). Its pathway into North America is unknown. A decade after its initial detection, it was discovered near Lake Placid (Highlands Co.), Florida (Robinson 1948). By 1995, *O. depressus* was collected in cattle and horse dung, pitfall traps with swine feces as bait, and blacklight traps in 27 counties of Georgia and in 5 counties of South Carolina (Hunter and Fincher 1996). Harpootlian (1995) also listed *O. depressus* from Aiken and Jasper counties, South Carolina. A collection of *O. depressus* in Torreya St. Park (Liberty Co.), Florida, in June 1982 (reported below), suggests that the species is perhaps more widely distributed between the Georgia/South Carolina sites in the north and the Highlands Co. locality in peninsular Florida. All available distributional records in the literature, and records listed below, are mapped in Figure 4.

Diagnosis: Length. 6.0-7.7 mm (males and females). **Coloration.** Brownish black to black; antennal clubs brown, legs dark reddish brown.

Remarks: *Onthophagus depressus* (Fig. 5) can be separated from all other North American *Onthophagus* by the sharply emarginate, bidentate, transversely tuberculate clypeus (Fig. 5) and by the rough and granular appearance of the pronotum created by the surface with closely-spaced, crescent-shaped punctures with an elongate flattened tubercle projecting toward their center from the anterior margin (Fig. 6). Additional distinguishing characters include the short, flattened, stubby yellow setae projecting from each puncture, and the heavily punctate tuberculate elytra.

Males and females exhibit no obvious secondary sexual characteristics. In the female, the ventral abdominal segment before the pygidium is much longer along the midline as compared to that of the male. The species is keyed in Howden and Cartwright (1963).

Additional United States Records: UNITED STATES: FLORIDA: *Highlands Co.,* Archbold Biol. Sta., 18-IV-1969, L. L. Pechuman (1) (CUIC); Archbold Biol. Sta., 8 mi. S. of Lake Placid, 30-III-1979, G. Mullen (4) (CUIC); Archbold Biol. Sta., 24-27-III-1984, J. S. Miller (5) (CUIC); 9-VI-1990, 13,14-VI-1990, R. A. Androw, G. Keeney, and M. Archangelsky (4) (RAAC). *Liberty Co.,* Torreya St. Pk., 2-VI-1982, M. Brattain (2) (RAAC).

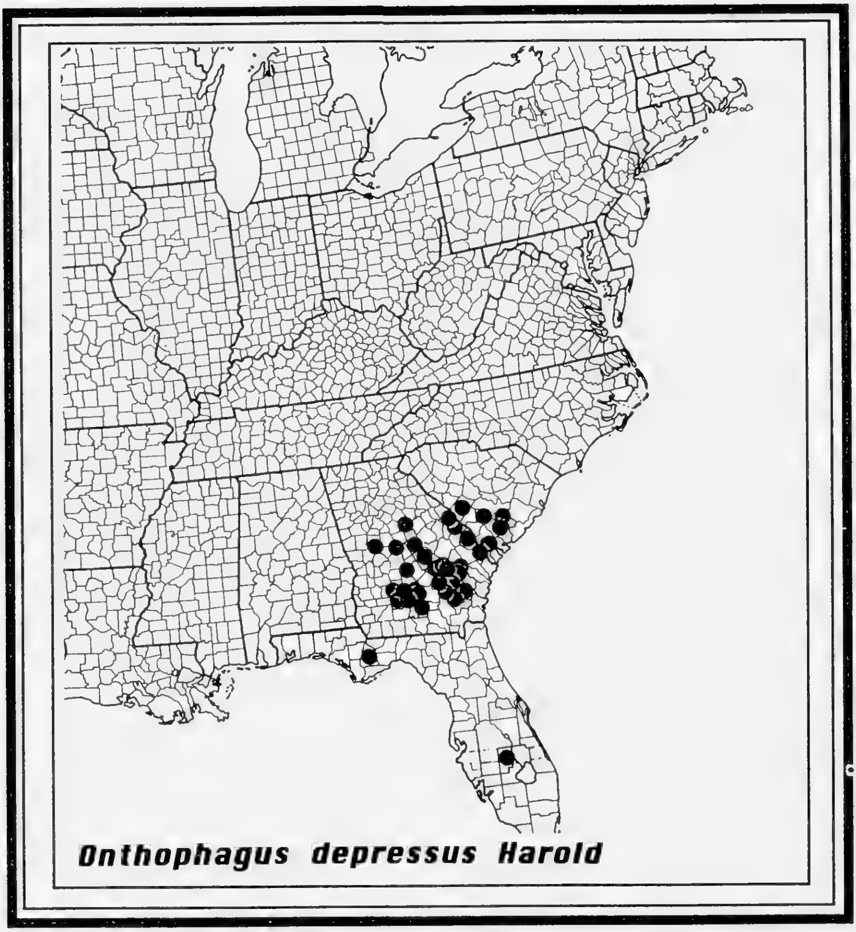
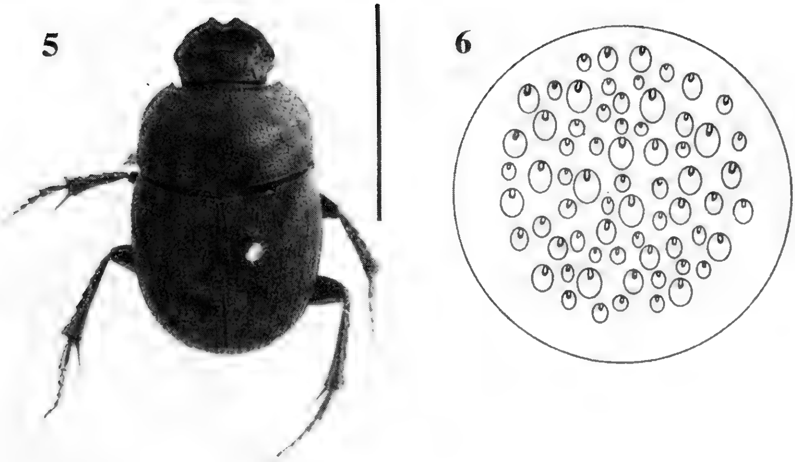


Fig. 4. Known distribution of *Onthophagus depressus* in North America.



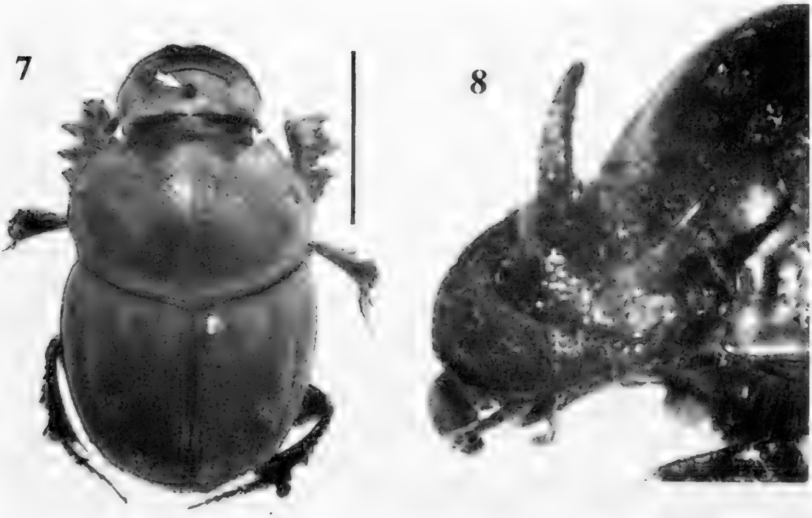
Figs. 5-6. *Onthophagus depressus.* 5, dorsal habitus, male. 6, close-up of pronotal punctation. Scale line for Fig. 5 = 5.0 mm.

Onthophagus bonasus (F.)

Releases: *Onthophagus bonasus*, an Indo-Asian dung beetle native to Pakistan, southern Afghanistan, India, Cambodia, Ceylon, and Burma (Balthasar 1963), was colonized in the laboratory in 1979 and first released at a site in east-central Texas (an owner-cooperator cattle ranch in Burleson Co.) during the winter of 1980-81 (Fincher 1986, Fincher and Hunter 1989). Additional releases of *O. bonasus* were made in other east-central Texas localities in the early 1980s: at one site in Brazos County, July to September, 1982 (Coulson 1992), and at one site in Grimes County, April to September, 1983 (Coulson 1994). Releases at unspecified sites in Georgia took place in 1984 (Fincher 1986). Fincher and Hunter (1989) concluded that the establishment of *O. bonasus* in the United States is equivocal, and that it "has not been recovered more than one year after release in any area."

Diagnosis: Length. 12-17 mm (males and females). **Coloration.** Testaceus yellow, with the head, pronotum (except a narrow pale margin at the sides and base), the elytral suture, the median portion of the metasternum, the upper surface of the femora and tibiae, and a large patch on the lower side of each femur, greenish-black. The entire surface is suffused with a slight metallic luster.

Remarks: Adults of *O. bonasus* (Fig. 7) are very similar in shape and coloration to those of *O. gazella* (discussed below), but in general are larger in size (12-17 mm vs. 8-13 mm). *Onthophagus bonasus* can be further distinguished by the vertex of the head of major males and females bearing a pair of horns (Figs. 7 and 8), forming a backwardly directed crescent, the base slightly flattened and granulate, and each horn with a slight basal tooth at the inner edge; by a short, acute, erect horn in the middle (Fig. 7) of the frons (forehead) in both sexes (median horn absent in male *O. gazella)*; and by the pronotum with a slight median groove, and a minute tubercle on each side. Female *O. gazella* bear no horns on the vertex of the head, only a strongly elevated transverse carina between the eyes.



Figs. 7-8. *Onthophagus bonasus*. 7, dorsal habitus, male. 8, head, male, fronto-lateral aspect. Scale line for Fig. 7 = 5.0 mm.

Onthophagus gazella (F.)

Releases, Establishment, and Geographic Range. *Onthophagus gazella*, an Afro-Asian dung beetle native to much of the hotter, drier parts of Africa south of the Sahara, and ranging into Madagascar, Asia Minor, India and Ceylon (Balthasar 1963, Tyndale-Biscoe 1990), was first introduced into North America in 1972 with releases in Victoria and Kleberg Counties, Texas (Blume and Aga 1978). This exotic dung beetle was also imported, mass-produced, and released at various sites in central and southern California (Anderson and Loomis 1978, Legner 1986, Kohlmann 1994). Since its initial introduction into Texas, *O. gazella* has successfully radiated from the release sites and now occurs throughout a vast portion of the southern two-thirds of Texas and the southern tier of

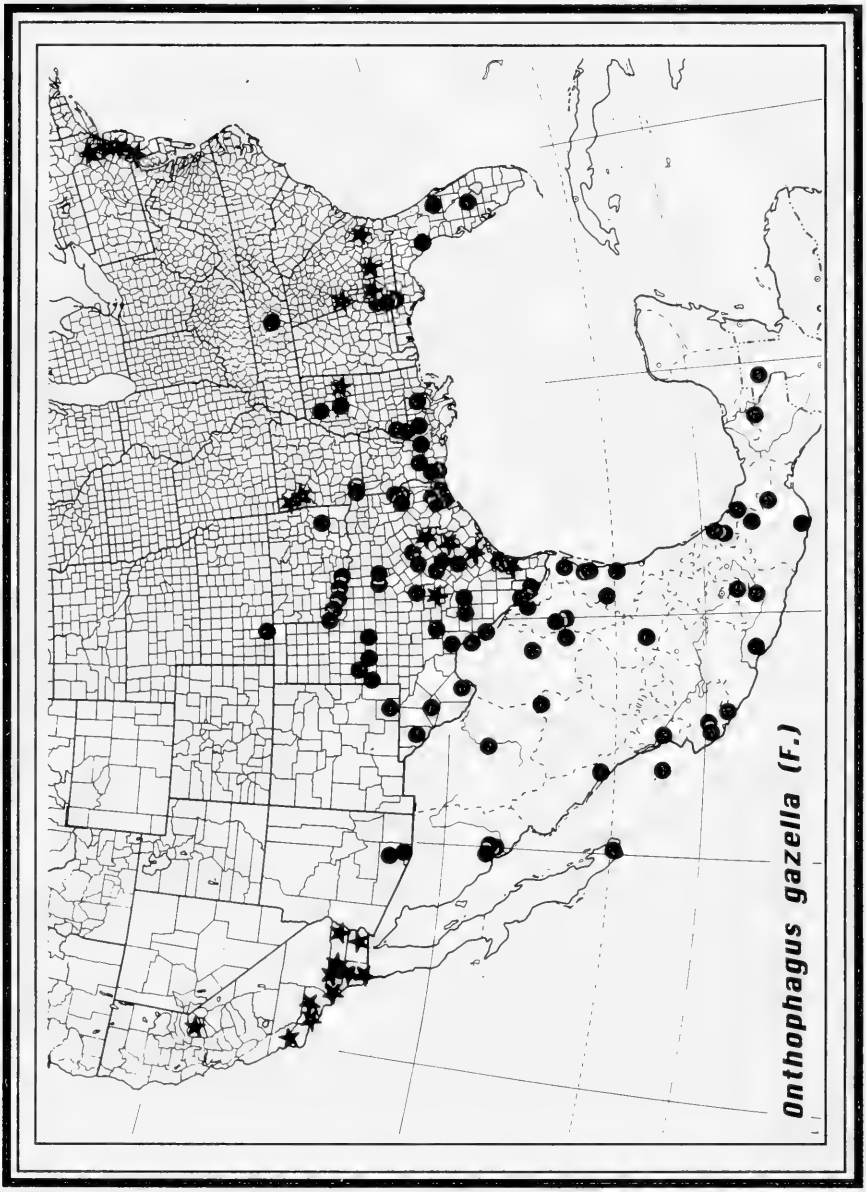


Fig. 9. Known distribution of *Onthophagus gazella* in the United States and Mexico. Stars denote release sites.

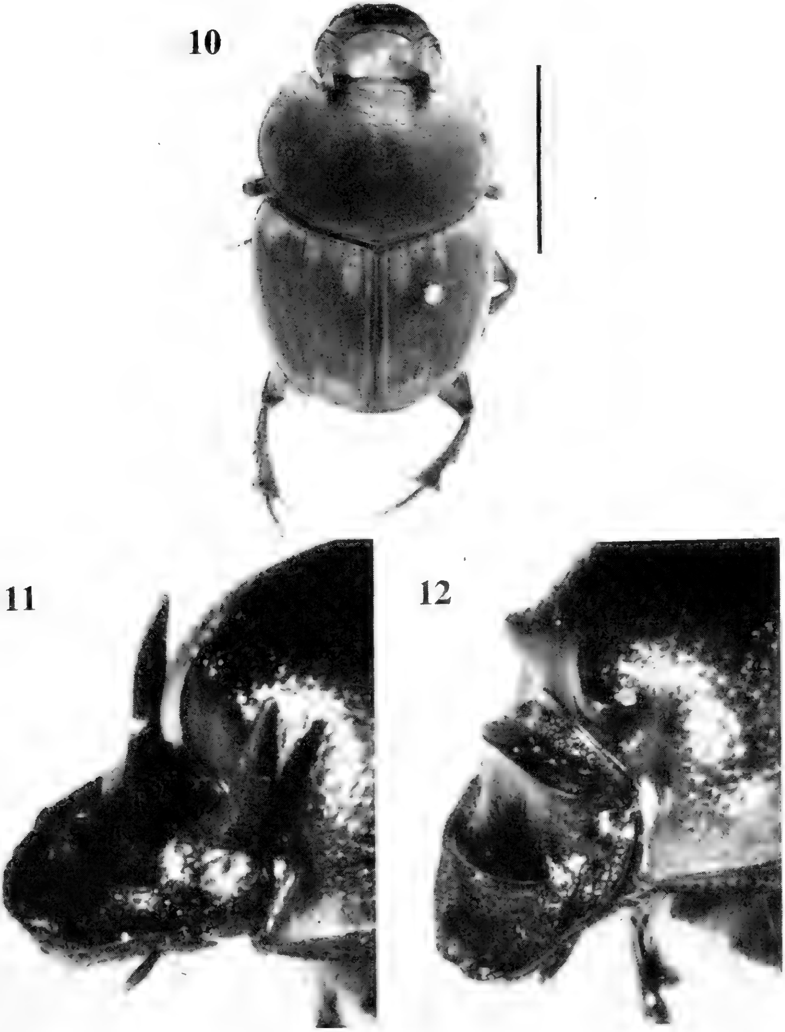
states from California to Georgia (Fincher et al. 1983, Fincher 1990) (see Fig. 9). Additional releases were also made in Arkansas, Georgia, and Mississippi, and by 1981, this dung beetle was securely established in California, Georgia, Louisiana, and Texas (for specific release and recapture localities see Fincher et al. 1983). By the end of 1983, *O. gazella* had been either collected from cattle dung, in pitfall traps baited with swine feces, or in a UV light trap from new additional counties in Oklahoma, Arkansas, Mississippi, Alabama, and Florida (Downie 1984, Hunter and Fincher 1985). Beginning in 1987, *O. gazella* was released by the New Jersey Department of Agriculture at various sites in 6 counties in northern and southern New Jersey, but was never recovered (R. Chianese, pers. commun.).

By late 1981, *O. gazella* had expanded its range very rapidly and started dispersing into the northeastern Mexican states of Coahuila, Nuevo Leon, and Tamaulipas (Fincher et al. 1983, Lago et al. 1984, Barbero and Lopez-Guerrero 1992). At an astounding pace, it has since invaded a vast area along the Atlantic and Pacific coasts of Mexico (Kohlmann 1994) and by 1988 it had spread into the states of Veracruz, Durango, Guerrero, and Jalisco (Morón et al. 1988, Zunino and Halffter 1988, Rivera-Cervantes and Garcia-Real 1991, and Barbero and Lopez-Guerrero 1992). Thomas (1993) reported *O. gazella* from sites in lowland rain forest and tropical deciduous forest in the southernmost Mexican state of Chiapas. By 1987, *O. gazella* had even penetrated into Guatemala (Kohlmann 1994).

Diagnosis: Length. 8-13 mm (males and females). **Coloration.** Very similar to *O. bonasus*; testaceus yellow, with the head, pronotum (except a narrow pale margin at the sides and base), the median part of the metasternum, the front tibiae, the greater part of the middle and hind tibiae, and a large oval spot on the lower surface of the four posterior femora, greenish- or coppery-black. The extreme edges of the pronotum, elytra, and all segments of the body and legs are also dark.

Remarks: In shape and coloration, *O. gazella* (Fig. 10) is extremely similar to *O. bonasus.* but can be separated by being slightly smaller in body size (8-13 mm vs. 12-17 mm) and by the lack of a short, acute, erect horn in the middle of the forehead of the male (present in male *O. bonasus).* In the male of *O. gazella,* the vertex bears a pair of slender horns (Figs. 10 and 11), curving outward and inclined a little backward, slightly flattened at the base and not united; the front of the pronotum is very smooth, glossy, and the declivity is crowned by two minute prominences separated by a slight groove. In the female, the frons bears a strongly elevated, transverse carina; the front of the pronotum is vertical in the middle and produced on each side forming a pair of strong, slightly divergent, blunt processes (Fig. 12).

Additional United States and Mexican Records: All previously reported locality records for *O. gazella* (releases and recaptures) in the literature and



Figs. 10-12. *Onthophagus gazella*. 10, dorsal habitus, male. 11, head, male, fronto-lateral aspect. 12, head and pronotum, female, fronto-lateral aspect. Scale line for Fig. 10 = 5.0 mm.

new and additional records given below are mapped in Figure 9. Specimens provided by K. W. Will (Cornell University), R. A. Androw (Carnegie Museum) and those sorted from unidentified scarabs in the CUIC provide the basis for 2 new state records for the United States [marked with an asterisk (*)]. These new distributional data, and other locality records, are as follows:

UNITED STATES: ARIZONA: *Pima Co.,* Continental, 23-30-VII-1992, J. & M. Huether (1) (CUIC); 31 km. NW Tucson, 600m., 29-VIII-1988, J. E. Rawlins & S. Thompson (1) (CMNHC). *Santa Cruz Co.,* Rock Corral Canyon, 2 mi. SW - 3 Tumacacori, 22-VII-1992, G. C. Eickwort (3) (CUIC); 3 km. N. Nogales, 6-IX 1992, L. Wismann (11) (CMNHC). FLORIDA: *Highlands Co.,* Archbold Biological Station, 25-III/5-IV-1984 (1) (CUIC); Lake Placid, 22-III-1988, M. Ishli (1) (CUIC). *Levy Co.,* Manatee Springs St. Pk., 15-VI-1990, R. A. Androw, G. Keeney, M. Archangelsky (1) (RAAC). *Seminole Co.,* Longwood, 5-VII-1987 (3) (RAAC). *KANSAS: *Meade Co.,* 3 mi. W. Meade, 23-IX-1990, Androw and Brattain (1) (KWC). LOUISIANA: *Allen Parish,* West Bay Game Area, 4-VI-1985, D. Sundberg (2) (RAAC). *St. Tammany Parish,* Slidell, 4-VI-1983, D. Sundberg (5) (RAAC). MISSISSIPPI: *Grenada Co.,* Grenada, 26-VI-1986, R. A. Androw (1) (RAAC). *Panola Co.,* no locality, 12-13-VII-1987, K. E. M. Galley, at black light (2) (CUIC). *Stone Co.,* 8.4 mi. E. of Wiggins, on Rte. 26, 24-V-1995, K. Will & R. Androw (2) (CUIC). NEW MEXICO: *Eddy Co.,* 10-15 mi. S. Carlsbad, 16-VII-1991, Androw and Brattain (1) (KWC). OKLAHOMA: *Latimer Co.,* no locality, 5-VII-1987., K. E. M. Galley, at black light (2) (CUIC). *TENNESSEE: *Cumberland* Co., Grassy Cove, 26-III-1990, R. A. Androw & G. Keeney (1) (RAAC). TEXAS: *Bastrop Co.,* 5 km. N. Smithville, 1-V-1983, 16-V-1983, J. E. Rawlins (2) (CMNHC). *Cameron Co.,* 10 km. SSE Brownsville, Southpointe Nursery, 11-X 1994, R. A. Androw & M. Brattain (1) (CMNHC). *Gonzales Co.,* Palmetto St. Pk., 13-X-1985, R. Davidson & J. E. Rawlins (1) (CMNHC). *Hudspeth Co.,* McNary, 8-VII-1986, R. A. Androw & D. Heffern (1) (RAAC). *Jefferson Davis Co.,* Davis Mtn. State Park, 28-VI/2-VII-1986, 22-VII-1992, R. A. Androw (2) (KWC, RAAC); 7-X-1993, R. A. Androw & S. M. Clark (2) (RAAC); Davis Mtns. Resort, 21-VII-1991, R. A. Androw (3) (KWC); vic. Ft. Davis St. Pk., 24-VII-1996, Wappes & Huether (2) (CUIC). *Medina Co.,* 8 km. S. Hondo, 26-XI-1978, J. E. Rawlins (1) (CMNHC). *Palo Pinto Co.,* Gordon, Rt. 193 at I-20, 12-VIII-1981, R. Davidson (27) (CMNHC). *San Patricio Co.,* 12.4 km. NE Sinton, Welder Refuge, 20-VII-1979, D. C. Darling (5) (CUIC). *Starr Co.,* 14 mi. E. El Sauz, 10-X-1993, R. A. Androw & S. M. Clark (2) (RAAC). *Sutton Co.,* near Sonora, 27-VI-1986, R. A. Androw, D. Heffern & J. Huether (3) (RAAC). *Travis Co.,* Austin, Brackenridge Field Lab., 140 m., 13-X-1984, J. E. Rawlins (2) (CMNHC); 1 km. SE Bee Cave, 17-X-1985, R. Davidson & J. E. Rawlins (6) (CMNHC); 7-X-1984, J. E. Rawlins (1) (CMNHC). *Val Verde Co.,* I-90 at Pecos River, 8-X-1993, R. A. Androw & S. M. Clark (4) (CMNHC). *Zapata Co.,* Falcon St. Pk., 15-X-1985, R. Davidson & J. E. Rawlins (6) (CMNHC) CHIAPAS: Palenque, approx. 20 km. S. of ruins, to UV & Mercury Vapor, 19-20-VIII-1990, M. H. Evans (1) (CUIC). NUEVO LEON: above Cola de Caballo, 2550 ft. alt., to UV, 5-6-VIII-1986, M. H. Evans (15) (CUIC). OAXACA: Betanias, 20-VII-1990, 200 m. el., UV light, J. K. Liebherr, CAS-CU-UCB Field Exp. (1) (CUIC). VERACRUZ: Est. Biol. "Los Tuxtla", 24-25-VII-1990, 250 m. el., J. K. Liebherr, CAS-CU-UCB Field Exp. (4) (CUIC).

Onthophagus taurus (Schreber)

Releases, Establishment and Geographic Range: *Onthophagus taurus,* a common Old World dung beetle native to central and southern Europe, Asia Minor, and ranging from Spain to Morocco, Turkey, Iran and Afghanistan (Balthasar 1963, Tyndale-Biscoe 1990), was recorded for the first time from the United States by Fincher and Woodruff (1975), based on a specimen taken in August 1971 in Santa Rosa County, Florida. Fincher and Woodruff (1975) suggested that it most likely had been accidentally introduced into the Florida panhandle near Pensacola; they proposed the theory of a cattle farmer or rancher easily bringing adult beetles back from an overseas trip, or that the beetles

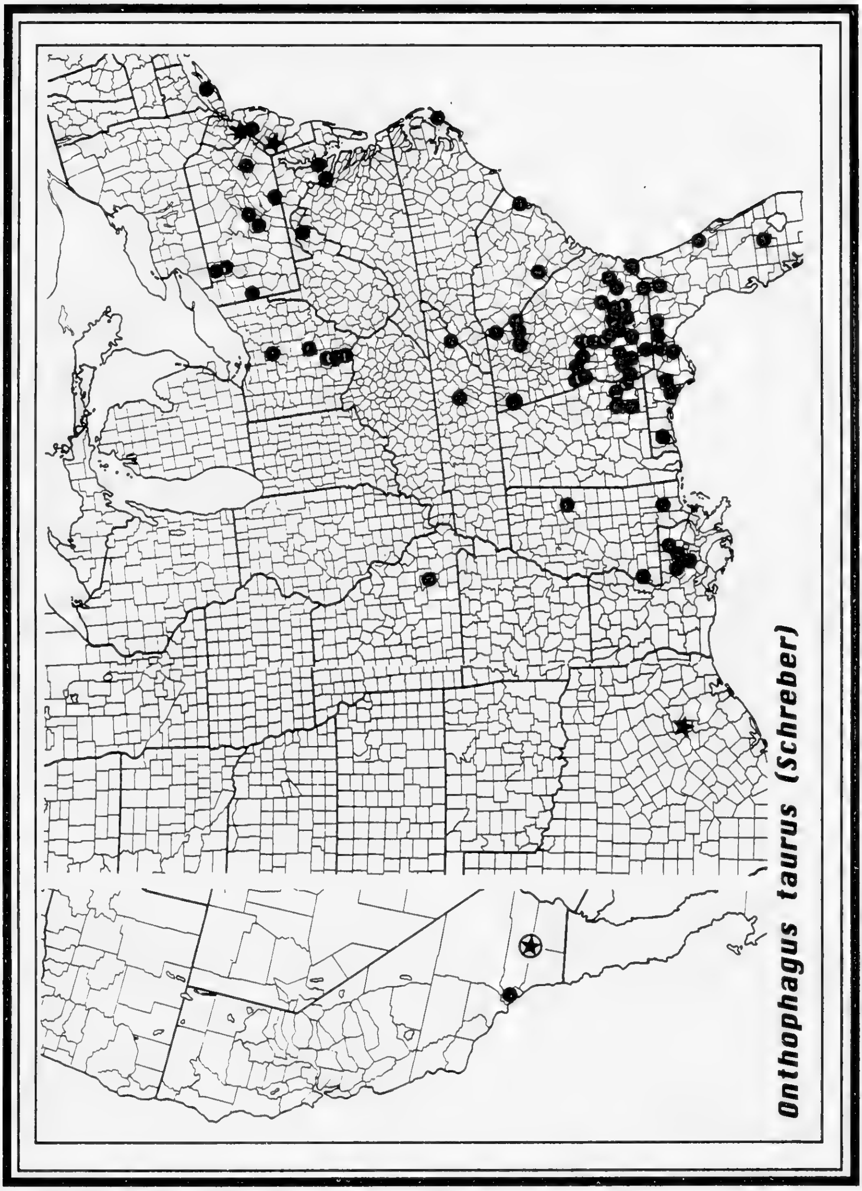


Fig. 13. Known distribution of *Onthophagus taurus* in North America. Stars denote release sites; star/circle denotes a number of unspecified release sites in southern California.

arrived aboard a military vehicle returned from Europe since there are several military bases in the Florida panhandle.

Since its initial detection in the Florida panhandle in 1971, *O. taurus* has spread with remarkable speed westward and northward (Fig. 13). It has been recorded (in chronological order) from southwestern Georgia and southeastern Alabama (Fincher and Woodruff 1975), Stone County, Mississippi (Lago 1979), Cumberland Island, Georgia (Fincher and Woodruff 1979), additional counties in Florida and Georgia, and new coastal localities in North and South Carolina (Steiner 1980, Bernhardt 1981), sites in southern Louisiana (Fincher et al. 1983), a locality in southern Maryland adjacent to the Potomac River (Glaser 1986), and at the Archbold Biological Station in southern peninsular Florida (Highlands Co.) (Vulinec and Eady 1993).

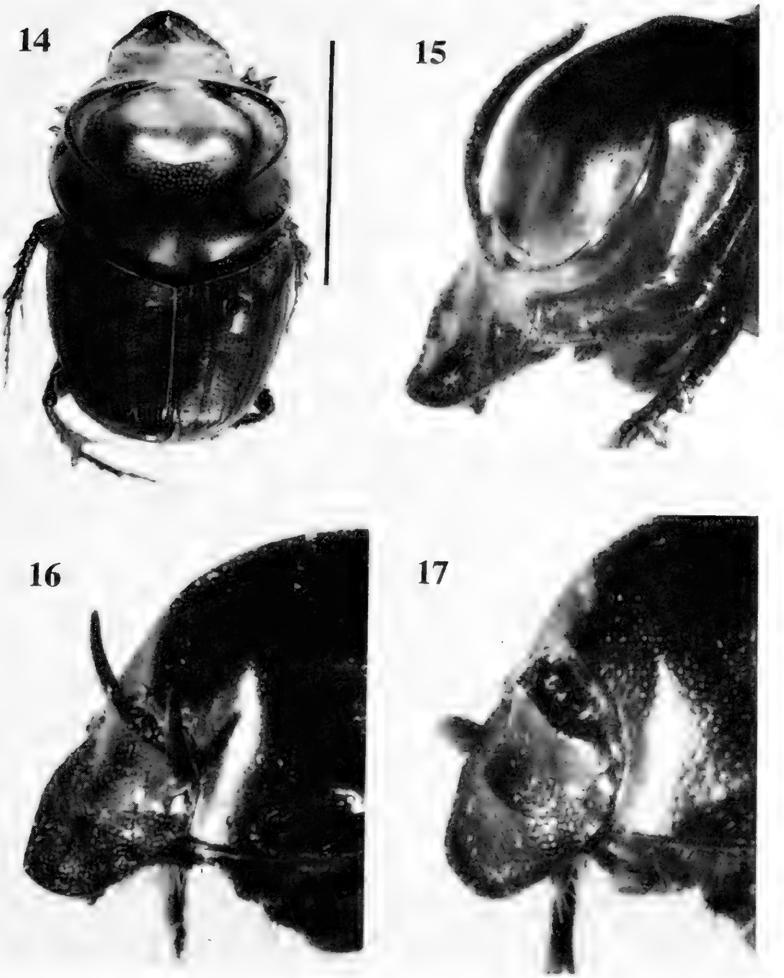
Field releases of *O. taurus* also have taken place at a number of unspecified sites in California and recapture studies have shown that it has successfully overwintered in different parts of the state (Anderson and Loomis 1978). Coulson (1994) noted releases of *O. taurus* at a single site in Grimes County, Texas, in April 1983. Moreover, this species was released at several sites in 2 counties of New Jersey beginning in 1987 by the New Jersey Department of Agriculture (Biological Control Group) and was again recovered from these counties during 1990-91 (R. Chianese, pers. commun.).

Diagnosis: Length. 6.0-11.5 mm (males and females). **Coloration.** Variable in coloration, but mostly unicolorous dull black; sometimes the head and pronotum with a slight metallic reflection. Antennae reddish, with black club, and legs blackish or dark reddish-brown. Elytra usually dull black or blackish-brown, occasionally reddish-brown. The entire pygidium, or portions of the pygidium, and the sides of the abdominal sternites sometimes reddish-brown.

Remarks: *Onthophagus taurus* (Fig. 14) can be easily distinguished from all American species by two long curved, divergent cephalic horns on major males (Fig. 15). However, minor males have a pair of very short, straight horns (Fig. 16), or else they are absent. In females, the clypeus and the frons (between the eyes) each has a transverse, elevated carina or ridge (Fig. 17).

New and Additional United States Records: All previously reported locality records for *O. taurus* in the literature and new and additional records given below are mapped in Figure 13. Specimens collected by one of us (KB), and those provided by K. W. Will (Cornell University) and R. A. Androw (Carnegie Museum), provide the basis for 6 new state records [marked with an asterisk (*)]. These new and additional distributional data are as follows:

UNITED STATES: CALIFORNIA: *Orange Co.*, Peter's Canyon Reservoir, 12-VII-1993, in dog dung, K. Beucke (2) (KBC). FLORIDA: *Leon Co.*, Lk. Iamonia Landing, 28-III-1986, ex black light, E. R. Hoebeke (1) (CUIC). *Union Co.*, 2 mi. S. Baker Co. line, 14-VIII-1976, R. Davidson (8) (CMNHC). *Volusia Co.*, Ormond Beach, 25-III-1982, R. A. Androw (3) (RAAC). GEORGIA: *Crisp Co.*, Cordele, 31-III-1982, R. A. Androw (7) (RAAC). MARYLAND: *Calvert*



Figs. 14-17. *Onthophagus taurus*. 14, dorsal habitus, major male. 15, head, major male, fronto-lateral aspect. 16, head, minor male, fronto-lateral aspect. 17, head, female, fronto-lateral aspect. Scale line for Fig. 14 = 5.0 mm.

Co., Chesapeake Beach, 2-VII-1986, J. Green (4) (RAAC). MISSISSIPPI: *Oktibbeha Co.*, Osborn Prairie, 16-20-III-1997, C. J. Marshall & K. W. Will, ex baited pitfall traps (3) (CUIC). *MISSOURI: *Reynolds Co.*, Ellington, 15-VI-1985, M. Brattain (5) (RAAC). NEW JERSEY: *Burlington Co.*, Mount Holly, 2-VII-1994, in cow dung, K. Beucke (2) (KBC). *NEW YORK: *Suffolk Co.*, Stony Brook, 29-VIII-1993, K. Beucke (1) (KBC); Rocky Point, (burned pine barrens, site #2), 21-IX-1996, ex chicken pitfall trap, K. Beucke (1) (KBC). *OHIO: *Fairfield Co.*, Barneby Ctn., 12-19-X-1991, ex pitfall/dung, K. Will & R. A. Androw (6) (KWC, CUIC). *Pike Co.,* Jackson Twp., Jackson Lk., 5-12-IX-1992, Will & Androw (1) (CUIC). *Richland Co.,* Shelby, Will's Farm, 29-IV-1991, ex dung, K. & I. Will (1) (KWC). *Ross Co.,* Rt. 50 at Scioto River, 4-VII-1989, R. A. Androw (1) (RAAC). *Scioto Co.,* Shawnee St. Pk., 26-V-1990, R. A. Androw & G. Keeney (2) (RAAC); 20-VII 1990, R. A. Androw (2) (RAAC). *PENNSYLVANIA: *Adams Co.,* Gettysburg, 10-VI-1995, in cow dung, K. Beucke (1) (KBC). *Berks Co.,* Wernersville, Stricker farm, V-1994, R. A. Byers & G. M. Barker, ex pitfall trap in grazed dairy pasture (1) (CUIC). *Forest Co.,* 8.7 km. N. Kellettville, 500m., 8-14-VIII-1995, J. R. Deeds (1) (CMNHC). *Huntington Co.,* Tyrone, Hawthorne farm, V-1994, R. A. Byers & G. M. Barker, ex pitfall trap in grazed dairy pasture (1) (CUIC). *Lawrence Co.,* New Castle, Harmon farm, VI-1994, R. A. Byers & G. M. Barker, ex soil samples in grazed dairy pasture (1) (CUIC); New Castle, Gebhart farm, VI-1994, R. A. Byers & G. M. Barker, ex pitfall trap in grazed dairy pasture (1) (CUIC). *Miflin Co.,* Belleville, Rodgers farm, V-1994, R. A. Byers & G. M. Barker, ex pitfall trap in grazed dairy pasture (1) (CUIC). *Warren Co.,* 8.6 km. S. Irvine, Hedgehog Run, 530 m., 19-27-V-1995, 28-V/2-VI-1995, 8-14-VIII-1995, J. R. Deeds (6) (CMNHC); 7.3 km. SSW Cherry Grove, 520m., 28-V/2-VI-1995 (1) (CMNHC); 3-10-VI-1995, C. Bier, J. R. Deeds & T. Schumann (1) (CMNHC); 6 km. E. Cobham, 565 m., 26-VII-1-VIII-1995, J. R. Deeds (1) (CMNHC). *TENNESSEE: *Cocke Co.,* Cosby, 13-VI-1987, R. A. Androw, M. Brattain & J. Huether (1) (RAAC). *Cumberland Co.,* Grassy Cove, 27-III-1989, R. A. Androw (13) (KWC, CUIC). *WEST VIRGINIA: *Hampshire Co.,* 0.5 km. E. North River Mills, Ice Mountain Preserve, 6-19-VII-1995, D. Koenig, W. Zanol & C. Young (1) (CMNHC); 1-VIII-20-IX-1995, C. Young & J. E. Rawlins (1) (CMNHC).

ACKNOWLEDGMENTS

We thank Kip Will (Cornell University) and Bob Androw (Carnegie Museum of Natural History) for reviewing the paper and making available to us new United States records of *Onthophagus gazella* and *O. taurus;* Kent Loeffler (Cornell University) for providing the habitus photographs of the species treated in this paper; R. Chianese (New Jersey Department of Agriculture) for sharing information on releases of exotic *Onthophagus* in New Jersey; and B. D. Gill (Agriculture Canada, Ottawa) and G. T. Fincher (USDA, ARS, FAPRL, College Station, TX) for reviewing and providing critical comments on a draft of this paper.

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BINDING ERROR – Sept. - Oct. '97 Issue (108:4)

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MICKSIOPS, A NEW GENUS OF SMALL MINNOW MAYFLIES (EPHEMEROPTERA: BAETIDAE) FROM AFRICA[1,2]

W. P. McCafferty[3], C. R. Lugo-Ortiz[3], H. M. Barber-James[4]

ABSTRACT: The new genus *Micksiops* is established for the African species *M. bicaudatus* (Gillies), n. comb. This species is known from Guinea, and undescribed species of *Micksiops* have been seen from Kenya and South Africa. In the larval stage, characters of the labium, the single row of denticles, lack of subtending setae on the claws, and the lack of armature on the dorsal thorax and abdomen distinguish the new genus from *Acanthiops*. The condition of the claws and caudal filaments, along with several other characteristics, will distinguish the larvae of *Micksiops* from *Afroptilum* s.s. and its cognates.

This work is part of the revision of those Afrotropical species of the mayfly family Baetidae that historically have been known as *Afroptilum* Gillies, and previous to that as *Centroptilum* Eaton. Other revisionary works on this subject have been contributed by Wuillot and Gillies (1994), McCafferty and de Moor (1995), Lugo-Ortiz and McCafferty (1996a,b,c, 1997a,b), and Barber-James and McCafferty (1997).

McCafferty and de Moor (1995) synonymized what had been known as the subgenus *Afroptiloides* Gillies of the genus *Afroptilum* with the genus *Acanthiops* Waltz and McCafferty. Barber-James and McCafferty (1997) indicated that the type of *Afroptiloides* and all species previously assigned to it, except one, were assignable to *Acanthiops.* That one exception is *Afroptilum bicaudatum* Gillies, originally described from adult and larval material from Guinea (Gillies 1990). *Afroptilum bicaudatum* does not share defining apomorphies with *Acanthiops,* as was pointed out by Barber-James and McCafferty (1997). This species also cannot be placed with *Afroptilum* s. s. or any other known genera of Baetidae, including those African taxa that now contain former species of *Afroptilum,* i.e., *Bugilliesia* Lugo-Ortiz and McCafferty, *Cheleocloeon* Wuillot and Gillies, *Crassabwa* Lugo Ortiz and McCafferty, *Dabulamanzia* Lugo-Ortiz and McCafferty, and *Dicentroptilum* Wuillot and Gillies (see also Lugo-Ortiz and McCafferty 1997b). We therefore describe a new genus herein for *A. bicaudatum,* and other closely related but undescribed species that have been seen from Kenya and South Africa.

The larval type material of *A. bicaudatum* could not be located at the Brit-

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[1] Received April 11, 1997. Accepted May 2, 1997.

[2] Purdue Agricultural Research Program Journal No. 15388.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

[4] Albany Museum, Somerset Street, Grahamstown 6140, South Africa.

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ish Museum, where it was to have been deposited. Because this taxon is so distinct but unplaceable in the current nomenclature and because there are additional closely related species from Africa to be described by other authors, we feel it is important to erect a genus at this time. Such a description is also one of the final necessary revisions to the species formerly known as *Afroptilum.* We are pleased to name this genus after M. T. (Mick) Gillies, who has contributed significantly to our knowledge of the African Ephemeroptera fauna.

Micksiops McCafferty, Lugo-Ortiz, and Barber-James, NEW GENUS

Larva. Head: Antennae relatively long, about four times length of head. Labrum (Fig. 1) broadly rounded in anterior half with broad emargination in medial third of distal margin. Left mandible (Fig. 2) with incisors fused; prostheca robust; tuft of setae absent. Right mandible (Fig. 3) with two sets of incisors; prostheca somewhat slender; tuft of setae present between incisors and mola. Maxillae (Fig. 4) relatively robust; palps two segmented, extending to about apex of galealaciniae. Labium (Fig. 5) with glossae shorter than paraglossae; palp segment 1 subequal to segments 2 and 3 combined; palp segment 3 globular and rounded apically, slightly more developed medially than laterally. Thorax: Legs (Fig. 6) with femora without villopore, with row of stout setae along dorsal margin; dorsal setae well developed on tibiae and tarsi of mid- and hindlegs. Tarsal claws (Fig. 7) angular at tip, with single row of distinctive subapical denticles, and without pair of long, subtending setae. Abdomen: Lamellate gills (Fig. 8) present on abdominal segments 1-7, asymmetrical subobovate, with pinnately branched tracheation. Median caudal filament not developed; cerci without row of swimming setae along medial margins.

Male Adult. Head: Eyes well separated and divergent apically. Thorax: Forewing with single marginal intercalaries. Hindwings (Fig. 9) narrow; costal process relatively large and compound, with straight and more laterally extended basal node and somewhat curved, slightly larger and distally oriented distal node. Genital forceps with short basal segment with somewhat developed medioapical process (Fig. 10); segment 3 narrow as in Figure 11.

Type species. *Micksiops bicaudatus* (Gillies), new combination.

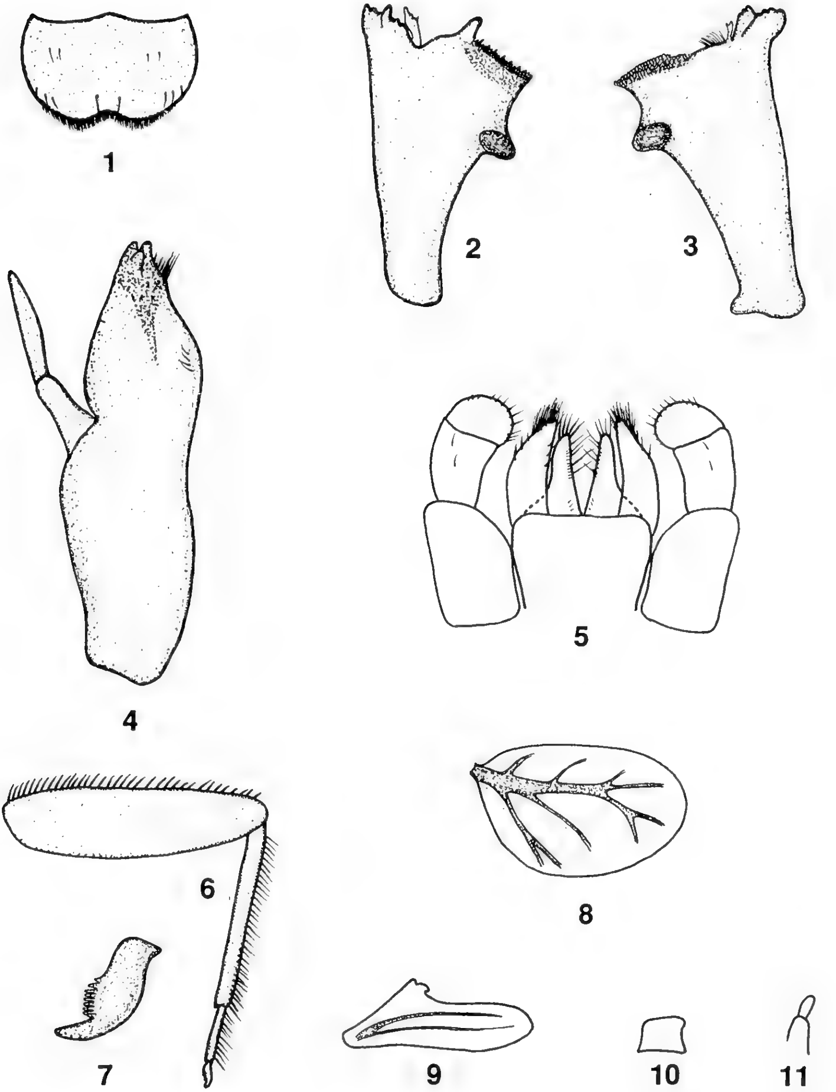
Included species.

Micksiops bicaudatus (Gillies)
  Afroptilum (Afroptiloides) bicaudatum Gillies, 1990:121.

Distribution. Guinea (*M. bicaudatus),* Kenya (undescribed sp.), and South Africa (undescribed: sp.).

DISCUSSION

Larvae of *Micksiops* can be easily told from larvae of *Acanthiops,* which is another African baetid genus having two-tailed larvae and adults with single marginal intercalaries in the forewings. Diagnositc characteristics of *Micksiops,* include the well-developed and much broader terminal labial palp segment, the unequal glossae and paraglossae, the single rather than double row of claw denticles, the lack of subtending claw setae, and the lack of dorsal armature on the thorax and abdomen. These characters can also be used to differentiate the larvae of *Micksiops* from larvae of *Thraulobaetodes* Elouard and Hideux, which we believe are very closely related to *Acanthiops.* The larvae of *Micksiops* may superficially resemble the two-tailed larvae of the African genera



Figs. 1-11. *Micksiops bicaudatus* [modified from Gillies (1990)]. 1-8. Larva. 1. Labrum (dorsal). 2. Left mandible. 3. Right mandible. 4. Right maxilla. 5. Labium (ventral). 6. Hindleg (details of apex of femur not shown). 7. Hindclaw. 8. Abdominal gill 5. 9-11. Male adult. 9. Hindwing. 10. Left basal segment of forceps, ventral. 11. Left segment 3 of forceps, ventral.

Demoreptus Lugo-Ortiz and McCafferty and *Tanzaniella* Gillies. However, those latter genera are quite unrelated to *Micksiops,* having adults with double marginal intercalaries in the forewings and larvae with a femoral villopore (see Gillies 1991, Lugo-Ortiz and McCafferty 1997c).

Adults of other genera are not well enough described at this time to draw conclusions with respect to adult diagnosis of *Micksiops.* The compound costal process of the *Micksiops* hindwings will distinguish it from some of the baetids with single marginal intercalaries in their forewings, but not all.

Barber-James and McCafferty (1997) suggested that *M. bicaudatus* was possibly a species that shared some common ancestry with the genus *Acanthiops* because of the possession of a tibial row of setae in the larvae of *M. bicaudatus* and ancestral species of *Acanthiops.* However, such setae are variable among and within many genera of Baetidae (e.g., *Baetis* Leach), and Lugo-Ortiz and McCafferty (unpublished) have more recently identified an entire grouping of genera from Africa and Madagascar that share a double row of claw denticles and other characteristics, which contains, among others, *Acanthiops* and *Afroptilum* sensu stricto. *Micksiops* would not be a member of this grouping unless it could be proven to be an entirely aberrant form. A more definite phylogenetic placement of *Micksiops* can not be made at this time.

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MALIQUA: A NEW GENUS OF BAETIDAE (EPHEMEROPTERA) FOR A SPECIES PREVIOUSLY ASSIGNED TO *AFROPTILUM*[1, 2]

C. R. Lugo-Ortiz, W. P. McCafferty[3]

ABSTRACT: *Maliqua* (Ephemeroptera: Baetidae), n. gen., is erected for *M. plumosa*, n. comb., a West African species previously assigned to the *dimorphicum* group of *Afroptilum*. Larvae of *Maliqua* are distinguished by possessing minute denticles on the tarsal claws. Adults are distinguished by having segment 2 of the male genital forceps medially expanded at base and setose. *Maliqua* is hypothesized to be closely related to *Cloeodes* on the basis of mouthpart and male genitalic similarities.

Gillies (1990) erected the genus *Afroptilum* (Ephemeroptera: Baetidae) to accommodate all African species previously assigned *to Centroptilum* Eaton. As such, the genus included 30 species in two subgenera, *Afroptilum* s.s. and *Afroptiloides* Gillies. Gillies (1990) further subdivided *Afroptilum* s.s. into informal groupings he called the *dimorphicum, sudafricanum, sudanense,* and *tarsale* species groups, but he did not provide any phylogenetic rationales for those subdivisions. Wuillot and Gillies (1993) later described four additional species of *Afroptilum* that they variously assigned to the *tarsale* and *dimorphicum* groups.

More recently, species ascribed to *Afroptilum* have been the subject of considerable revisionary work. Wuillot and Gillies (1994) erected the genus *Dicentroptilum* for two distinct species previously considered in the *sudafricanum* group. McCafferty and de Moor (1995) synonymized the subgenus *Afroptiloides* with *Acanthiops* Waltz and McCafferty, and Barber-James and McCafferty (1997) elaborated the rationale for that revision. Lugo-Ortiz and McCafferty (1996a,b,c) erected the genera *Bugilliesia, Crassabwa,* and *Dabulamanzia* for most species in the *tarsale* and *sudanense* groups, and Lugo-Ortiz and McCafferty (1997a) demonstrated that two species assigned to the *dimorphicum* group are referable to *Cheleocloeon* Wuillot and Gillies. McCafferty et al. (1997) erected the genus *Micksiops* for a species previously assigned to the subgenus *Afroptiloides*.

In this paper we erect a new genus for *A. plumosum* Wuillot, a West African species originally assigned to the *dimorphicum* group of *Afroptilum* (Wuillot and Gillies 1993). We describe the new genus, hypothesize that it is closely related to *Cloeodes* Traver, and provide guidelines to differentiate the two gen-

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[1] Received April 11, 1997. Accepted May 2, 1997.

[2] Purdue Agricultural Research Program Journal No. 15378.

[3] Department of Entomology, Purdue University, West Lafayette, IN 47907.

era. Our attempts to secure original material from Paris for examination were not successful; however, because the new genus is so distinctive and involves one of only a few unresolved species that were previously placed in *Afroptilum*, it is judicious to describe it at this time.

Maliqua Lugo-Ortiz and McCafferty, NEW GENUS

Larva. Head: Labrum (Fig. 1) anteriorly broadly rounded, with deep anteromedial notch. Left mandible (Fig. 2) with incisors fused; prostheca relatively robust, apically denticulate; small tuft of setae between prostheca and mola. Right mandible (Fig. 3) with two broadly based sets of incisors; prostheca somewhat slender, apically with sharp denticles. Maxillae (Fig. 4) relatively robust; palps two segmented, slender, not reaching galealaciniae. Labium (Fig. 5) with glossae and paraglossae subequal in length and width; palps three segmented; palp segment 1 slightly longer than segments 2 and 3 combined; palp segments 2 and 3 subequal in length and width; palp segment 3 apically rounded. Thorax: Hindwingpads absent. Legs (Fig. 6) with femora without villopore and with subparallel dorsal and ventral margins; tarsal claws (Fig. 7) with one row of minute subapical denticles. Abdomen: Gills (Figs. 8, 9) on abdominal segments 1-7, platelike, asymmetrical, anteriorly serrate. Median caudal filament well developed, with abundant short, fine, simple setae on both margins; cerci with abundant long, fine, simple setae medially and short, stout, simple setae laterally every fourth segment.

Adult. Thorax: Forewings (Fig. 10) with single marginal intercalaries. Hindwings absent. Abdomen: Male genital forceps (Fig. 11) three segmented; segment 1 short, subcylindrical; segment 2 medially expanded at base, with short, fine simple setae medially; segment 3 short, ovoid.

Type species. *Maliqua plumosa* (Wuillot), new combination.

Included species –

Maliqua plumosa (Wuillot), new combination.

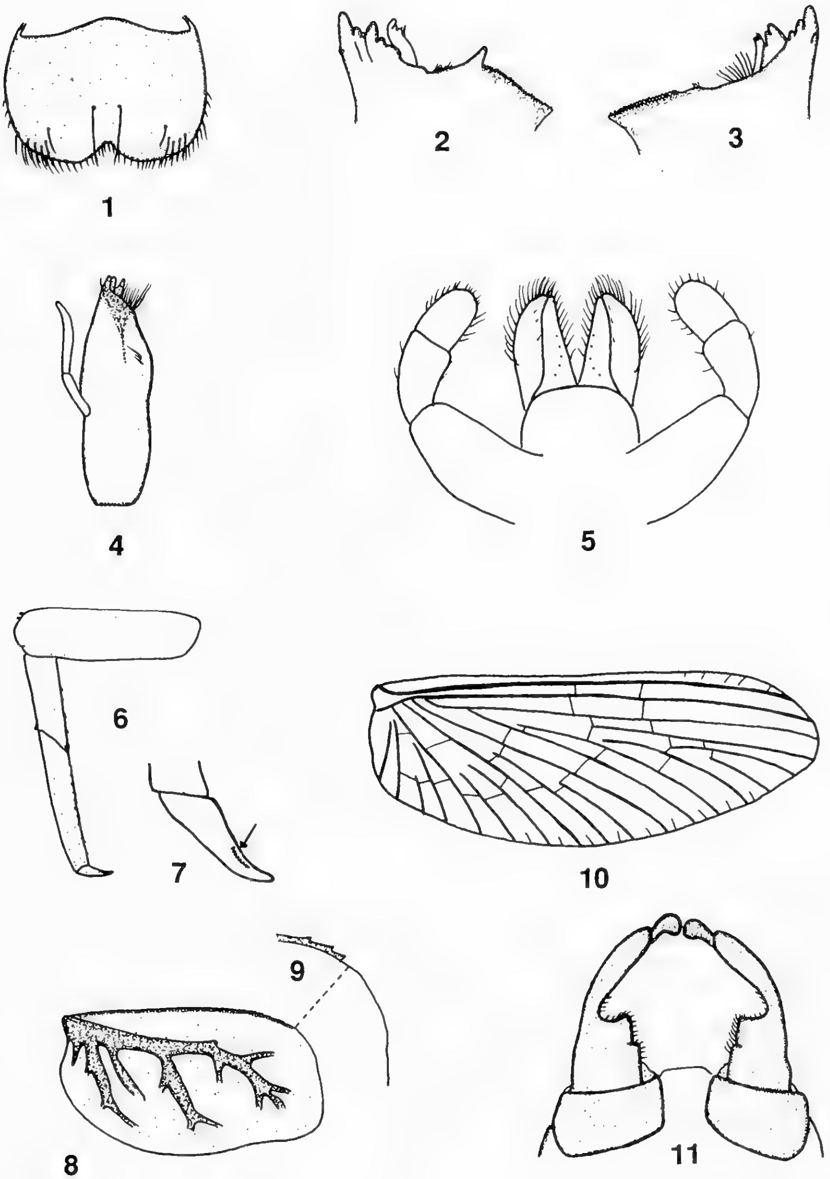
Afroptilum plumosum Wuillot, in Wuillot and Gillies 1993:276. (larva, male adult).

Distribution. Guinea, Mali.

Etymology. The generic name is an arbitrary combination of letters that incorporates the name of the country where the type locality of the type species is located. The gender is feminine.

DISCUSSION

Larvae of *Maliqua* are generally similar to those of the Pantropical genus *Cloeodes*, but are distinguished from that genus by the presence of tufts of setae between the prosthecae and molae of both mandibles (Figs. 2, 3) and minute denticles on the tarsal claws (Fig. 7). Adults of *Maliqua* are also similar to those of *Cloeodes*, but segment 2 of the male genital forceps of *Maliqua* (Fig. 11) is considerably more expanded than in *Cloeodes*. Other differences that aid in distinguishing larvae of *Maliqua* from those of *Cloeodes* are the presence in larvae of the latter genus of subproximal arcs of long, fine, simple setae on the tibiae [Waltz and McCafferty (1987b): Figs. 1, 7], edentate tarsal claws [Waltz and McCafferty (1987b): Fig. 8], and tufts of long, fine, simple setae on abdominal sterna 2-6 [Waltz and McCafferty (1987a): Fig. 5; Waltz and McCafferty (1987b): Figs. 9, 44]. The tendency of some female adults of



Figs. 1-11. *Maliqua plumosa* (Wuillot), larva and male adult [modified from Wuillot and Gillies (1993)]. 1. Labrum (dorsal). 2. Left mandible. 3. Right mandible. 4. Right maxilla. 5. Labium (ventral). 6. Right foreleg. 7. Tarsal claw (pointer to row of denticles). 8. Gill 5. 9. Detail of gill 5. 10. Forewing. 11. Male genitalia.

Cloeodes to have single marginal intercalary veins in the forewings [Waltz and McCafferty (1987a): Fig. 1; Waltz and McCafferty (1987b): Figs. 16, 18, 19, 22, 33] is also noteworthy.

Maliqua plumosa cannot be considered to belong to *Afroptilum* because it differs considerably from *A. sudafricanum* (Lestage), the type species of *Afroptilum.* Moreover, the shape of the claws and presence of a single row of denticles on the larval tarsal claws of *Maliqua* excludes it from consideration in a complex of African and Malagasy genera to which Afroptilum belongs and that also includes *Acanthiops, Centroptiloides* Lestage, *Dicentroptilum, Edmulmeatus* Lugo Ortiz and McCafferty, *Nesoptiloides* Demoulin, and *Thraulobaetodes* Elouard and Hideux (Lugo-Ortiz and McCafferty 1997b). That complex is characterized, in part, by the distinctive shape of the claws and presence of two subparallel rows of denticles on the larval tarsal claws [Lugo-Ortiz and McCafferty (1997b): Fig. 12].

The larval mouthparts are remarkably similar in *Maliqua* and *Cloeodes,* particularly with respect to the relatively robust maxillae and their somewhat short and slender palps [Fig. 4; Waltz and McCafferty 1987b: Figs. 5, 28] and the labial palps having segments 2 and 3 subequal in length and width [Fig. 5; Waltz and McCafferty 1987b: Figs. 6, 29]. Those larval similarities, plus the fundamentally similar medially expanded and setose segment 2 of the male genital forceps [Fig. 11; Waltz and McCafferty 1987b: Fig. 34], support the hypothesis that the two genera are closely related. It is possible that other apomorphies tie *Maliqua* and *Cloeodes,* but because the original description of *M. plumosa* by Wuillot and Gillies (1993) is rather brief, they cannot be ascertained at this moment.

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(continued from page 344)

Further research pointed to strong asynchrony in egg hatching among populations, but synchrony with the flowering of the hostplants. The brief mating periods, in which females mate only once with one of the short-lived males are sufficiently asynchronous to preclude mixed matings. Furthermore, it is now known that males have distinctive courtship "songs," to which only females from the same host respond. Other experiments showed that eggs laid on hosts other than the females' own have nearly nil survival and reproduction. They also showed a most interesting fact: eggs on the "wrong" host hatched at the time eggs of populations adapted to that host hatched, not at the time they would have on the "correct" host. It turned out that egg hatch is controlled by the plant's spring sapflow, which rehydrates the eggs after winter dissication.

Tom now asked, could a shift to a new hostplant, coupled with asynchronous egg hatch and the short mating period, lead to host race formation and eventual speciation? Preliminary trials suggested it could, so he has now established a large outdoor experiment, involving twenty-eight, 28' x 8' x 8' cages. In these, *Enchenopa binotata* (he is getting ready to name the host races as new species) are confined on mixed and unmixed pairs of four species of *Viburnum*. He and his students, after tens of thousands of individual transplantings of nymphs, have documented non-random mating and oviposition among the populations. This success has finally persuaded NSF to support the effort. The possibility of sympatric speciation by host shift remains controversial, despite the extensive studies of cases such as *Rhagoletis pomonella*, and his research may do a lot to clear matters up. Tom says he looks forward to thirty more years of study of this fascinating beast.

W.J. Cromartie,
Corresponding Secretary

NEW *ORCHESELLA* SPECIES (COLLEMBOLA: ENTOMOBRYIDAE) FROM NORTH AMERICA[1]

Richard J. Snider[2]

ABSTRACT: Three new species of Orchesellinae are described from North America: *Orchesella gloriosa* n. sp. from lichens on granite in Great Smoky Mountains National Park, North Carolina; *Orchesella imitari* n. sp. from mosses growing in Parc de la Gaspésie, Quebec; and *Orchesella texensis* n. sp. from cave litter in Williamson and Travis Counties, Texas. The new species are separated from those previously described by body chaetotaxy and color patterns.

Orchesella gloriosa, NEW SPECIES

COLOR DESCRIPTION

Background white to cream-yellow with blue pigmented color pattern (Figs. 1 and 2) Head, in dorsal aspect, with dark blue pigment forming a band between antennal bases; dorsum with interocular maculae in broken pattern extending posteriorly; gena with blue forming an irregular band extending to oral region, with "C"-shape maculae best seen laterally; ANT I with dark blue basally and distally, ANT II blue distally with longitudinal blue streaking, ANT III with blue basally and distally, ANT IV light blue, darkest apically. Trunk with broken color patterns composed of dark blue pigment: TH II to ABD II with irregular medial stripe and paramedial stripes; ABD III almost entirely blue dorsally; ABD IV and V with medial line continued to mid-ABD V; ABD VI dark blue; laterally with blue forming irregular stripes defined by white, (taken together, overall pattern could be viewed as forming 5 irregular longitudinal stripes); all micro and macro setee with white surrounding sockets giving a stippled-streaking.

MORPHOLOGICAL DESCRIPTION

HEAD: eyes 8 + 8 on black patches, ocelli A,B,C,D slightly larger than E and F, G and H subequal, G/F ratio ≈.5 (Fig. 3). ANT IV lacking apical bulb, with Type 4 pin seta (Fig. 4); antennal segmentation ratio 3.5 : .5 : 6 : 6 with segment II subsegmented (Fig. 5). Labral papillae clearly unisetaceous (Fig. 6); labial triangle not observed. LEGS: hind foot complex (Fig. 7) with tenent hair shorter than unguis; pretarsus with 2 diagonal, strong bosses; unguis with 2 outer lateral teeth, 4 inner teeth, basal teeth more pronounced; unguiculus .52 - .80 times as long as unguis, with an outer tooth inserted over 1/2 distance from base. FURCULA: dens 1.08 - 1.22 times as long as manubrium; mucronal teeth subequal (Fig. 8). SETAE: Type 5 body setae narrowly fusiform and ciliate for apical .75 of length. Macrochaetae of ABD III with 3 + 3 inner a, 0 + 0 outer a, and 2 + 2 m setae (Fig. 9). LENGTH: 2.4 - 2.6 mm.

TYPES: Holotype (female) preserved in ethanol, 145 paratypes in 95% ethanol, and 26 paratype dissection slides prepared with modified polyvinyl alcohol. Holotype and paratypes deposited in the Center For Arthropod Diversity Studies, Department of Entomology, Michigan State University, East Lansing, Michigan. Holotype and paratypes collected from North Carolina, Swain County, Great Smoky Mountains National Park, December 15, 1987, from lichens growing on a granite boulder, R. J. Snider, collector.

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[1] Received and accepted August 2, 1997.

[2] Department of Zoology, Michigan State University, East Lansing, Michigan 48824.

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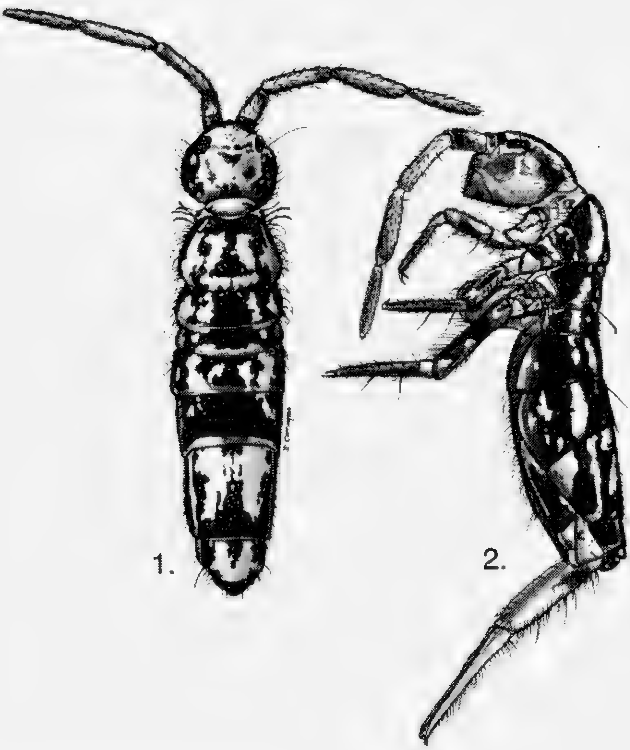
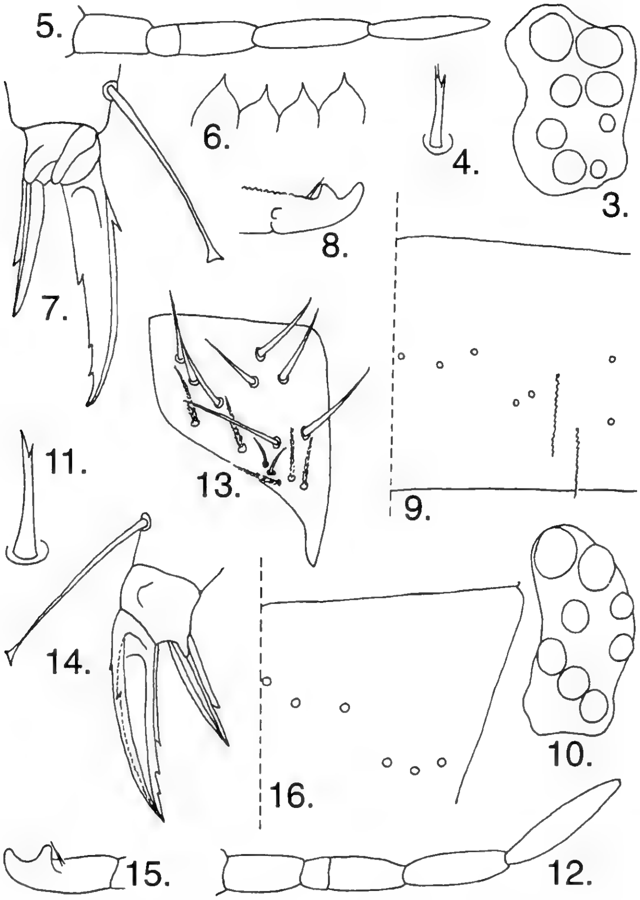


Figs. 1 & 2 *Orchesella gloriosa* habitus illustrations. 1. Dorsal view showing color pattern. 2. Lateral view showing color pattern.

DIAGNOSIS

Orchesella gloriosa n. sp. keys out in Christiansen & Bellinger (1980-81) to *Orchesella zebra* Guthrie. Color pattern will easily separate the two species. In addition, the chaetotaxy pattern of ABD III for *O. zebra* has 4-6 + 4-6 inner a, 1(0) + 1(0) outer a, and 3 + 3 m setae. *O. gloriosa* has 3 + 3 inner a, 0 + 0 outer a, and 2 + 2 m setae. The claw of *O. gloriosa* is more robust, ungual and unguicular teeth are sharply defined. Chaetotaxy of abdominal segments II and IV are also very different. *O. gloriosa* keys out poorly in Stach (1960) between *O. zebra* Guthrie and *O. xerothermica* Stach. Color pattern alone will separate it from those species.



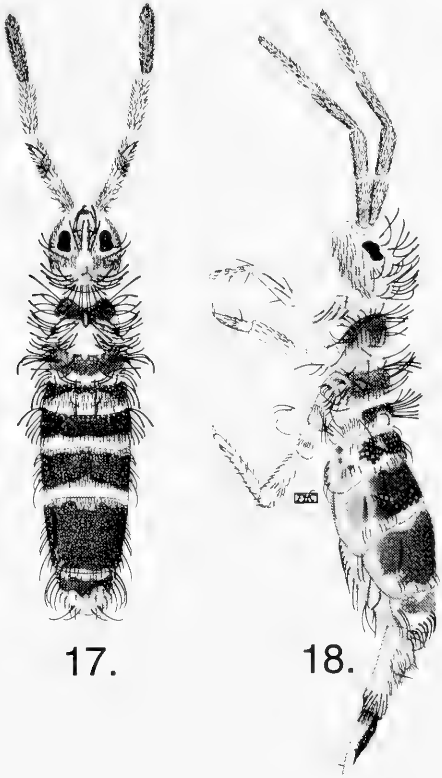
Figs. 3-9. *Orchesella gloriosa* morphology. 3. Left eyepatch. 4. Pin seta of antennal segment IV. 5. Antenna. 6. Labral papillae. 7. Hind foot complex. 8. Mucro, lateral view. 9. Abdominal segment III, dorsal chaetotaxy. Figs. 10-16, *Orchesella imitari* morphology. 10. Left eyepatch. 11. Pin seta of antennal segment IV. 12. Antenna. 13. Labial triangle, setal pattern. 14. Hind foot complex, 15. Mucro, lateral view. 16. Abdominal segment III, dorsal chaetotaxy.

Orchesena imitari, NEW SPECIES

COLOR DESCRIPTION

Background cream-white to light orange with Tuscan red (deep purple brown) pigmented color patterns (Figs. 17 and 18). Head, in dorsal aspect, with dark pigment forming a band between antennal bases with circumantennal extensions; genal area with light dusting of purple;

antennal segments distally ringed with Tuscan red and light pigmental dusting becoming pronounced from base to apex. Trunk dorsally with Tuscan red rings or bands that do not quite terminate at pleural region. TH II with light anterior band leaving most of segment background color; TH III with wide anterior band extending over 3/4 of segment; ABD I with band 1/2 length of segment; ABD II band extends 3/4 length of segment; ABD III with wide band extending more than 3/4 length of segment; ABD IV with band covering most of segment; ABD V with wide band; ABD VI mostly cream-white to light orange with occasional pigment spots. In dark specimens a "T"-shaped pattern is formed connecting segments V and VI. Legs with broken pigment spots on precoxae and coxae, rest of legs dusted with light purple becoming darker distally, especially tibiae. Furcula and collophore without pigmentation. Many specimens showed pigment reduction to the point of only a scattering of light orange with an overlay of common body setae defining where the color pattern should be.



Figs. 17 & 18. *Orchesella imitari* habitus illustrations. 17. Dorsal view showing color pattern. 18. Lateral view showing color pattern.

MORPHOLOGICAL DESCRIPTION

HEAD: eyes 8 + 8 on black patches, ocelli A and B larger than D, E, F, G while H and C are smaller and subequal, ratio of G/F ≈ .85 - .90 (Fig.10). ANT IV lacking apical bulb, with Type 1 pin seta (Fig. 11); antennal segmentation ratio 3.5 : 4.5 : 5 : 6 with segment II subsegmented (Fig. 12). Labral papillae strongly unisetaceous as in *gloriosa* (Fig. 6); labial triangle setae as illustrated (Fig. 13). LEGS: hind foot complex (Fig. 14) with tenent hair subequal to unguis; unguis with 2 outer lateral teeth, 4 inner teeth; unguiculus .48 - .60 times as long as unguis, with an outer tooth inserted approximately two thirds distad from base. FURCULA: dens 81 - 1.11 times as long as manubrium; mucronal teeth subequal (Fig. 15). SETAE: Type 5 body setae narrowly fusiform and ciliate for apical .80 of length. Macrochaetae of ABD III with 3 + 3 inner a, 0 + 0 outer a, and 3 + 3 m setae (Fig. 16). LENGTH: 1.9 - 2.7 mm.

TYPES: Holotype (female) preserved in ethanol, 128 paratypes in 95% ethanol, and 13 paratype dissection slides prepared with modified polyvinyl alcohol. Holotype and 122 paratypes deposited in the Center For Arthropod Diversity Studies, Department of Entomology, Michigan State University, East Lansing, Michigan. 6 paratypes deposited in the Université de Montreal, Quebec. Holotype and paratypes collected from Canada, Prov. Quebec, Parc de la Gaspésie, Mines Madeleine, July 3, 1996, from moss growing in an exposed location at edge of mixed mesophytic forest. Additional paratypes taken from the following localities: Rte 299 at Chute Ste. Anne, July 2, 1996, from mosses growing along footpath and wet spots; Les Lac Castors, July 3, 1996, from moss overhanging trail margin; Lac Cascapédia, July 4, 1996, from *Sphagnum* moss; Lac aux Americains, trail to Gîte du Mont-Albert, nr. parking lot, July 4, 1996, from *Sphagnum* moss, (R. J. & R. M. Snider, collectors.

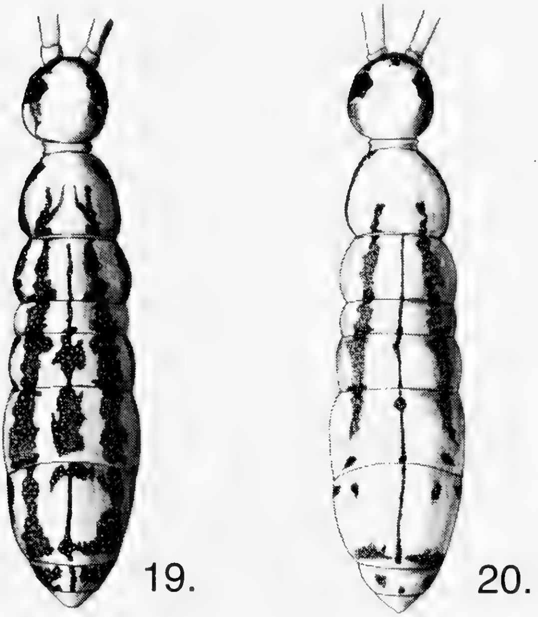
DIAGNOSIS

Orchesella imitari n. sp. keys out in Christiansen and Bellinger (1980-81) to *Orchesella hexfasciata* Harvey and superficially resembles that species. However it can be easily separated from that species by color pattern, and type 1 pin seta. *O. imitari* keys out in Stach (1960) between *Orchesella leucocephala* Stach and *Ombesella montana* Stach. While *O. leucocephala* is very similar in pattern to *O. imitari*, it has ABD I mostly black banded, *imitari* is cream-yellow with a very narrow band anteriorly; ABD IV of *O. leucocephala* has light areas dorsally, *O. imitari* is solid dark purple.

Orcheselia texensis NEW SPECIES

COLOR DESCRIPTION

Background white with blue pigmented patterns (Figs. 19 & 20). Head with interantennal spot spreading to circumantennal extensions; blue stripe originating at posterior edge of eyepatch and ending at occiput; antennal segments with apical rings, light blue dusting becoming darker apically on ANT IV. Trunk with 5 longitudinal, broken lines: medial line begins at posterior edge of TH II and terminates at posterior edge of ABD IV; paramedial lines begin 1/4 distance from anterior of TH II and end at ABD V; lateral lines originate at anterior of TH II and end at ABD V. Legs without pigmentation except trochanter have broken blue patterns.

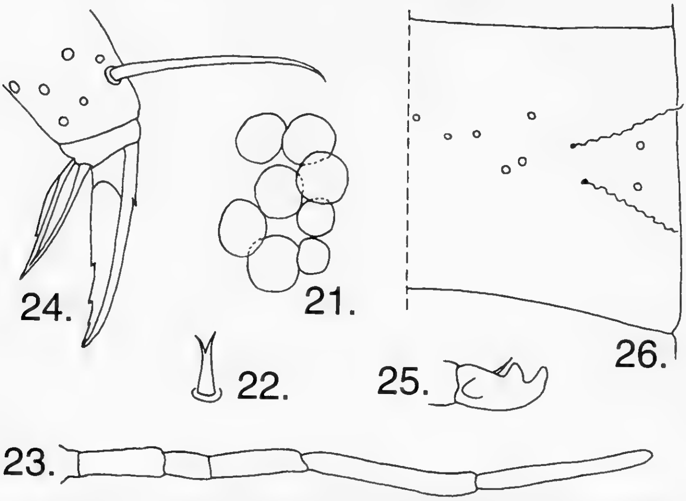


Figs. 19 & 20. *Orchesella texensis* diagramatic illustrations from slide mounted specimens. 19. Dorsal view showing color pattern. 20. Dorsal view showing reduced color pattern.

MORPHOLOGICAL DESCRIPTION

HEAD: eyes 8 + 8 on black patches, ocelli G and half diameter of A-F, G/F ratio .65 - .75 (Fig. 21). ANT IV lacking apical bulb, with Type 2 pin seta (Fig. 22); antennal segment ratio 1 : 2 : 2.7 : 2.7, segment II subsegmented (Fig. 23). Mouthparts not observed. LEGS: hind foot complex (Fig. 24) with tenent hair subequal to ungual length; unguis with 2 outer lateral teeth and 4 inner teeth, unguiculus .93 - .96 times as long as unguis, with outer tooth inserted 3/4 distance from base. FURCULA: dens 1.25 - 1.57 times as long as manubrium; mucronal teeth subequal, condyle pronounced (Fig. 25). SETAE: Type 5 body setae, narrowly fusiform and ciliate for apical .77-.85 of length. Macrochaetae of ABD III with 3 + 3 inner a, 0-1 + 0-1 outer a, and 2(3) + 2(3) m setae (Fig. 26). CAPS: Length 2 mm.

TYPES: Holotype (female) on slide prepared with Marc Andre's fluid, Texas, Williamson County, Jug,cave, May 18, 1989, J. Reddel & M. Reyes, colr. Paratypes taken from the following localities: Williamson County, 2 on slide, Raccoon cave, March 16, 1990, litter, J. Reddell & M. Reyes, colr.; Travis County, 1 on slide, Goat cave, January 23, 1991, litter, J. Reddell & M. Reyes, colr.; 2 on slide, 1 in ethanol, Travis County, Hideout cave, January 31, 1991, litter, J. Reddell & M. Reyes, colr. Holotype and paratypes deposited in the Museum of Comparative Zoology at Harvard University, Cambridge, Massachusetts.



Figs. 21-26. *Orchesella texensis* morphology. 21. Left eyepatch. 22. Pin seta of antennal segment IV. 23. Antenna. 24. Hind foot complex. 25. Mucro, lateral view. 26. Abdominal segment III, dorsal chaetotaxy.

DIAGNOSIS

Orchesella texensis, sp. keys out in Christiansen & Bellinger (1980-81) to *O. celsa* Christiansen & Tucker. It differs from that species by color pattern, *O. celsa* has the middorsal line not well defined and lacking on ABD IV and V. In addition, *O. texensis* has type 2 pin seta while *O. celsa* has type 4. In Stach (1960) *O. texensis* keys out to *Orchesella xerothermica* Stach. This species from Poland and Ukraine has the mid-dorsal line originating on the posterior of TH II like *O. texensis,* but not reaching beyond ABD I and it is a large species, 4 - 6.2 mm.

ACKNOWLEDGMENTS

Special thanks are offered to Kenneth A. Christiansen of Grinnell College, Grinnell, Iowa for his loan of the *O. texensis* specimens and critical review of this report. And thanks to Robert D. Waltz, Indiana Department of Natural Resources, Indianapolis, Indiana for his review. Thanks to Laurent LeSage, Agriculture Canada, Biosystematic Research Center, Ottawa who initiated me to the Parc de la Gaspésie Collembola fauna. Very special thanks are extended to François Landry, Park Biologist, Parc de la Gaspésie for guidance to collection sites known to be productive for Collembola; to Renate M. Snider for helping to collect specimens in the field, and to Peter H. Carrington for his excellent renderings of *O. gloriosa* and *O. imitari.*

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NEW SPECIES OF *TENAGOBIA* (HETEROPTERA: CORIXIDAE) FROM VENEZUELA[1]

J. T. Polhemus[2], N. Nieser[3]

ABSTRACT: *Tenagobia (Baliagobia) castanea* sp. n. is described from the Territorio Amazonas, Venezuela.

The genus *Tenagobia* Bergroth was last revised by Nieser (1977), who reviewed previous works and recognized 26 valid species. Since then, Bachmann (1979) described one subspecies.

The CL number given below refers to ecological data held in collection data books with the Polhemus Collection (JTPC). The Nieser Collection is noted as (NCTN), the U. S National Museum as (USNM). All measurements are in millimeters.

Tenagobia (Baliagobia) castanea, NEW SPECIES

Length, male 2.45 - 2.52 mm., female 2.39 - 2.68 mm.

General color castaneous, head between eyes yellowish, variably infuscated. Hyaline V-shaped mark on clavus indistinct, often lacking on posterior part; clavus and corium with hyaline guttae, costal margin of hemelytra dark, obscuring darker blotch on middle of corium; hyaline stripe on right membrane curved backward, nearly reaching costal margin; left membrane with outer half smoky, inner half hyaline, membranal suture distinct. Thoracic venter light to medium brown, abdominal venter medium to dark brown. Legs yellowish, joints and claws darker.

Head with ocular index of male 1.12-1.20, female 1.10-1.22; sutures of vertex convergent behind eyes; laterocaudal angles of vertex perpendicular to slightly obtuse; inner postocular space about four times as long as an eye facet. Apical antennal segment with 2-3 distinctly longer and thicker hairs; relative length of antennal segments I:II:III about 2.00:1.00:3.25; ratio of width:length of apical segment about 3.

Pronotum short for the genus, lateral margin almost straight, lateral parts of concave posterior margin somewhat truncate; width, male 0.94-0.95, female 0.96-0.97; proepimera weakly expanded, without mustache-like bristles but ventrally with 6 bladelike bristles, a few scattered hairs dorsad of proepimeral expansion. Ratio width of pronotum:width of scutellum 1.6-1.8.

Hemelytra with many minute spines and a few small apical hairs; costal margin without spines; ratio, length of pruinose area of embolium:length of hemelytron about 0.2-0.3; only macropterous specimens known.

Fore femur with 2 spines in basal row and 1 small spinule in apical part, a spine at apical 1/4 and two apical spines on dorsal face. Pala with 23-24 bristles in lower row, 14-18 in intermediate row and 6 in upper row. Intermediate leg, ratio length of femur:tibia:tarsus:claws about 8.5:3.0:4.0:2.0. Hind leg, metatrochanter knobby (somewhat less obvious than in subgenus *Romanagobia*), ratio length of femur:tibia:tarsal I:tarsal II:claws about 8:6:6:3:3. Claw appar-

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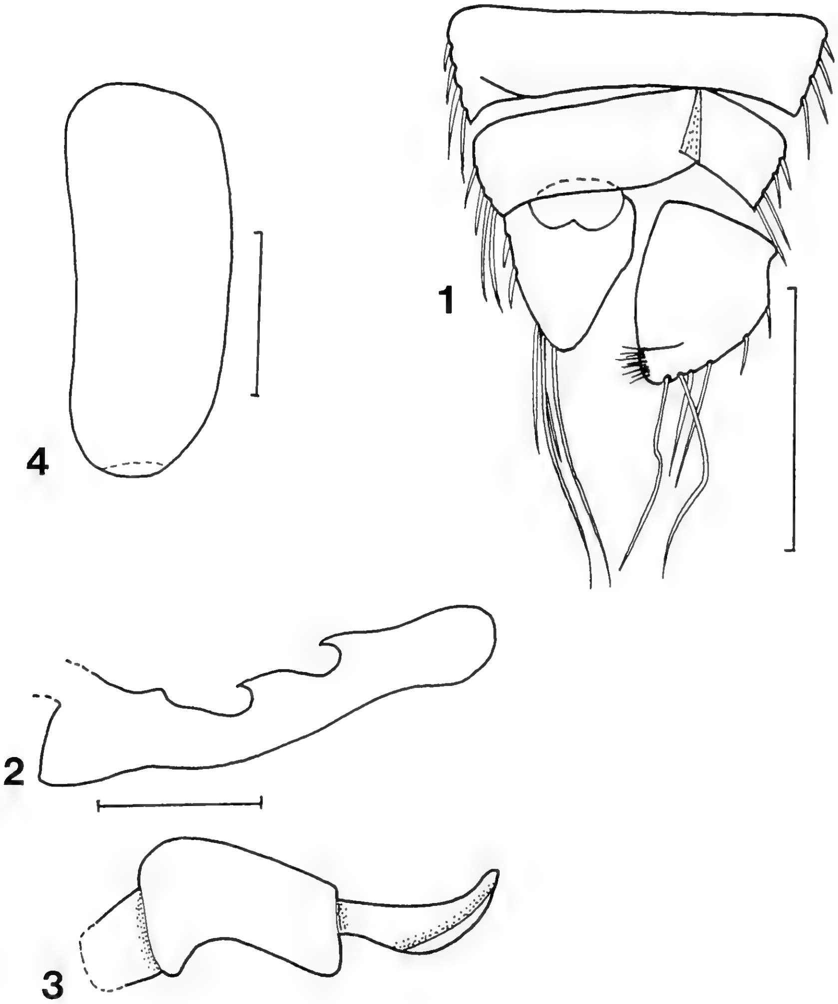
[1] Received February 22, 1997. Accepted March 22, 1997.

[2] Colorado Entomological Museum, 3115 S. York St., Englewood, CO. 80110.

[3] Htg. Eduardstr. 16, 4001 RG Tiel, The Netherlands.



Figures 1 - 4. *Tenagobia* (*Baliagobia*) *castanea* sp. n.

1. Male abdominal terminalia, dorsal view (scale bar = 0.5 mm).

2. 3. Male parameres. 2 right, 3 left (scale bar = 0.1 mm)

4. Female, receptaculum seminis (scale bar = 0.1 mm).

ently with two prongs, the shorter one about half the length of the longer one (measured from incision to tip).

Number of spines and bristles along the lateral margins of abdominal segments: V, 3 spines + 1 bristle; VI, 2 + 1; VII, 2 (3) + 2 (1); VIII, 3 + 4 (of which 2 are very long).

Male: paler claw elongate like a very stout bristle; apicodorsal bristle of anterior tibia absent. Prostrigil absent; dorsal lobe of left part of tergite VIII broad, bilobed (Fig. 1), with 8 hooked bristles on apical margin. Parameres characteristic (Figs. 2, 3).

Female: Length of fore femur subequal to tibia + pala, dorsal tibiotarsal bristle absent. Receptaculum seminis simple, ovate (Fig. 4).

Type material. Holotype, male, Venezuela, Territorio Federal Amazonas, Tobogan area, seep pool on rock, CL 2381, 23 Jan. 1989, J. T. Polhemus (USNM). Paratypes, 29 males, 28 females, 2 nymphs (not paratypes), same data as holotype (JTPC, NCTN, USNM).

Etymology. The epithet *castanea* refers to the yellowish-brown color.

Habitat. The corixid described above was among the many undescribed taxa discovered during an expedition in 1989 to the Tobogan Region of the Territorio Federal Amazonas, Venezuela, south of Puerto Ayacucho. The Tobogan area is named for the smoothly flowing cascade created by the flow of the Caño Coromoto over the sloping edge of a large, slick rock shield in the jungle. *Tenagobia (B.) castanea* was collected only from a small, shallow pool in rock fed by seeps, in a shallow depression quite removed from the main river.

Comparative notes. In the keys given by Nieser (1977), this species runs to the subgenus *Baliagobia*, previously monotypic. *Tenagobia (B.) balia*, the only other species of the subgenus, is known only from 2 females from the upper Rio Negro, Brazil. *Tenagobia (B.) balia* differs by a lighter color, narrower receptaculum seminis, lateral margins of pronotum longer and ratio of width of pronotum:width of scutellum slightly less. Other *Tenagobia* species have very differently shaped parameres.

ACKNOWLEDGMENTS

We are indebted to R. W. Sites and D. A. Polhemus for their constructive reviews. JTP is indebted to P. J. Spangler, Smithsonian Institution, Washington, D. C. (USNM), for assisting with logisitics in Venezuela. JTP carried out this research as a faculty affiliate of the Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins.

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A NEW SPECIES OF *DACNUSA* (HYMENOPTERA: BRACONIDAE) FROM SPAIN[1]

I. Docavo[2], J. Tormos[3]

ABSTRACT: *Dacnusa rodriguezi*, a new species from Spain, is described and compared with allied species of the genus. The new species is a parasitoid of *Chromatomyia horticola* on lettuce.

The subfamily Alysiinae is subdivided traditionally into two tribes, Alysiini and Dacnusini (Shenefelt, 1974; Wharton, 1994), whose members are endoparasitoids of cyclorrhaphous Diptera. Most of the Dacnusini attack agromyzid hosts, and their classification and biology have been studied by Griffiths (1964, 1966, 1968, 1984) and Tobias (1986, summary of the Palearctic taxa with keys to genera and species, translated into English 1995).

The genus *Dacnusa* Haliday belongs to the latter tribe, and contains approximately 87 Holarctic species. We discovered a new species, described below, in Játiva (province of Valencia), Spain, reared from *Chromatomyia horticola* (Goureau), a species of agromyzid very common in the Comunitat Valenciana (Spain) on cultivated plants (Docavo et al., 1987).

Terms for body morphology and wing venation follow Griffiths (1964) and Wharton (1977, 1986).

Dacnusa rodriguezi, NEW SPECIES

Female: Head (Figs. 1, 2, 3) - 1.78-2.0 ($\bar{x}$ = 1.85) times wider than long, 1.34-1.57 ($\bar{x}$ = 1.45) times higher than long; eyes in lateral view 0.7-0.9 ($\bar{x}$ = 0.8) times as long as temples, slightly more closely approximated underneath; head width 1.79-1.95 ($\bar{x}$ = 1.87) times distance between eyes; face fairly smooth, with fine pubescence towards sides and at centre of its foremost part; clypeus width 0.62-0.72 ($\bar{x}$ = 0.69) times distance between eyes; antennae with 20-22 antennomeres; mandibles 3-toothed, weakly expanded, 0.28-0.39 ($\bar{x}$ = 0.33) times length of head, with middle tooth blunt; maxillary palpi moderately long.

Mesosoma (Figs. 2, 3) - 1.21-1.32 ($\bar{x}$ = 1.26) times longer than high, 1.63-1.90 ($\bar{x}$ = 1.76) times longer than wide; pronotum with a median pit; mesoscutum with dorsal pit, extensively smooth, shiny, with pubescence, although longer in its posterior 2/3, covering all its surface; notauli weak; prescutellar furrow simple; precoxal suture short, weak, slightly crenulated; metapleuron with extended pubescence, towards the posterior coxa; wrinkled propodeum cov-

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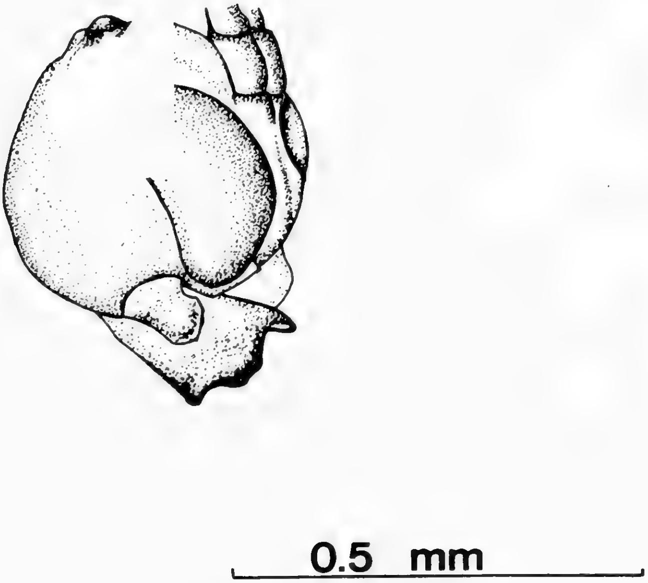
[1] Received February 12, 1997. Accepted April 10, 1997.

[2] Departamento de Biología Animal, Biología Celular y Parasitología. Facultad de Biología. Universidad de Valencia. C/Dr. Moliner, 50. Burjasot (Valencia). Spain.

[3] Unidad de Zoología. Facultad de Biología. Universidad de Salamanca. 37071-Salamanca. Spain.

ENT. NEWS 108(5) 382-388, November & December, 1997



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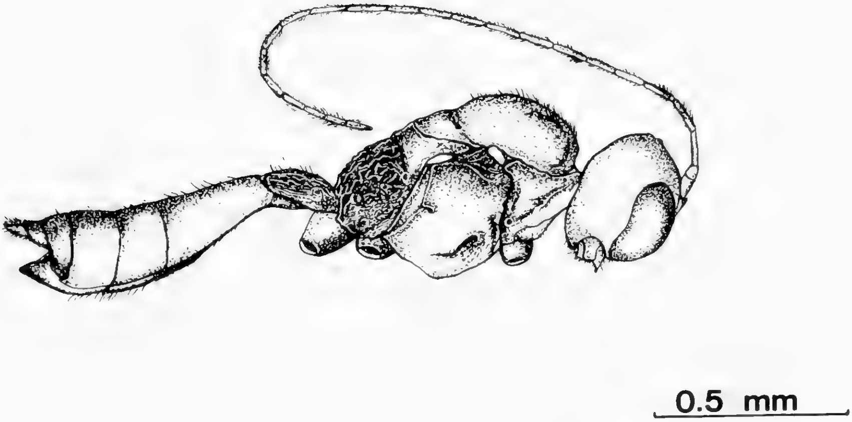

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Figures 1 and 2. *Dacnusa rodriguezi* sp. nov. 1. Head in lateral view, female; 2, Body (except legs and wings) in side view, female.

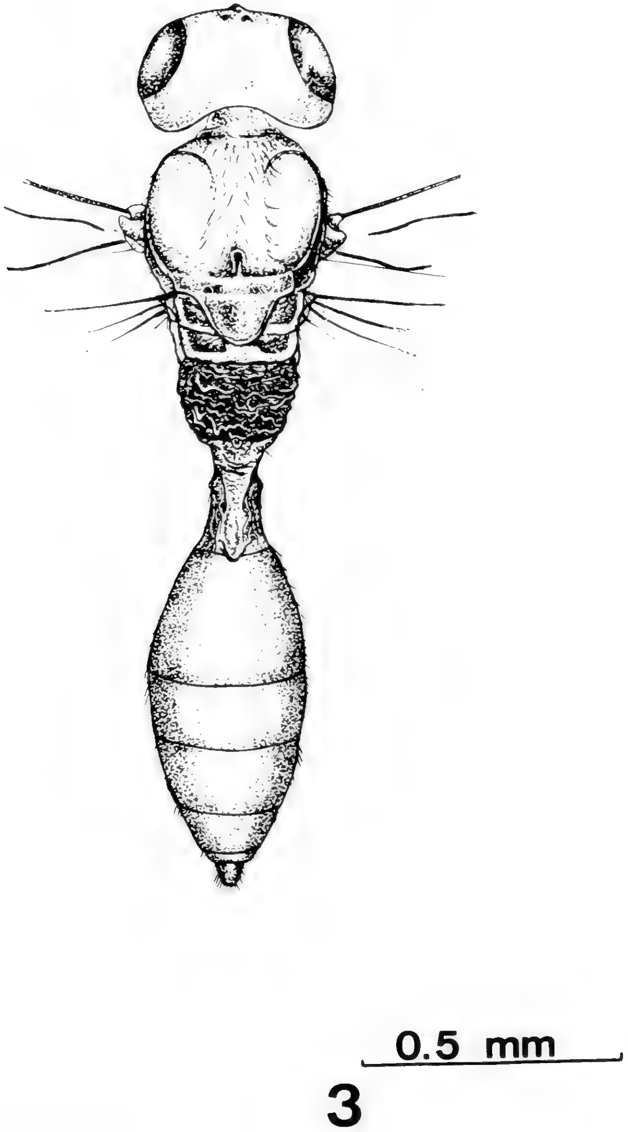

Figure 3. *Dacnusa rodriguezi* sp. nov. Body in dorsal view, female.

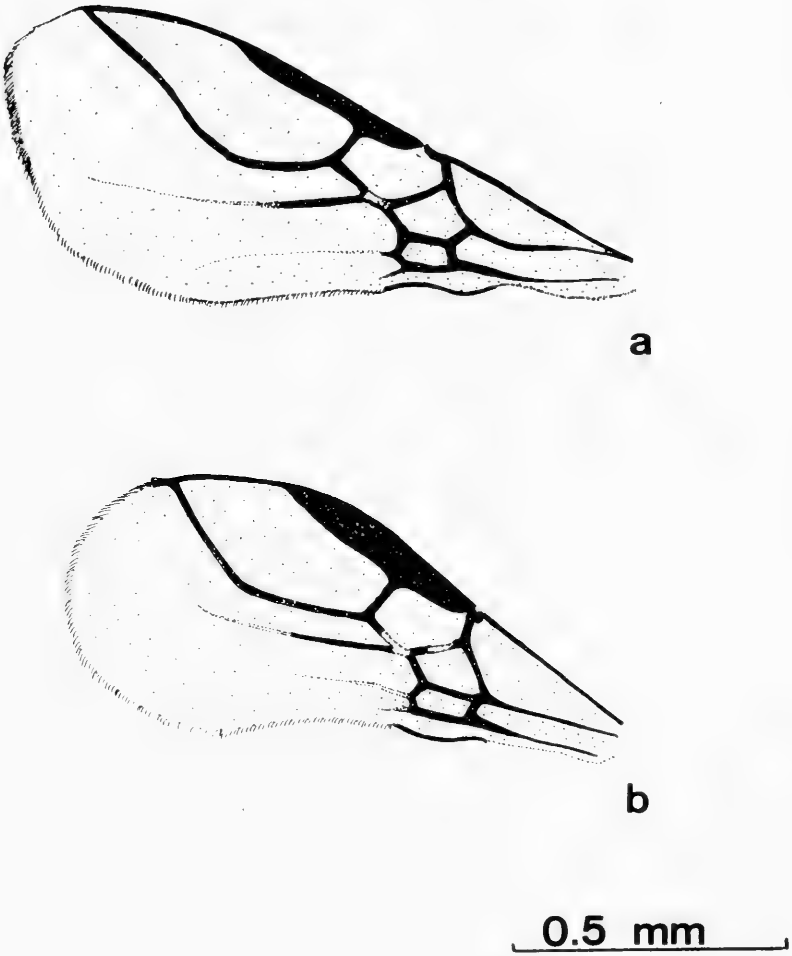

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Figure 4. *Dacnusa rodriguezi* sp. nov. 4a. Anterior right wing, female. 4b. Anterior right wing, male.

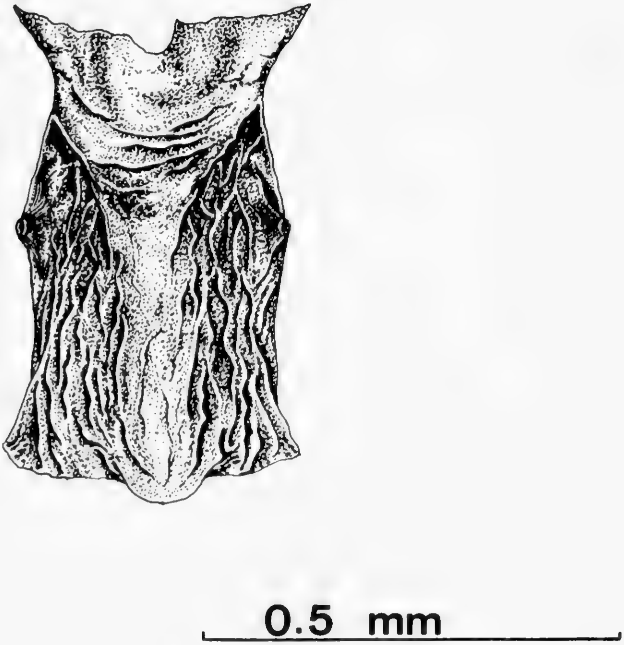

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Figure 5. *Dacnusa rodriguezi* sp. nov. First tergite in dorsal view, female.

ered with fine extended pubescence; hind tarsi shorter than hind tibia.

Wings (Figs. 4a) Pterostigma moderately wide and dark, 1.8-2.0 ($\bar{x}$ =1.9) times longer than metacarp; lm-cu distinctly antefurcal (Fig. 4); Rs sinuate.

Metasoma (Figs. 2, 3) - First tergite (Figs. 2, 3, 5) 1.3 times longer than wide apically; fairly glabrous, with a few fine setae laterally; tergite 3 smooth, without setae on its base; ovipositor sheath not extending beyond apical tergite in retracted position.

Color and size - Head, mesosoma and first tergite black; face black shiny; clypeus dark brown; labrum and palpi yellow; antennae dark brown, with yellowish brown scape, base of pedicel and annellus; centre of mandibles orange yellow; legs pale yellow, with slightly darkened tarsi; wings hyaline, with dark pterostigma; second and following tergites yellowish brown, becoming darker apically. Body length: 1.49-1.52 mm ($\bar{x}$ = 1.50 mm).

Male: Similar to female, but pterostigma wider and dark (Fig. 4b).

Material examined (deposited in the Fundación Entomológica "Juan de Torres Sala" (Docavo Collection) (Valencia, Spain)): SPAIN: Valencia: Játiva, 10-VII-1988 (date host capture)/26-29-XI-1988 (emergence date of the parasitoids): Holotype, female, from puparium of *C. horticola* (host)/on *Lactuca sativa* L. (hosts food-plant). Paratypes: 4 females, 3 males, from puparia of *C. horticola* /on *L. sativa*.

Etymology: This species is dedicated to José Antonio Rodriguez Docavo as a token of appreciation for his help in many entomological excursions.

Notes: This new species is most similar to *Dacnusa austriaca* (Fischer). *D. rodriguezi* sp. nov. is distinguished mainly by: a) mandibles weakly expanded, with middle tooth blunt; b) precoxal suture present; weakly crenulated; c) pterostigma much longer than metacarp, and d) first metasomal tergite black.

This species can be identified by using the keys of Tobias (1995: 226) with the following modifications:

Males

159 (144) Antennae 22-23 segmented. Mandibles 3-toothed, not expanded. First abdominal tergite dark brownish red, 1.7 times longer than wide apically. Stigma narrower than in *D. melicerta* (Fig. 140: 8). Sternauli absent. Body 1.3 mm. Parasite of *Liriomyza dracunculi* Hering, *L. artemisicola* de Meijere. Center, Central Ural; East Germany; Austria .... ***D. austriaca*** Fischer

159' (144) Antennae 20-22 segmented. Mandibles weakly expanded, with middle tooth blunt. First abdominal tergite black, 1.3 times longer than wide apically. Stigma (Fig. 4b). Sternauli present. Body 1.5 mm. Parasite of *Chromatomyia horticola* (Goureau). Spain .... ***D. rodriguezi* nov. sp.**

Females

214 (215) Antennae 21-24 segmented. Mandibles 3-toothed, not expanded. First abdominal tergite reddish dark brown, slightly pubescent, 1.7 times longer than wide apically. Stigma yellowish dark brown, parallel-sided, few longer than metacarp. Sternauli absent. Body 1.3 mm .... ***D. austriaca*** Fischer

214'(215) Antennae 20-22 segmented. Mandibles weakly expanded, with middle tooth blunt. First abdominal tergite black, fairly glabrous, 1.3 times longer than wide apically. Stigma dark brown, much longer than the metacarp (Fig. 4a). Sternauli present. Body 1.5 mm .. .. ***D. rodriguezi* nov. sp.**

The remaining species of Dacnusini that have been corroborated as parasitoids of *C. horticola* (Docavo et al., 1987, 1988, 1992; Griffiths, 1984; Spencer, 1973; Tormos et al., 1989) are: *Chorebus canariensis* Griffiths; *Ch. misellus* (Marshall); *Ch. nana* (Nixon); *Ch. sativi* (Nixon); *Dacnusa areolaris* (Nees von Esenbeck); *D. laevipectus* Thomson; *D. pubescens* (Curtis); *D. nipponica* Takada and *D. sibirica* Telenga. They can be separated from the new species described through the keys of Tobias (1995) and Fischer (1994).

Detailed information on the economic importance and the biology of *C. horticola* has been given by Spencer (1973, 1990).

We wish to thank C. van Achterberg (National Museum of Natural History, Leiden), G. Griffiths (University of Alberta), M. Fischer (Naturhistorisches Museum Wien), R. Wharton (Texas A&M University) and J. Papp (Hungarian Natural History Museum), for their observations and critical reading of the manuscript. We are also very grateful to Ana Sanchis for the drawings, and the Fundación Entomológica "Torres Sala" (Valencia, Spain) for their support in this study.

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CATOCALA LOUISEAE, C. GRISATRA AND *C. JAIR* (LEPIDOPTERA: NOCTUIDAE) IN NORTH CAROLINA[1]

W. J. Cromartie,[2] D. F. Schweitzer[3]

ABSTRACT: Three species of *Catocala* are newly recorded from North Carolina, all from the coastal plain in Bladen County. All are species previously known mainly from localities farther south. In addition, the status and distribution of *Catocala jair* are clarified.

The lepidopteran fauna of the outer coastal plain of North Carolina is relatively poorly documented. Recent efforts to obtain a more complete knowledge of this area, supported by The Nature Conservancy, the U.S. Forest Service and the North Carolina Natural Heritage Program, have found many species not previously collected in the state, including numerous species that are found mainly in the coastal plain farther south. Surveys in Bladen County, N.C., in 1992-1994, found three species of *Catocala* which fit this latter pattern and underscore the unusual diversity of this area. This report is based on occasional collecting by the first author. All surveys used blacklight, two bulbs (Sylvania 350 F15T8/350BL 15 watt) per trap or sheet, and most were run from dark until dawn. Sugar bait was used in 1992, but not in 1993 or 1994. Most *Catocala* specimens were taken at light.

A single somewhat worn but normal-looking male of *Catocala louiseae* Bauer was collected at a private nature area, 1 km south of Whitehall Road, Lake Creek Township, Bladen Co. on 2-3 July 1992 at blacklight. The other three closely related *Vaccinium* (Ericaceae)-feeding species of *Catocala,* five *C. gracilis* W.H. Edwards (including two form "lemmeri"), one *C. andromedae* (Guenée) and *C. sordida* Grote, were also taken at this site at blacklight. The first two were taken the same night as *C. louiseae;* the third had been taken on 28-29 May 1992. This is the first known instance of all four of these blueberry feeders occurring sympatrically. This record extends the documented range of *C. louiseae* at least 500 km to the northeast.

Two male *Catocala grisatra* Brower were collected at Susies Hill, a sand ridge north of Johnson Mill Bay in Bladen Lakes State Forest on 25-26 June 1993. The site was dry forest dominated by *Pinus palustris* Miller (Pinaceae), *Quercus laevis* Walter (Fagaceae) and *Q. incana* Bartram, with an understory that included *Crataegus* sp. (Rosaceae) along with lichens and poison sumac. This species is generally considered rare (Sargent 1976) and we know of no modern records outside of Florida, although the type locality is Athens, Georgia. *C. grisatra* feeds on *Crataegus.*

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[1] Received January 27, 1997. Accepted March 4, 1997.

[2] Faculty of Natural Sciences and Mathematics, Richard Stockton College, Pomona NJ 08240.

[3] The Nature Conservancy, 1761 Main St., Port Norris NJ 08349.

In 1993 and 1994, *Catocala jair* Strecker was collected at blacklight on the north side of Singletary Lake, just inside the state park boundary: 28-29 June 1993, four males; 25-26 June 1994, one male; 27-28 June 1994, five males. The site was a recently-burned, very xeric, white sand ridge, dominated by medium size *P. palustris* and small (1-3 m) *Q. laevis,* with a very sparse understory of shrubs, grasses and forbs. J. B. Sullivan has also collected three similarly dark *C. jair* in xeric oak scrub in New Hanover County, N.C. on 31 May 1994 and 3 June 1995 (J.B. Sullivan, pers. comm., determinations by Schweitzer). All North Carolina specimens are very dark, similar to the New Jersey specimen illustrated by Sargent (1976, plate 8, fig. 27). Two have the postmedian line very straight, like many Florida specimens (Sargent 1976, plate 8, fig. 26). Sargent was uncertain whether such dark specimens were conspecific with *C. jair.* Similar dark specimens are found in older collections, mostly from Texas. Smith (1910) reported *C. jair* from New Jersey, but most subsequent authors have discounted this record.

We believe all these specimens are indeed *C. jair.* The genitalia, which are fairly distinctive, are apparently identical in Florida and New Jersey specimens, particularly the females (Schweitzer, pers. obs.). Several broods of larvae from Citrus County, Florida, and Burlington County, New Jersey, have been reared by Dale Schweitzer. Larvae from the two states were virtually identical and easily distinguished from those of related species. The habitat in New Jersey is also xeric, sandy oak scrub, and larvae occur on shrubby oaks, *Q. marilandica* Muenchhausen and *Q. ilicifolia* Wangenheim (Schweitzer, pers. obs.). *Quercus laevis* seems likely to be a foodplant in North Carolina.

We believe that these three species have probably not expanded their ranges recently. The most likely explanation of our findings is that they have simply been overlooked due to limited collecting, specialized habitats, or, in the case of *C. grisatra,* general rarity. For *C. jair,* specimens from New Jersey date back to at least the 1930's, so range expansion is highly improbable.

Most *Catocala* specimens, including the *C. louiseae* and one *C. grisatra,* will be deposited in the North Carolina State Museum collection, along with other Lepidoptera from these surveys.

ACKNOWLEDGMENTS

We thank the late Aubrey Shaw and the staff of Bladen Lakes State Forest and Singletary Lake State Park for permission to collect. Dr. Cromartie received funding from the Stockton Research and Professional Development Committee in 1992.

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Sargent, T.D. 1976. Legion of night. The underwing moths. Univ. Mass. Press, Amherst, MA. xiii + 222 pp.

Smith, J.B. 1910. Insects of New Jersey. Report N.J. State Mus. for 1909. Trenton, NJ. pp 15-888.

STATEMENT OF OWNERSHIP, MANAGEMENT & CIRCULATION

1. Title of publication: ENTOMOLOGICAL NEWS
2. Date of filing September 16, 1997.
3. Frequency of issue: Bimonthly (every other month) except July and August
4. Location of known office of publication: 232 Oak Shade Rd., Tabernacle Twp., Vincentown PO, New Jersey 08088
5. Location of the headquarters or general business offices of the publishers: 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103-1195
6. Name and address of publisher, editor and managing editor:
   Publisher: American Entomological Society, 1900 Benjamin Franklin Parkway, Philadelphia. PA. 19103-1195. Editor; Howard P. Boyd, 232 Oak Shade Rd Tabernacle Twp, Vincentown PO, New Jersey, 08088
7. Owner: American Entomological Society, 1900 Benjamin Franklin Parkway, Philadelphia. PA 19103-1195
8. Known bondholders. mortgagees and other security holders owning or holding one percent or more of total amount of bonds, mortgages and other securities: None
9. For optional completion by publishers mailing at the regular rates: signed
10. For completion by nonprofit organizations authorized to mail at special rates: The purpose, function and nonprofit status of this organization and the exempt status for Federal income tax purposes:
    Have not changed during preceding 12 months (checked)

11. EXTENT AND NATURE OF CIRCULATION	Average No. Copies Each Issue During Preceding 12 Months	Actual Number of Copies of Single Issue Published Nearest to Filing Date
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C. TOTAL PAID CIRCULATION	640	624
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E. TOTAL DISTRIBUTION	640	624
F. OFFICE USE. LEFTOVER. UNACCOUNTED, SPOILED AFTER PRINTING.	160	176
G. TOTAL	800	800

12. I certify that the statements by me above are correct and complete. Signed: Howard P. Boyd, editor.

MAILING DATES
VOLUME 10~~4~~.1993
8

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2	Mar.& Apr.	77-160	May 6, 1997
3	May & June	161-244	July 31, 1997
4	Sept. & Oct.	245-320	Sept. 16, 1997
5	Nov. & Dec.	321-396	Nov. 3, 1997

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ENT. NEWS 108(5): 392-396, November & December 1997

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